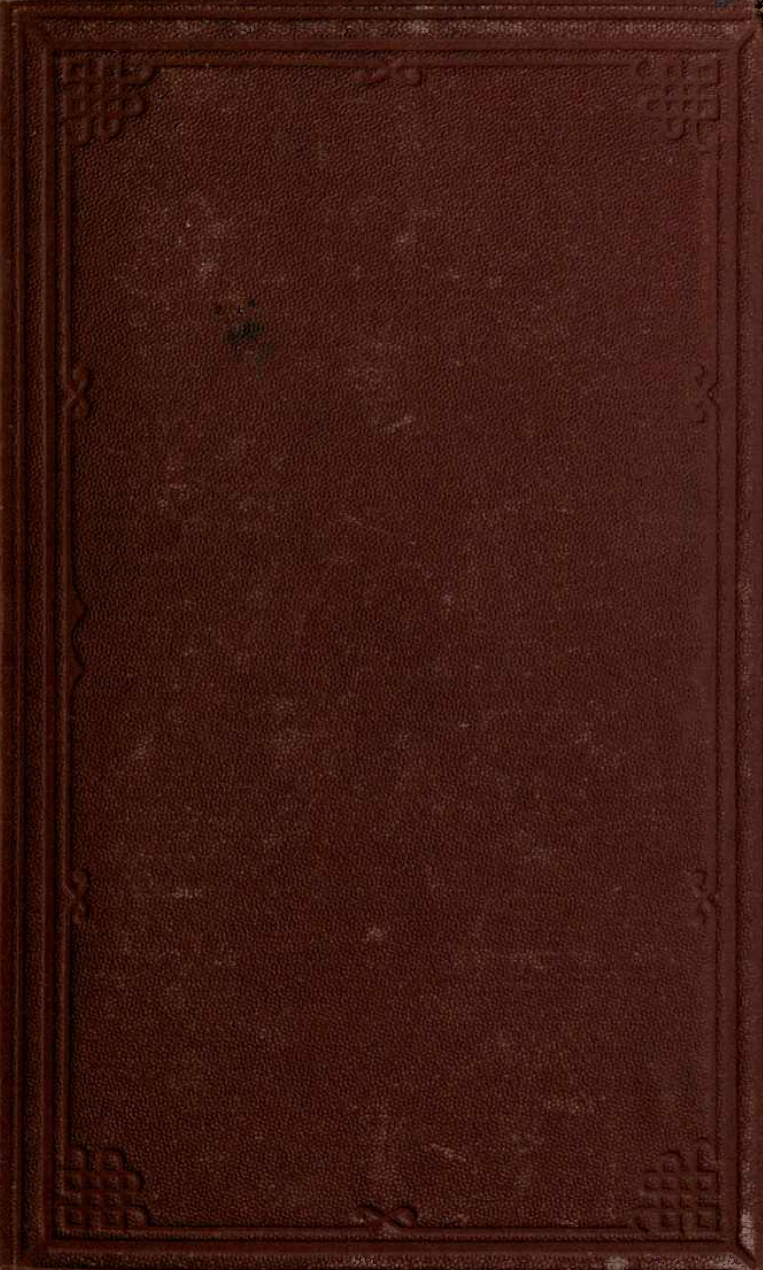

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A MANUAL

OF

PHOTOGRAPHY

FOUNDED ON

HARDWICH'S PHOTOGRAPHIC CHEMISTRY

BY

GEORGE DAWSON, M.A., PH.D.

LECTURER ON PHOTOGRAPHY IN KING'S COLLEGE, LONDON

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PREFACE.

It will be necessary to make a few remarks by way of Preface to this edition of Mr. Hardwich's treatise on Photography. The short compendium of general Chemistry has been omitted, because this Science can be better studied from the more comprehensive works on that subject which now abound. Indeed, a knowledge of Chemistry is not essential to the practical Photographer, for it is only on very exceptional occasions that he will be called on to prepare any of his own Chemicals. At the same time it is deemed desirable to give a Vocabulary, mentioning the nature and properties of the various substances used in Photography, except when these are described in the body of the work.

Further it will be observed, that all Hypothetical speculations, or suppositions, respecting the action of Light on certain bodies submitted to its influence, have been expunged. Sometimes when an undoubted explanation could be given of certain phenomena, that explanation has been made so far as is consistent with well ascertained facts.

The main object of the Editor has been to give practical instruction in our fascinating art, to lead up the novice from first principles to the higher branches, and to impress the value of care and exactitude in every operation.

A considerable portion of Mr. Hardwich's practical instructions have been retained, simply because the Editor could not improve upon such examples of clear description and minute detail. For the rest, he is content to rely on the verdict of his brother Photographers.

The Editor takes this opportunity of acknowledging his great obligations to several gentlemen for valuable hints, and to others for material assistance in the treatment of subjects with which they are more familiar than himself.

GEORGE DAWSON.

KING'S COLLEGE, *February*, 1873.

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HISTORICAL SKETCH OF PHOTOGRAPHY.

The Art of Photography, which has now attained such perfection, and has become so popular amongst all classes, is one of comparatively recent introduction.

The word Photography means literally "writing by means of Light;" and it includes all processes by which any kind of picture can be obtained by the chemical agency of Light, without reference to the nature of the sensitive surface upon which it acts.

The philosophers of antiquity, although chemical changes due to the influence of Light were continually passing before their eyes, do not appear to have directed their attention to them. Some of the *Alchemists* indeed noticed the fact that a substance termed by them "Horn Silver," which was Chloride of Silver which had undergone fusion, became *blackened* by exposure to Light; but their ideas on such subjects being of the most erroneous nature, nothing resulted from the discovery.

The first philosophical examination of the decomposing action of Light upon compounds containing Silver was made by the illustrious Swedish chemist, Scheele, in the year 1777. It was remarked by him that the maximum chemical or decomposing effect of the spectrum lay near the *violet* part and gradually diminished towards the red. He also attributed the blackening of Chloride of Silver by light to the liberation of Chlorine and the formation of Hydrochloric acid. Both these statements have been proved to be true. Scheele's experiments terminated here, but they do not seem to have attracted that attention which they deserved. In fact, they were looked upon as more curious than useful.

Earliest application of these Facts to purposes of Art.—The first attempts to render the blackening of Silver Salts by Light available for artistic purposes were made by Wedgwood and Davy, and published in 1802. But it is evident that the experiments must have been made several years previously, as Wedgwood had been dead several years before that date. A sheet of white paper or of white leather was saturated with a solution of Nitrate of Silver, and the *shadow* of the figure intended to be copied projected upon it. Under these circumstances the part on which the shadow fell remained white, whilst the surrounding exposed parts gradually darkened under the influence of the sun's rays.

Unfortunately these and similar experiments, which appeared at the outset to promise well, were checked by the experimentalists being unable to discover any means of fixing the pictures, so as to render them indestructible by diffused Light. The unchanged Silver Salt being permitted to remain in the white portions of the paper, naturally caused the proofs to blacken in every part, unless carefully preserved in the dark.

It is singular that these distinguished philosophers, finding *leather* to be the most sensitive medium, did not hit on the cause, viz., Tannin or Gallic acid.

The sensitive surfaces employed by Wedgwood and Davy could not be impressed in the Camera, although, it would appear, the attempt was made. Davy, however, succeeded in getting a faint impression in the solar microscope, where the image was much condensed in size.

Wedgwood and Davy's plan of throwing the shadow of the object to be copied on to a medium sensitive to Light forcibly reminds us of the origin of Portrait painting as given by an ancient Roman writer.

"Corinthi puella, capta amore juvenis, illo abeunte peregre, umbram ex facie ejus ad lucernam in pariete lineis circumscripsit. Talis picturæ fuit origo."

Whether this was the origin of painting or not is a matter which cannot now be determined; but we know, from authentic evidence, that this was exactly the plan adopted by Wedgwood and Davy in their earlier experiments on Photography. The only difference is, that these eminent Philosophers used *Nature's pencil* to delineate the object, and not a crayon worked by hand.

Introduction of the Camera Obscura, and other Improvements in Photography.—The "Camera Obscura," or darkened chamber, by means of which a luminous image of an object may be formed, was invented by Baptista Porta, of Padua; but the preparations employed by Wedgwood were not sufficiently sensitive to be easily affected by the subdued light of that instrument.

In the year 1814, however, twelve years subsequent to the publication of Wedgwood's paper, M. Niépce, of Châlons, having directed his attention to the subject, succeeded in perfecting a process in which the Camera could be employed, although the sensibility was still so low that an exposure of some hours was required to produce the effect.

In the process of M. Niépce, which was termed "Heliography," or "sun-drawing," the use of the Silver Salts was discarded, and a resinous substance, known as "Bitumen of Judæa," substituted. This resin was smeared on the surface of a metal plate, and exposed to the luminous action. The light in acting upon it so changed its properties, that it became *insoluble* in certain essential oils. Hence, on subsequent treatment with the oleaginous solvent, the *shadows* dissolved away, and the *lights* were represented by the unaltered resin remaining on the plate.

There are several specimens of Niépce's original process in the British Museum; some of which also show his attempts at etching by the same process.

The Discoveries of M. Daguerre.—MM. Niépce and Daguerre appear at one time to have been associated as partners, for the purpose of mutually prosecuting their researches; but it was not until after the death of the former, viz. in 1839, that the process named the Daguerreotype was given to the world. Daguerre was dissatisfied with the slowness of action of the Bitumen sensitive surface, and directed his attention mainly to the use of the Salts of Silver, which are thus again brought before our notice.

Even the earlier specimens of the Daguerreotype, although far inferior to those subsequently produced, possessed a beauty which had not been attained by any Photographs prior to that time.

The sensitive plates of Daguerre were prepared by exposing a silvered tablet to the action of the vapour of *Iodine*, so as to form a layer of Iodide of Silver upon the surface. By a short exposure in the Camera an effect was produced, not visible to the eye, but appearing when the plate was subjected to the vapour of Mercury. This feature, viz., the production of a *latent* image upon Iodide of Silver, with its subsequent development by a chemical reagent, is one of the first importance. Its discovery at once reduced the time of taking a picture from hours to minutes, and promoted the utility of the Art.

Daguerre also succeeded in partially fixing his proofs by removal of the unaltered Iodide of Silver from the shadows; but it was not till some years afterwards that attention was called to Herschel's researches on the Hyposulphites. These contributions to Chemical science were published in the course of the year 1821, in "The Edinburgh Philosophical Journal." He not only investigated the Chemical composition of the soluble Hyposulphites, but also their power of dissolving the Haloid Salts of Silver, within certain limits, when double salts were formed. These also he chemically formulated and described. Strange as it may appear, Herschel's discoveries escaped the attention of our early Daguerreotypists and workers by the Talbotype process.

On a means of Multiplying Photographic Impressions, and other Discoveries of Mr. Fox Talbot.—The first communication made to the Royal Society by Mr. Fox Talbot, in January 1839, related to the preparation of a more sensitive paper than had been previously known, and also to a method of fixing the pictures by common Salt. It was directed that the paper should be first dipped in Solution of Chloride of Sodium, and then in Nitrate of Silver. By proceeding in this way a white substance termed *Chloride of Silver* is formed, more sensitive to light than the Nitrate of Silver originally employed by Wedgwood and Davy. The object is laid in contact with the prepared paper, and being exposed to light, a copy is obtained, which is *Negative*, —*id est*, with the light and shade reversed. The discovery of a way of fixing these Negatives was of great importance, as it not only rendered them unalterable by light, but it further allowed of their being used to obtain copies having the light and shade correct, or *Positive* copies, which was effected by laying the Negative over a second sheet of prepared sensitive paper, so as to allow the sun's light to pass through the transparent parts. Under these circumstances, when the Negative is raised, a natural representation of the object is found below, the tints having been again reversed by the second operation.

This production of a Negative Photograph, from which any number of Positive copies may be obtained, is a cardinal point in Mr. Talbot's invention, and one of great importance.

Another most important discovery was that of the existence of an invisible image impressed on the paper by a much shorter exposure to light than was necessary to produce a visible one, and capable of being afterwards rendered visible. Mr. Talbot took out a patent for a process of this kind in 1841. Mr. Brayley had, however, as early as 1839, described in a lecture at the

London Institution a similar method communicated to him by the Rev. Mr. Reade. Mr. Talbot's process was, however, a decided advance on the former, in consequence of his employing Acetic Acid to check action not due to light. In this process, a sheet of paper is first coated with Iodide of Silver by soaking it alternately in Iodide of Potassium and Nitrate of Silver; it is then washed with solution of Gallic Acid, containing Nitrate of Silver and Acetic Acid (sometimes termed *Gallo-Nitrate of Silver*), by which the sensibility to light is greatly augmented. An exposure in the Camera of some seconds or minutes, according to the brightness of the light, impresses an invisible image, which is brought out by treating the plate with a fresh portion of the mixture of Gallic Acid, Nitrate of Silver, and Acetic Acid employed in exciting.

On the use of Glass Plates to retain sensitive Films.—The principal defects in the Calotype process are attributable to the coarse and irregular structure of the fibre of paper, even when manufactured with the greatest care, and expressly for Photographic purposes. In consequence of this, the same amount of exquisite definition and sharpness of outline as that resulting from the use of metal plates cannot be obtained.

We are indebted to Sir John Herschel for the first employment of glass plates to receive sensitive Photographic films.

The Iodide of Silver may be retained upon the glass by means of a layer of Albumen or white of egg, as proposed by M. Niépce de Saint-Victor, nephew to the original discoverer of the same name.

A more important improvement still was the employment of "Collodion" for a similar purpose.

Collodion is an ethereal solution of Pyroxyline, a weakly explosive variety of Gun-cotton. On evaporation it leaves a transparent layer, resembling gold-beater's skin, which adheres to the glass with some tenacity. M. Le Grey, of Paris, originally suggested that this substance might perhaps be rendered available in Photography, but our own countryman, the late Mr. Archer, was the first to carry the idea out practically. In a communication to "The Chemist," in the autumn of 1851, this gentleman gave a description of the Collodion process much as it now stands; at the same time proposing the substitution of *Pyro*-gallic Acid for the Gallic Acid previously employed in developing the image.

At that period no idea could have been entertained of the stimulus which this discovery would render to the progress of the Art; but experience has now abundantly demonstrated that, as far as all qualities most desirable in a Photographic process are concerned, none at present known can excel, or perhaps equal, the Collodion process.

Parallel with the above Photographic discoveries were others in a different direction, and these, at the present day, are exercising a vast influence on commercial Photography. In the year 1839, Mr. Mungo Ponton announced to "The Royal Scottish Society of Arts" that Bichromate of Potash might be used to sensitize paper. The parts exposed to light became of a dark orange tint, which was insoluble in water; while the yellow colour, not acted on by light, could be removed by washing in water.

The full significance of this discovery was not appreciated till Mr. Fox Talbot afterwards showed that it was only in combination with organic matter that this salt was sensitive to light at all. In the year 1852 he took out a patent for the use of a Bichromate and Gelatine for a new process of engraving on steel. This is the foundation of almost all the Photo-engraving and Photo-lithographic processes of the present day, besides others of still greater importance in Photographic printing.

In 1855 M. Poitevin patented a Carbon printing process founded on this principle. He dabbed over a sheet of paper a mixture of Bichromate of Potash, Gum Arabic, and finely divided charcoal. When dry, it was exposed to light under a negative, and then placed in water. The parts unacted on by light were washed away, leaving the white paper exposed. The rest remained unchanged. This was the first Carbon-printing process, which, by judicious improvements, bids fair to supersede sun-printing by means of the salts of Silver.

When a large number of prints are required, no mode is comparable to the Collo-type process, which has now reached a high state of perfection. By this method the half-tones of a Negative are most perfectly rendered, while the rapidity of production is vastly increased.

PHOTOGRAPHIC PRACTICE.

PRELIMINARY EXPERIMENTS.

THE ACTION OF LIGHT ON THE SALTS OF SILVER USED IN PHOTOGRAPHY.

Nitrate of Silver.—The Nitrate of Silver is one of the most permanent of the Silver Salts. It may be preserved unchanged in the crystalline form, or in solution in distilled water, for an indefinite length of time, even when constantly exposed to the light of day.

Nitrate of Silver may, however, be rendered susceptible to the influence of Light, by adding to its solution *organic matter*, vegetable or animal. The phenomena produced in this case are well illustrated by dipping a sheet of white paper in solution of Nitrate of Silver, and exposing it to the direct rays of the sun; it slowly darkens, until it becomes nearly black. The stains upon the skin produced by handling Nitrate of Silver are caused in the same way, and are seen most evidently when the part has been exposed to light.

The varieties of organic matter which especially facilitate the blackening of Nitrate of Silver are such as tend *to absorb Oxygen ;* hence pure vegetable fibre, free from Chlorides, such, for instance, as the Swedish filtering-paper, is not rendered very sensitive by being simply brushed with solution of the Nitrate, but a little grape sugar added soon determines the decomposition.

Decomposition of Chloride, Bromide, and Iodide of Silver by Light.—Pure Chloride of Silver prepared in the moist way changes slowly from white to *violet* on exposure to light. Bromide of Silver becomes of a grey colour, but it is less affected than the Chloride. Iodide of Silver (if free from excess of Nitrate of Silver) does not alter in appearance by exposure even to the sun's rays, but retains its yellow tint unchanged. Of these three compōunds therefore, *Chloride* of Silver is the most visibly acted on by light, and papers prepared with this salt will become far darker on exposure, than others coated with Bromide or Iodide of Silver.

There are certain conditions which render the action of light upon the Chloride of Silver more decided. These are, first, *an excess of a soluble salt of Silver such as the Nitrate*, and second, *the presence of organic matter*. Pure Chloride of Silver would be useless as a Photographic agent, but a Chloride with excess of Nitrate takes a strong impression. Even Iodide of Silver, ordinarily unaffected, is darkened by light when moistened with a solution of the Nitrate of Silver.

Organic matter combined with Chloride and Nitrate of Silver gives a still higher degree of darkening in the solar ray, and in this way Photographic printing papers are prepared.

Action of Light upon Organic Compounds of Silver.—On adding diluted Albumen, or white of egg, to solution of Nitrate of Silver, a flocculent deposit forms, which is a compound of the animal matter with Oxide of Silver, and is known as "Albuminate of Silver." This substance is at first white, but on exposure to light it assumes a brick-red colour.

Caseine, the animal principle of milk, is precipitated by Nitrate of Silver, the product behaving in the same manner as the Albuminate when exposed to light. Gelatine does not precipitate Nitrate of Silver; but if a sheet of transparent Gelatine be allowed to imbibe a solution of the Nitrate, they enter into combination and the product becomes of a clear ruby-red tint on exposure to light.

Many other organic compounds of Silver are darkened by light. The white Citrate of Silver changes to a red colour. Glycyrrhizin, the Sugar of Liquorice, also forms a white compound with Oxide of Silver, which becomes brown or red in the sun's rays.

SIMPLE EXPERIMENTS ILLUSTRATING THE ACTION OF LIGHT UPON A SENSITIVE LAYER OF CHLORIDE OF SILVER ON PAPER.

In the performance of the most simple experiments on the decomposition of Silver Salts by Light, the student may employ ordinary *test-tubes*, in which small quantities of the two liquids required for the double decomposition may be mixed together.

When however *concentrated* solutions are used in this way, the insoluble Silver Salt falls in dense and clotted masses, which, exposed to the sun's rays, quickly blacken on the exterior, but the inside is protected, and remains white. It is of importance therefore in Photography that the sensitive material should exist in the form of *a surface*, in order that the various particles of which it is composed may each one individually be brought into relation with the disturbing force.

Full directions for the preparation of sensitive Photographic paper are given farther on. The following is the theory of the process:—A sheet of paper is treated with solution of Chloride of Sodium or Ammonium, and subsequently with Nitrate of Silver; hence results a formation of Chloride of Silver in a fine state of division, with an excess of Nitrate of Silver, since the Silver bath is applied *after* the salting solution, and is made purposely of a greater strength.

Illustrative Experiment No. I.—Place a square of sensitive paper, prepared as above, in the direct rays of the sun, and observe the gradual process of darkening which takes place; the surface passes through a variety of changes in colour until it becomes of a deep chocolate-brown. If the light is tolerably intense, the brown shades are probably reached in from three to five minutes; but the sensibility of the paper, and also the nature of the tints, will vary much with the character of the organic matter present.

Experiment No. II.—Lay a device cut from black paper upon a sheet of sensitive paper, and compress the two together by means of a sheet of glass. After a proper length of exposure the figure will be exactly copied with the tint reversed: the black paper protecting the sensitive Chloride beneath, produces a *white* figure upon a dark ground.

Experiment No. III.—Repeat the last experiment, substituting a piece of lace or gauze-wire for the paper device. This is intended to show the minuteness with which objects can be copied, since the smallest filament will be distinctly represented.

Experiment No. IV.—Take an engraving in which the contrast of light and shade is tolerably well marked, and having laid it closely in contact with the sensitive paper, expose as before. This experiment shows that the surface darkens in degrees proportionate to the intensity of the light, so that the *half* shadows of the engraving are accurately maintained, and a pleasing gradation of tone is produced.

In the darkening of Photographic papers, the action of the light is quite superficial, and although the black colour may be intense, yet the amount of reduced Silver which forms it is so small that it cannot be conveniently estimated by chemical reagents. It becomes therefore of great importance in preparing sensitive paper to attend to the condition of the surface layer of particles, the action rarely extending to those beneath. The use of Albumen, Gelatine, etc., which will be explained hereafter, has reference to this amongst other advantages, and secures a better and more sharply defined print.

The action of Light on Chloride of Silver may be studied by suspending pure Chloride of Silver in distilled water and exposing to the sun's rays for several days. When the process of darkening has proceeded to some extent the supernatant liquid will be found to contain Hydrochloric Acid formed by the disengaged Chlorine combining with the Hydrogen of the water. Whether a complete separation of the two elements Chlorine and Silver can thus be effected by prolonged exposure to actinic light is a disputed question which need not be discussed here.

Experiments illustrating the Formation of an Invisible Image.—Take a sheet of sensitive paper, prepared with Iodide of Silver (for details *see* Talbotype), and having divided it into two parts, expose one of them to the luminous rays for a few seconds. No visible decomposition takes place, but on removing the pieces to a room dimly illuminated, and brushing with a solution of *Gallic Acid*, a manifest difference will be observed; the one being unaffected, whilst the other darkens gradually until it becomes black.

Experiment II.—A prepared sheet is shielded in certain parts by an opaque substance, and then after the requisite exposure, which is easily ascertained by a few trials, treated with the Gallic Acid as before; in this case the protected part remains white, whilst the other darkens to a greater or less extent. In the same way, copies of leaves, engravings, etc., may be made, very correct in the shading, and much resembling those produced by the prolonged action of light alone upon the Chloride of Silver.

A great economy of time is effected by employing a substance like Gallic Acid to *develop* or bring out to view an invisible image, in preference to forming the picture by the direct action of light, unassisted by a developer. This is well shown in the results of some experiments conducted by M. Claudet in the Daguerreotype process: he found that with a sensitive layer of Bromo-Iodide of Silver, an intensity of light three thousand times greater was required if the use of a developer was omitted, and the exposure continued until the picture became visible upon the plate.

To increase the sensitiveness of Photographic preparations is a point of great consequence; and indeed, when the Camera is used, from the low intensity of the luminous image formed in that instrument, no other plan than the one above described would be practicable. Hence the advancement, and indeed the very origin, of the Photographic Art, may be dated from the first discovery of a process for bringing out to view an invisible image by means of a reducing agent.

Developing or reducing Agents.—These are all deoxydizing substances of a more or less powerful kind. Hence it is presumed that they act by virtue of this power of removing oxygen from compound bodies, under certain conditions. The developers used in Photography are Gallic and Pyrogallic Acids, and Protosulphate of Iron. Their preparation and properties are described in the Vocabulary of Chemicals under their respective headings.

It must not be supposed, however, that all images developed on Salts of Silver are necessarily metallic. In many instances the reduction seems to stop short of this, resulting in a compound intermediate between silver and the original salt. This is especially the case when organic compounds of silver form the sensitive medium.

Presence of Free Acids, etc., in Development.—Acids exercise a retarding effect upon the reduction of Salts of Silver by the developing agents, and especially acids, like Nitric or Sulphuric Acid, which have strong affinities for bases. Solution of Pyrogallic Acid mixed with Nitrate of Silver produces a deposit immediately, and Salts of Iron will also separate Silver before long; but if a little Acetic Acid be previously added, the precipitation is more gradual, and when both solutions are strongly acidified with Nitric Acid, it is for a time suspended. On the other hand, *alkaline* liquids produce an opposite effect, and favour quick reduction.

Fixing Agents.—A sensitive layer of Chloride or Iodide of Silver on which an image may be formed, either with or without the aid of a developing agent, must pass through further treatment in order to render it indestructible by diffused light. The image itself is sufficiently permanent, and cannot be said, in correct language, to need *fixing;* but the unchanged Silver Salt which surrounds it, being still sensitive to light, tends to be decomposed in its turn, and by darkening, to obliterate the picture.

In order that any body may be employed with success as a fixing agent, it is required not only that it should dissolve unchanged Chloride or Iodide of Silver, but that it should produce no injurious effect upon the image. A solvent action upon the image is most liable to happen when the agency of light alone, without a developer has been employed: in that case the darkened surface, not being reduced perfectly to the metallic state, remains soluble to a certain extent in the fixing liquid.

Ammonia.—Ammonia dissolves Chloride of Silver readily, but not Iodide of Silver: hence its use is necessarily confined to the direct sun proofs upon paper. Even these, however, cannot advantageously be fixed in Ammonia unless a deposit of *Gold* has been previously produced upon the surface by a process of "toning," presently to be explained; an unpleasant *red tint* is always caused by Ammonia acting upon the darkened material of a sun picture as it comes from the printing-frame.

The principal objections to the use of Ammonia as a fixing agent are its pungent odour, and also the fact that it is scarcely strong enough in its affinities to dissolve the Oxide of Silver when associated with Albumen and similar bodies.

Chloride and Iodide as Fixing Agents.—The Chlorides of Potassium, Ammonium, and Sodium possess the property of dissolving a small portion of Chloride of Silver. In the act of solution a *double salt* is formed, a compound of Chloride of Sodium with Chloride of Silver, which may be crystallized out by allowing the liquid to evaporate spontaneously. The earlier Photographers employed a saturated solution of common Salt for fixing paper prints; but the fixing action of the Alkaline Chloride is very slow and imperfect.

The Iodide of Potassium has been used as a fixing agent for Iodide of Silver. It dissolves it by forming a double salt in the manner before described.

It is important to remark in the solution of the insoluble Silver Salts by Alkaline Chlorides, Iodides, etc., that the amount dissolved is not in proportion to the *quantity* of the solvent, but to the degree of concentration of its aqueous solution. The reason is that the double salt formed is *decomposed* by a large quantity of water. Hence it is only a saturated solution of Chloride of Sodium which possesses any considerable power of fixing; and with the Iodide of Potassium the same rule holds good—the stronger the solution the more Iodide of Silver will be taken up by a given weight. The addition of water produces milkiness and a deposit of the Silver Salt previously dissolved.

Hyposulphite of Soda as a Fixing Agent.—Hyposulphite of Soda is an energetic solvent of the haloid silver salts, and is the salt most commonly used by photographers for the purpose of fixing images. When Hyposulphite of Soda is used for fixing *negative* images no precautions need be taken to keep it from free acid and consequent decomposition, because a slight amount of Sulphurous or Sulphuric Acids which are part of the products of decomposition do not seem, during the short time they are in contact with the developed image on collodionized glass, to exercise any prejudicial effect. On the other hand, when *positive* images on paper are *fixed* with this agent, too much care cannot be exercised in keeping this easily decomposed body clear from all extraneous acids, and also from substances such as Nitrate of Silver, which acts as an acid and sets free Sulphur and also Sulphurous Acid. Both of these are most baneful to prints on Silver-chlorized paper. The best way of avoiding such decompositions will be described in the practical portion of this work treating of Positive Printing.

Cyanide of Potassium as a Fixing Agent.—This salt is most energetic in dissolving the *haloid* salts of silver, far more so than Hyposulphite of Soda. It is generally used for *fixing* negatives and positives developed on collodionized glass, but, on account of its very powerful action on sub-salts or organic salts of silver, is totally unsuited for fixing Positives on paper. Even when a developer has been used, unless the solution of Cyanide is tolerably dilute, it is apt to attack the image, converting it superficially into Cyanide of Silver, and then dissolving it in the form of a double Cyanide of Potassium and Silver. The solvent powers of this Cyanide on metallic silver are greatly increased by the addition of a little Iodine to its aqueous solution. A colourless liquid is thus obtained which has been termed "Iodo-cyanide of Potassium."

Sulphocyanides as Fixing Agents.—Sulphocyanides of Potassium and Ammonium have been proposed, and to some extent used, as fixing agents for positives on paper. They resemble the alkaline chlorides used for this purpose, inasmuch as their solvent power *depends on the degree of concentration of the solution*, but they greatly exceed the latter salts in their power of dissolving the insoluble Salts of Silver, when strong solutions are used.

Though inferior to Hyposulphites in this varying degree of solvent power, they have the advantage of imparting no Sulphur to the print, and they preserve the tones clear and free from mealiness.

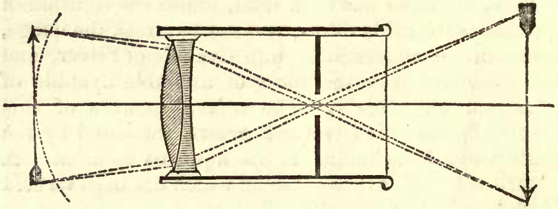
Photographic Objectives or Lenses.

It would swell the pages of this Manual beyond the allotted bounds to discuss the nature and properties of Light and the principles involved in the construction of Photographic lenses or objectives. For a full description of these the reader is referred to Dr. Monckhoven's special treatise on "Photographic Optics."* It will be sufficient to indicate here the various forms of lenses and the sort of work for which each is best adapted.

THE SINGLE ACTINIC VIEW LENS.

The following diagram will serve to explain the construction of this lens.

The glass is an Actinic meniscus, placed with its concave side towards the object. In front of the lens, and at a distance from it equal to a fifth part of its focal length, are fixed a series of diaphragms, the largest being employed for subjects nearly in one plane; and the smaller for those embracing both foreground and distance.



This form of lens is dependent entirely upon the *stop or diaphragm* for correct action, and could not be used with the full aperture. For in the first place the spherical aberration is only partially overcome by the curves given to the two glasses used in actinizing, and hence a residual error which must be corrected by the stop. Secondly, the curvature of field is so considerable, that only a small surface could be covered *flat* by the lens of full aperture. It is for the purpose of dealing with this latter error that the diaphragms are fixed in so peculiar a position with reference to the glass. By referring to the diagram it will be seen that the effect of a stop placed at a distance in front of the lens is to direct the oblique rays, represented in the

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* Robert Hardwicke, Publisher, Piccadilly, London.

diagram by dotted lines, through the outside portions *only* of the glass; upon which they fall at such an angle that the focus is *lengthened out*, and consequently the field instead of being concave is nearly flat. If the diaphragm were pushed in until it came in contact with the lens, the effect would then be similar to using a *small* lens having the same diameter as the aperture of the stop; and the picture on the ground glass would be indistinct at the edges, from curvature of the image. Hence the View lens is not unnecessarily large and cumbrous, as might at first appear; and every portion of the glass is really employed in forming the picture, the centre taking the middle part, and the outer part refracting the rays which proceed from the sides of the object.

THE APLANATIC LENS.

The Aplanatic lens, patented by Mr. Grubb, of Dublin, resembles the ordinary Actinic View lens in outward form, but differs entirely in the mode in which it is actinized,* the crown-glass taking the place of the flint, and *vice versâ*. It is constructed by cementing a crown-glass Meniscus lens of suitable focus to a *concavo-convex* of flint, the concave side of the latter being ground to the same curve as the convex side of the flint, so as to admit of perfect contact.

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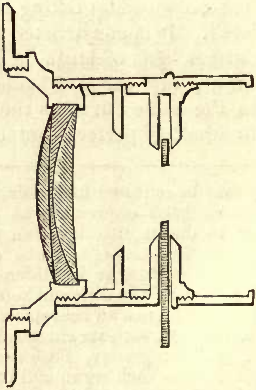
* Some apology may be required for coining a new verb, but the adoption of some such expression as "to actinize" is necessary in order to distinguish between an "achromatic" lens, that is, corrected for colour, and one corrected for the chemical focus. These points lie in different parts of the spectrum, and are caused by the different refrangibility of the different coloured rays. Hence an achromatic lens has not its visual necessarily coincident with its chemical or actinic focus. In the early days of Photography, Professor Hunt strongly urged the adoption of some such term, and proposed the word "di-actinic," that is, admitting of the passage of the chemical rays. The word "actinic" has now come into general use and is not likely to be set aside; it has therefore been proposed to coin the verb from the shorter adjective in preference to the longer, as being sufficiently distinctive.

The advantage claimed for this mode of actinizing a lens, is a considerable reduction thereby in the amount of spherical aberration as compared with the ordinary form of View lens; hence follows also another advantage, in enabling the stop to be placed nearer the front of the lens than its usual position, which would to some extent diminish the barrel-shaped distortion common to all single combinations.

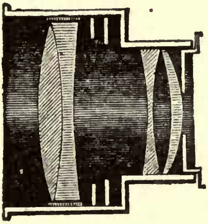
DALLMEYER'S ACTINIC SINGLE LENS.

In order to reduce the distortion common to all single lenses to a minimum, and to obtain a maximum angle of view, Mr. Dallmeyer, instead of two cemented lenses, the one of crown and the other of flint glass, uses three lenses—viz., a central one of flint glass and the two outer ones of different kinds of crown glass, all cemented together, making the meniscus form more decided, and thus enabling the stop to be placed nearer the lens than in the older forms.



THE ORTHOSCOPIC OR ORTHOGRAPHIC LENS.

This instrument, constructed from calculations by Professor Petzval, was proposed to supersede the old form of View lens, as giving a more truthful representation of the object. The name indicates the straightness of the lines produced by the lens; but unfortunately the marginal lines are not represented in their correct position, being curved *inwards* towards the centre of the picture or in an opposite direction to those of the single View lens.



The above diagram is a sectional view of the Petzval Orthoscopic lens. It has two actinic combinations, the posterior of which (consisting of a biconcave and a meniscus, touching at their edges) is a *dispersing* lens, and lengthens out the focus of the rays converged by the first. The use of this negative or dispersing lens constitutes the peculiarity of this instrument, and confers many advantages.

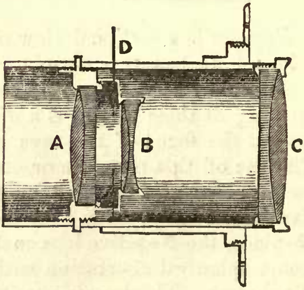
In the first place, the Negative lens enables the optician to overcome spherical aberration without employing a small diaphragm. This lens is not itself free from the above-named defect, but the aberration is in an opposite direction to that of the first lens, consequently the two neutralize each other and the picture is sufficiently sharp.

More important still is the effect which the dispersing lens exerts in improving the oblique pencils, or those which form the outside portions of the picture. They are so far lengthened out as to lessen the concavity of the field, and to render the image sufficiently flat to fall correctly upon the focussing screen.

This lens is now to a great extent superseded by other forms, which not only possess freedom from distortion, but also equal or greater illumination of image.

THE TRIPLET LENS.

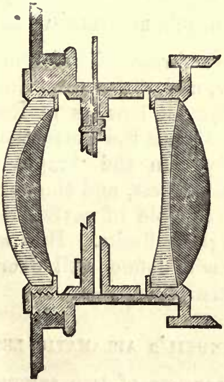
The late Mr. Archer was the first who suggested and, indeed, constructed an objective consisting of three separate lenses. Thereafter Mr. Sutton and Mr. Goddard invented triplets. The former described a symmetrical form—that is, the two lenses at the ends of the tube having the same form. The latter constructed his triplet on non-symmetrical principles; but it was not till Mr. Dallmeyer, and subsequently Mr. Ross, practically worked out the problem that Photographers could have in their hands a thoroughly reliable instrument.



The above sectional diagram of Mr. Ross's "Actinic Triplet" will show its construction. It consists of two Positive or condensing plano-convex lenses, A (the anterior) and C (the posterior), so arranged that without the intervention of the central lens they would form a combination of short focus somewhat similar to the ordinary portrait lens, but possessing greater curvature of field. The Negative or dispersing lens, B, while from its smallness it acts to some extent as a stop, elongates the pencils of rays over the entire field, and is so constructed as also to act more powerfully on the extreme than on the central pencils, thereby flattening the field. For this latter object it was first used by Petzval in his Orthoscopic, and subsequently by Mr. Sutton in his Triplet combination. The axis of the emergent being parallel to that of the incident pencils renders the marginal lines straight, and gives an entire freedom from distortion—a defect which constitutes the great drawback to the use of the Petzval and the single combinations for architectural and copying purposes. In common with these lenses, it also gives nearly equal illumination over the whole field. Each lens is rendered actinic, and the contact surfaces are cemented in order to reduce the reflecting surfaces to a minimum. The stop D, placed immediately in front of the Negative lens, serves the purpose of still more flattening the field and diminishing spherical aberration.

DOUBLET LENSES.

As the name implies these consist of two separate combinations, by which, with less expenditure of optical



Ross's Wide-Angle Doublet.

means, better results as respects sharpness of definition, rapidity of action, extent of picture (when desired), and complete freedom from distortion are obtained. It is needless to say that all these frequently necessary Photographic desiderata in a lens cannot be secured in the same objective.

The above diagram represents the wide-angle doublet of Mr. Ross. It consists of two deep meniscus and actinized lenses, the diaphragms being inserted between the lenses. The angle of good definition included is enormous, amounting with a small stop to nearly 100° of view. This quality is of great value when the Photographer, from obstructions, is unable to place his camera farther from the object, but under ordinary circumstances is objectionable as giving rise to false ideas of perspective.

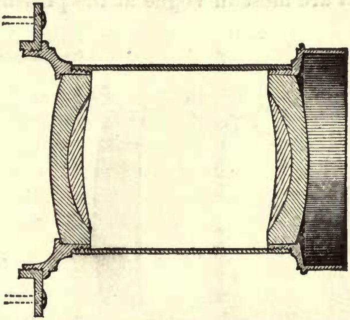
To obviate these defects Mr. Ross has constructed two other forms of Doublet, the one including a medium angle of view, and the other a still narrower angle. The latter acts very rapidly, because it can be used with large aperture, at the same time including sufficient subject to suit artistic requirements.

DALLMEYER'S RECTILINEAR LENSES.

These are other forms of the Doublet introduced by Mr. Dallmeyer, and differ from Ross's in some respects. His wide-angle lens, as in Ross's, includes an angle of nearly 100°, but the correction for actinism is effected differently. In the "rapid rectilinear," the angle of view is much less, and the curves are such as to render the lens capable of perfect definition without a stop, within certain limits. But when moderately stopped down it will define well over an angle wide enough for all artistic purposes.

STEINHEIL'S APLANATIC LENS.

This Doublet consists of two symmetrical meniscus lenses, each of which is composed of two *flint* glasses of different densities, which serve to actinize the lens, instead of the usual plan by means of crown and flint glass. The following diagram represents a section of one of Steinheil's lenses.



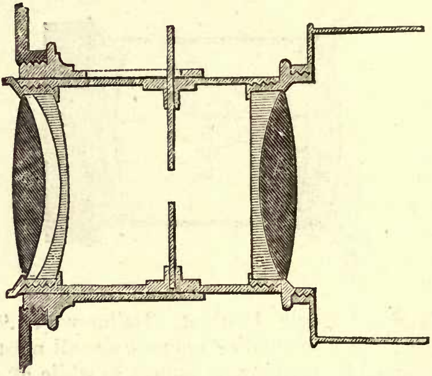
Ross's small angle Doublet, Dallmeyer's "rapid rectilinear," and Steinheil's Aplanatic are all most eminently adapted for copying, inasmuch as while affording abundance of light they possess the valuable quality of freedom from distortion of the image.

THE PORTRAIT LENS.

This objective was invented by Herr Petzval, of Vienna, and from calculations by him first constructed by the eminent optician Voigtlander. The following illustration represents a sectional view of the portrait combination as made by opticians of the present day.

The front combination is an actinic plano-convex cemented lens, with the convex side towards the object. The back lens is a double convex uncemented combination, having a meniscus of air interposed between them. With its full aperture the field of view of the portrait lens is much curved, and cannot be made to embrace, with distinctness, objects at different distances from the Camera. Hence it is, in most instances, necessary to employ stops or diaphragms, which are inserted in an intermediate position between the anterior and posterior combinations.

Various other forms of Photographic lenses have been devised and used; but the above list comprehends those which are most in vogue at the present day.

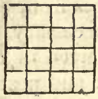


In the Appendix will be found an easy and ingenious method by which the real or *equivalent* focal length of any lens or combination of lenses can be readily ascertained.

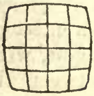
ON DISTORTION IN LENSES.

If a single Actinic lens be employed to photograph a rectangular figure like the diagram No. 1, the outside lines will be found on close inspection to be slightly curved inwards at the extremities, thus producing a barrel-shaped copy, as shown in No. 2. If instead of these the Orthographic lens be used, the resulting photograph will be of an hour-glass shape (No. 3), the lines being bent outwards at the extremities.

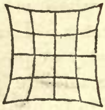
No. 1.



No. 2.



No. 3.



Observe that the central lines in each figure are perfectly straight, and that the distortion is most discernible at the edges. The larger the copy in proportion to the original the greater the distortion.

Since it is not the object of this work to enter into the optical principles involved in the construction of lenses, it will be sufficient to say that distorting lenses should not be used for copying or delineating objects in which *exact* proportions of parts are required.

The ordinary Portrait combination with a small diaphragm placed in proper position between the components is almost free from distortion. The Triplet lens is often used for copying and answers very well, except that it too slightly distorts towards the margins of the picture. But the most perfect of all are the new forms of Doublets by Ross, Dallmeyer, Steinheil, and others. These give absolutely correct representations of relative parts.

THE CAMERA.

The Photographic *camera obscura*, in which the image is impressed by actinic rays refracted by the lens, deserves considerable attention. Many different kinds of this instrument have been devised to suit various requirements, but a detailed description of them here would occupy too much space. It will be sufficient if we indicate some of the most prominent essentials of a really good instrument. The Camera should be made of well-seasoned wood, else it is apt to warp in the sun or by vicissitudes of moisture, etc. The focussing glass must be so arranged as that its ground surface (nearest the lens) shall be absolutely coincident with the sensitive film which replaces it in the same groove. A line drawn through the axis of the lens should fall perpendicularly on the focussing glass, or sensitive surface. The dark slide, or plate-carrier, should have pieces of silver wire attached to the inside corners to prevent the sensitive film from becoming contaminated with the wood. At the bottom of the interior of the slide, a well or ditch, extending along the whole breadth and connecting with the draining corners of the plate, should be provided, in order to prevent the Nitrate of Silver from running by capillary attraction or otherwise over the film. This well may be stuffed with blotting paper which will prevent any reflux of silver, should the slide by inadvertence be reversed. These two latter precautions—viz., silver wires and a drainage well—are totally unnecessary in slides intended for dry plates.

Swing backs, or arrangements by which objects in different planes can be brought into more correct focus on the ground glass, are sometimes useful in portraiture, but the writer does not recommend them for ordinary landscape work. These clumsy contrivances are not much used now for any kind of work, being superseded by increased sensitiveness of chemicals, which enable the operator to work with a smaller aperture of lens.

A Landscape Camera should always be fitted with a front capable of being moved perpendicularly and horizontally; the former movement to raise the lens when greater altitude of view and less foreground are required, and the latter, when in a confined position, to enable more subject to be included in one or the other horizontal direction without moving the Camera.

How to test the Correctness of the Camera and Lens.—This point must always be attended to in purchasing a new apparatus; from neglecting it many fail in obtaining as good pictures as the lens might yield.

First ascertain that the prepared sensitive plate falls precisely in the plane occupied by the ground glass. Suspend a newspaper or a small engraving at a distance of about three feet from the Camera, and focus the letters occupying the centre of the field; then insert the slide, with a square of *ground glass* substituted for the ordinary plate (the rough surface of the glass looking inwards) and observe if the letters are still distinct. In place of the ground glass, a transparent plate smeared with glazier's putty may be used, but the former is preferable.

Another method, more simple than the last, is to gauge the slide with a strip of card. Begin by inserting a glass plate in the slide, and then lay it down upon the table side by side with the focussing glass. Raise the door of the slide, and having applied a flat rule, measure the exact distance between the edge of the rule and the surface of the glass plate. Now place the rule upon a corresponding portion of the focussing glass, when it will be at once evident whether the two planes coincide.

If the result of these trials seems to show that the Camera is good, proceed to test the correctness of the lens.

Take a Photograph with the full aperture of the objective, the central letters of the newspaper being carefully focussed as before. Then examine at what part of the plate the greatest amount of distinctness of outline is to be found. It will sometimes happen that whereas the exact centre was focussed visually, the letters on a spot midway between the centre and edge are the sharpest in the Photograph. In that case the chemical focus is longer than the other, and by a distance equivalent to, but in the opposite direction of, the space through which the lens has to be moved, in order to define those particular letters sharply to the eye.

When the chemical focus is the shorter of the two, the letters in the Photograph are indistinct at every portion of the plate; the experiment must therefore be repeated, the Lens being shifted an eighth of an inch or less. Indeed, it will be proper to take many Photographs at minute variations of focal distance before the capabilities of the Lens will be fully shown.

The object of finding the point at which the sharpest image is obtained will also be assisted by placing several small figures in different planes, and focussing those in the centre. This being done, if the more distant figures come out distinctly in the Photograph, the chemical focus is *longer* than the visual, and *vice versâ* when the nearest ones are more sharply defined.

Mr. Shadbolt has given very lucid instructions for testing a Portrait Lens, which apply equally well to any Lens.

Put the Lens in its place, and test for coincidence of chemical and visual foci as follows: take any paper with a number of *fine* lines drawn upon it—for instance, that upon which patterns are printed for ladies' Berlin-wool work—or else some small but clear printed matter, and paste either upon stout cards, with a large distinctive letter or number upon each one: about ten or a dozen will be enough. Place a slip of deal at an angle of 45°, and with a thin saw make a series of cuts perpendicular to the horizon, one behind another, at about an inch distance apart, a card with the printed matter or lines being slipped into each. All will then be visible at once from a single point, just in the same way as would be the case with the faces of a number of people standing one behind another upon a flight of stairs. Now carefully focus for the fine lines or small letters on one of the cards in the *centre* of the group, taking special note at the same time of its distinctive letter or number, and having done so, expose a sensitive plate and develop it. If the card upon which the focus was taken be most distinct and sharp, the *actinic correction* is perfect: if, however, the best definition be upon one nearer to the Lens than that focussed, it is under-corrected; if further from it, over-corrected.

The above directions are abundantly sufficient for testing the Camera and Lens. White light, however, occasionally enters the instrument between the two sliding portions of the body, and this will be seen on throwing a black cloth over the head and looking into the interior. Or some scattered rays may pass in through the chink when the door of the slide is raised.

It is therefore customary always to throw a large black focussing cloth over the Camera, and to introduce the arm beneath this cloth whilst opening the slide.

Portrait Lenses *magnify* those parts of the object which are nearest to the glass, and hence the complaints of enlargement of the hands and lower portions of the figure. In sitting portraits, this may, to some extent, be obviated by pointing the Lens a little downwards; but when taking a full-length portrait, such as a carte-de-visite, the Camera must be placed quite horizontal, and pointing at right angles to the object. If the whole figure is not in correct focus, which will seldom be the case if the object is near, the Camera must be placed further away, or the Lens stopped down with a Waterhouse diaphragm, which both flattens the field and gives greater depth of focus, but lengthens the time of exposure.

In cleaning the glasses of a *Portrait lens*, which will sometimes be necessary before taking a picture, use wash-leather, as being less likely to scratch the glass than silk; and observe in replacing the Lenses that the front one, which consists of two Lenses, cemented together, must be placed with its convex side towards the sitter. The back combination also consists of two lenses, not cemented together, but separated by a brass ring. Put in the double-convex Lens first into the cell, then the ring, and lastly, the other glass, with its concave side towards the brass ring.

When Lenses are not in use they should be protected from light, as it has been found that glass after a long continuation of such exposure is changed in colour—that is to say, glass which was originally perfectly transparent, becomes, throughout its whole substance, tinged with yellow, and consequently, as yellow is a non-actinic colour, less rapid in its action.

ON ACTINISM.

The term "actinism" (Gr. *ἀκτίν*, a ray or flash) has been proposed as convenient to designate the property possessed by light of producing chemical change; the rays to which the effect is especially due being known as *actinic* rays.

If the pure Solar Spectrum formed by means of a prism be allowed to impinge upon a prepared sensitive surface of Iodide of Silver, the latent image being subsequently developed by a reducing agent, the effect produced will be something similar to that represented in the following diagram:—

FIG. 1.

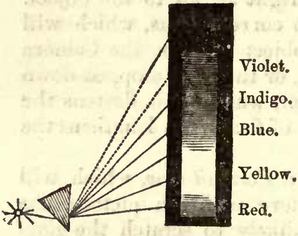


FIG. 2.

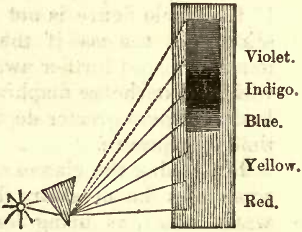


Fig. 1 shows the visible spectrum as it appears to the eye; the brightest part being in the yellow space, and the light gradually shading off until it ceases to be seen. Fig. 2 represents the effect (visible after development) of throwing the Spectrum upon Iodide of Silver. Observe that the darkening characteristic of chemical action is most evident in the upper spaces, where the *light* is feeble, and is altogether absent at the point corresponding to the bright yellow spot of the visible spectrum. The actinic and luminous spectra are therefore totally distinct from each other, and the word "Photography," which signifies the process of taking pictures by *light*, is in reality inaccurate.

To those who have not the opportunity of working with the Solar Spectrum, the following experiments will be useful in illustrating the photographic value of different colours:—

Experiment I.—Take a sheet of sensitive paper prepared with Chloride of Silver, and lay upon it strips of blue, yellow, and red glass. On exposure to the sun's rays for a few minutes, the part beneath the blue glass darkens rapidly, whilst that covered by the red glass is perfectly protected, and the paper covered by the yellow glass darkens very slowly. This result is the more striking from the extreme *transparency* of the yellow glass, giving the idea that the Chloride would certainly be blackened first at that point. On the other hand, the blue glass appears very dark, and effectually conceals the tissue of the paper from view.

Experiment II.—Select a vase of flowers of different shades of scarlet, blue, and yellow, and make a Photographic copy of them, by development, upon Iodide of Silver. The blue tints will be found to act most violently upon the sensitive compound, whilst the reds and yellows will be scarcely visible; were it not that it is difficult to procure in nature pure and homogeneous tints, free from admixture with other colours, they would make no impression whatever upon the plate.

In exemplifying further the importance of distinguishing between visual and actinic rays of light, we may observe that if the two were in all respects the same, Photography must cease to exist as an Art. It would be impossible to make use of the more sensitive chemical preparations, from the difficulties which would attend the previous preparation and subsequent development of the plates. These operations are now conducted in what is termed a dark room; but it is dark only in a *Photographic* sense; being illuminated by means of orange or red light, which, whilst it enables the operator easily to watch the progress of the work, produces no injurious effect upon the sensitive surfaces. If the windows of the room were glazed with *blue* in place of orange glass, then it would be strictly a "dark room," but one altogether unfitted for the purpose intended.

In selecting glass for the Photographic dark room, considerable difference will be found in the actinic opacity of the various shades of colour. A dark orange-yellow is more impervious to chemical rays than a lighter canary yellow, whilst a blood-red colour possesses almost perfect opacity, a Collodion sensitive plate being unaffected even by the direct rays of the sun shining through the glass. Rooms glazed with red glass, however, are extremely painful to the eyes, the retinæ being rendered after a time insensitive to this colour, and all objects assuming the complementary tint, green, on emerging into the daylight.

Another point connected with this subject of visual and actinic rays is the extent to which the sensibility of the Photographic compounds is influenced by atmospheric conditions not visibly interfering with the *brightness* of the light. It would be natural to suppose that those days on which the sun's rays are very powerful would be the best for rapid impression, but such is not by any means the case. If the light is at all of a yellow cast, however bright it may be, its actinic power will be small.

It will often be observed also in working towards the evening, that a sudden diminution of sensibility in the plates begins to be perceptible at a time when but little difference can be detected in the brilliancy of the light; the sun sinks behind a golden cloud, and all chemical action is soon at an end.

Thus it is evident that the eye is a bad judge of what may be called Photographic illumination, and therefore all experiments depending on this source of information, for comparing the sensitiveness of different silver compounds, are valueless unless made under exactly the same conditions of actinic illumination. In the same manner also is explained the frequent difficulty of obtaining photographs in the glowing light of tropical climates; the superiority of spring months to those of midsummer and autumn, of the morning sun to that of the afternoon, &c.

THE SUPERIOR SENSIBILITY OF BROMIDE OF SILVER TO RAYS OF HIGH REFRANGIBILITY.

In copying the Solar Spectrum alternately upon a surface of Iodide and Bromide of Silver, we notice a difference in the Photographic properties of these two salts. The latter is affected more extensively, to a point lower in the spectrum, than the former. In the case of the Iodide of Silver, the action after a certain amount of exposure ceases in the Blue space; but with the Bromide after the same exposure, it reaches to the Green. This is shown in the following diagrams:—

Fig. 1. Fig. 2. Fig. 3.

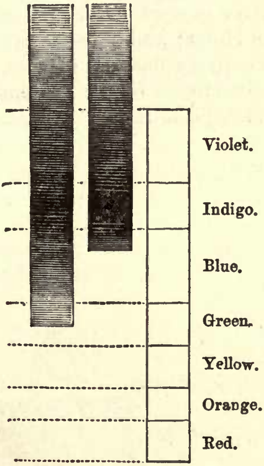


Fig. 1 represents the chemical spectrum on Bromide of Silver; fig. 2, the same upon Iodide of Silver; and fig. 3, the visible spectrum.

It might perhaps be supposed that the superior sensibility of the Bromide of Silver to green rays of light would render that salt useful to the Photographer in copying landscape scenery. It is doubtful, however, whether such is the case, and for the following reasons:—

A reference to the foregoing diagrams—which are shaded to represent nearly the relative intensity of the chemical action exerted by the rays at different points of the spectrum—will show that the maximum point of blackness is in the indigo and violet space, the action being more feeble in the blue space lower down; there are also highly refrangible rays extending upwards beyond the visible colours, and these invisible rays are actively concerned in the formation of the image. Hence we see that the amount of effect produced by a pure green, or even a light blue tint, upon a surface of Bromide of Silver is very small as compared with that of an indigo or violet; and since radiations of all kinds are present in copying natural objects, the green tints may not have time to act before the image is impressed by the more refrangible rays.

PRACTICE OF PHOTOGRAPHY UPON COLLODION.

CHAPTER I.

PREPARATION OF PLAIN COLLODION.

This includes the manufacture of the Pyroxyline, and the solution of the same in mixed ether and alcohol.

Photographic Pyroxyline may be made from linen, calico, paper, or cotton wool. As the latter is the most convenient form of Cellulose, our observations will be confined to the use of the latter material.

The Nitre Process for Pyroxyline.

Use only the best Nitrate of Potash, and having reduced it to powder, dry it on a hot metal plate, or in an oven heated to a temperature above that of boiling water; then pulverize a second time, to prevent the formation of lumps on adding the Sulphuric Acid. Take of

Strong Sulphuric Acid .	6 fluid ounces.
Dried Nitre	3½ ounces (avoirdupois).
Water	1 fluid ounce.
Best Bleached and Dried Cotton Wool . . .	60 grains.

Mix the Acid and Water in a porcelain or stoneware vessel, and throw in the pulverized Nitre by degrees, stirring meanwhile with a glass rod, until lumps disappear, and a transparent viscid liquid is obtained. This will occupy two or three minutes.

Pull out the Cotton into separate balls of the size of a walnut, and when a mercurial thermometer,* dipped in the acid and stirred backwards and forwards, remains stationary at 145° to 150° Fahr., immerse the balls singly with a glass rod, and press each against the sides of the cup. This part of the operation ought not to take more than two minutes. Supposing the acid to have cooled down below 140° during the pulling out of the Cotton, float the cup upon boiling water for a few minutes until the exact temperature is attained. Leave the Cotton in ten minutes, and afterwards pour off the excess of the acids and squeeze the Pyroxyline with the glass rod. Do this quickly, and then dash the cup and its contents suddenly into cold water, moving the Cotton backwards and forwards with the hand until it feels perfectly cold.

Complete the washing of the Cotton, either by leaving it for twenty-four hours in a slowly-running stream of water, or by squeezing it with the hand like a sponge, for twenty minutes or half an hour; after which it may be spread out upon a cloth, and allowed to dry spontaneously.

In this process the chances of failure are very slight, if the Sulphuric Acid be sufficiently strong, and the sample of Nitre not too much contaminated with Chloride of Potassium. If however a failure should occur from the Cotton dissolving in the acid, the operation must be repeated with a drachm less of Water.

Another Formula—

Pulverized and dried Nitrate of Potash .	8 ounces.	
Sulphuric Acid, sp.gr. 1·840	14 ,,	by measure.
Water	1 ,,	,,
Best Dried Cotton Wool	165 grains.	

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* In the preparation of soluble cotton, a thermometer is indispensable. Instruments of sufficient delicacy for common purposes are sold in Hatton Garden and elsewhere, at a low price. The bulb should be uncovered, to admit of being dipped in acids, etc., without injury to the scale.

This formula has been constructed so as to do away with the troublesome operation of watching the temperature, and to avoid the necessity of taking precautions with respect to it.

PREPARATION OF PYROXYLINE BY MIXED ACIDS.

When Pyroxyline has to be made on a large scale this is by far the most convenient method of preparation, and at the same time yields a product readily soluble in Ether and Alcohol.

1*st Formula*—

Sulphuric Acid, sp. gr. 1·845	18 fluid ounces.
Nitric Acid, sp. gr. 1·457 .	6 „
Water	5¼ „
Dried Cotton Wool . . .	300 grains.

2*nd Formula*—

Sulphuric Acid, sp. gr. 1·845	12 fluid ounces.
Nitric Acid . „ 1·450	4 „
Water	17 drachms.
Dried Cotton Wool . . .	270 grains.

3*rd Formula*—

Sulphuric Acid, sp. gr. 1·840	12 fluid ounces.
Nitric Acid . „ 1·400	6 „
Water	6 drachms.
Dried Cotton Wool . . .	270 grains.

If the acids be somewhat weaker than in the last formula, omit the Water altogether, and slightly increase the quantity of Nitric Acid.

We have never found that extreme purity of the acids is a point of much importance, provided they do not contain bodies which materially affect their specific gravity.

Manipulations.—These are nearly the same as those connected with the Nitrate of Potash process previously described, but in this case more precautions are necessary to guard against failure. In the first place, the specific gravity of the acids must be accurately ascertained, in order to regulate the quantity of water to be added. The temperature, generated by an admixture of acids, of various strengths, with water, also differs much. Hence it will be necessary to rely entirely on the indications of the thermometer as to the proper time for immersing the cotton. If the acids are strong the temperature will spontaneously rise higher than the required degree; if weaker, as in *Formula* 3, artificial heat will be needed. A good plan of procedure in every case, whether the acids be strong or not, is to fill a glazed earthenware pipkin or *thick* porcelain vessel with boiling water, which is allowed to remain till the outside of the vessel feels hot to the touch. Whilst this is taking place the operator should occupy himself in measuring out the acids and the water and weighing the cotton. Empty the pot of the hot water and at once pour in the Nitric Acid, then the water, and lastly the Sulphuric Acid. Intimately mix them by stirring with the thermometer, and note the temperature. When it falls to 150° F., an assistant pulls out the cotton into tufts, and throws them one by one into the pot, where they are squeezed under the acids by two glass spatulæ or strong rods. This will occupy about two minutes. When the last tuft is immersed pull the cotton about under the acids with the glass rods so as to secure uniform action. After about from six to eight minutes' immersion, the contents of the pot are emptied into a large basin of water under a running tap and the cotton immediately pulled asunder with a pair of glass rods or pointed wooden sticks. After two or three minutes in abundance of water, to remove the great excess of corrosive acids, the cotton may be safely handled. Complete the washing as before. The best plan of ascertaining when the Pyroxyline is thoroughly freed from acid is to take a handful of the wet cotton and squeeze up with it a piece of blue litmus paper. If acid be present the paper will turn red.

It is dangerous to dry Pyroxyline by artificial heat, as instances have been known where it has exploded by drying even on a steam-bath. The best plan is to pick out the matted tufts of Pyroxyline and allow them to dry spontaneously on sheets of blotting paper in a dry room.

Miscellaneous Observations.—Pyroxyline prepared by the above formulæ should, when quite dry, show a gain in weight, over the original cotton, of from 20 to 30 per cent. If the gain in weight reaches a higher percentage, the Pyroxyline will be of an inferior quality and will leave a large residue when dissolved in Ether and Alcohol. Again, if the action of the acids be continued for a longer time than that above recommended, 20 per cent. of increased weight will be nearer the mark; but we have never found any advantage gained by a more prolonged immersion, especially if the completion of the process is facilitated by moving about the cotton when under the acids. Farther, if the cotton while in the acids is dissolved or much disintegrated in texture, this fact shows that the acids are too weak. On the other hand, if no apparent disintegration takes place, the resulting compound will be highly explosive, and will be only very partially soluble in Ether and Alcohol.

If Pyroxyline is not required for immediate use, a few words on the best method of storing it will not be out of place, as this compound is peculiarly liable to spontaneous decomposition; more so indeed than the less soluble and more explosive varieties. 1st. It should be thoroughly washed and dried. 2nd. It should be stored in a well ventilated receptacle. It is dangerous, for instance, to store it closely packed in a stoppered bottle. A thin cotton bag, in which it is loosely stowed, answers remarkably well. 3rd. Both light, heat, and moisture favour decomposition; store it away, therefore, in a dark, dry, and cool place. Under these conditions Pyroxyline may be preserved uninjured for years.

The first symptoms of deterioration of Pyroxyline are generally manifested by an evolution of red fumes, which consist of Oxides of Nitrogen; but not always so, as instances of entire decomposition have been seen unaccompanied by this phenomenon. In one instance which came under the writer's notice a sample of very soluble cotton was exposed to strong light, in a hermetically sealed glass tube. After a few months the Pyroxyline had entirely changed its character. Without evolution of red fumes it changed into a pasty mass having a strong acid reaction. Under all circumstances it is a bad plan to keep a large stock of Pyroxyline, inasmuch as, apart from the danger attending this course, the product, from all that we know of its character, is certain, sooner or later, to undergo partial decomposition.

CHAPTER II.

THE COLLODION FOR POSITIVES.

This may be made with Methylated Ether and Alcohol, or by preference with pure solvents. Take of—.

Ether, sp. gr. ·725 . . .	$4\frac{1}{2}$ fluid ounces.
Alcohol, sp. gr. ·805 . .	$1\frac{1}{2}$,, ,,
Pyroxyline	48 grains.

Less highly rectified solvents may be used, but in that case it will be desirable to increase slightly the proportion of Alcohol and increase that of the Ether. Shake up the Pyroxyline first with the Alcohol and afterwards add the Ether; then agitate the bottle till the cotton is dissolved.

To Bromo-iodize the above Collodion. Take of—

Iodide of Ammonium . .	90 grains.
Iodide of Cadmium . . .	90 ,,
Bromide of Ammonium .	40 ,,
Alcohol, sp. gr. ·810 to ·825	10 fluid ounces.

Powder the salts in a mortar, and shake them with the Alcohol in a bottle. No artificial heat will be required for their solution. This Bromo-iodizer should be kept in a cool place and exposed as little as possible to light, which has a tendency to decompose some of the Iodides.

The proportions for mixing are three parts of plain Collodion to one of Bromo-iodizer; that is to say, six fluid drachms of the former to two drachms of the latter. But the whole stock may be salted at once, and perhaps with advantage, because the Collodion seems to work better and cleaner after several months' salting, although probably the sensitiveness to light has somewhat decreased.

THE NITRATE BATH.

Nitrate of Silver	90 grains.
Distilled Water	3 ounces.
Nitric Acid	1 drop.

Make *quant. suff.* of the above solution in the proportions indicated, and after the solution is completed add to it about one grain—exact weight is not necessary—of a soluble Iodide, that of Potassium for instance, previously dissolved in about a drachm of distilled water. Shake up the solution and allow to stand for a night, when it will be found that most of the Iodide of Silver thus formed has been dissolved by the Nitrate. Of course, when a larger quantity of "Nitrate bath" is made, a corresponding increase in the weight of Iodide will be necessary. This constitutes what is called "Iodizing the bath," or, in other words, it destroys the tendency of the bath to eat out or dissolve the Iodide of Silver which is formed in the Collodionized film immersed in it.

After filtration the bath is ready for use, and may at once be poured into the glass trough for future use, taking care to prevent the ingress of dust and to guard against much evaporation.

Another method of "Iodizing" the bath is often adopted. It consists in immersing into the trough, filled nearly to the top with plain silver solution, a clean glass plate coated with Bromo-iodized Collodion and leaving it there for several hours. The Nitrate first forms Bromo-iodide of Silver in the film and then dissolves it out again.

DEVELOPING SOLUTIONS FOR POSITIVES.

Formula No. 1.

Protosulphate of Iron	12 grains.
Glacial Acetic Acid	30 minims.
Water	1 ounce.

As a rule no filtering is required; but should the solution be turbid it is better to filter it.

An addition of Nitric Acid, half a minim to the ounce, makes the image whiter and more metallic; but if too much be used, the development proceeds irregularly, and spangles of Silver are formed.

The Acetic Acid renders the development uniform, by restraining the violent action of the iron and enabling it to combine more readily with the film; it has also an effect in whitening the image and increasing its brightness.

The solution of Sulphate of Iron becomes red on keeping, from a gradual formation of *per*salt. This to some extent weakens the developing power of the iron; but on the other hand, it seems to give greater clearness of image.

A little Alcohol, about half a drachm to the ounce of solution, is a useful adjunct, especially in hot weather, as it enables the developer to spread more uniformly over the film.

Some operators add pure Nitrate of Potash to this developing solution, to form a *small portion* of Protonitrate of Iron. It is said to improve the colour slightly. The proportions are 10 grains of Nitrate of Potash to about 14 or 15 grains of Protosulphate of Iron.

Formula No. 2.

This is a mixture of Sulphate and Nitrate of Iron, employed with much success by many operators. Take of—

Sulphate of Iron	1½ ounce.
Nitrate of Baryta	1 „
Alcohol	1 „
Pure Nitric Acid	40 minims.
Water	16 ounces.

Reduce the Nitrate of Baryta to fine powder in a mortar, and dissolve it in the water by the aid of heat. This may be done in a porcelain capsule standing on a tripod, with a spirit-lamp below, or the water may be boiled in a kettle and poured upon the pulverized salt with constant stirring. Next, reduce the Sulphate of Iron also to powder, and when the whole of the Nitrate of Baryta has dissolved, stir the Sulphate into the warm liquid, and continue to stir for three minutes, to insure a perfect decomposition. A dense white deposit of Sulphate of Baryta forms, rendering the whole milky, but on leaving the capsule for ten minutes, the heavy powder settles to the bottom, leaving a clear liquid of an apple-green colour, with occasionally a little reddening at the edges, from oxidation and conversion into *Per*nitrate of Iron. Throw the whole on a paper filter, and if the liquid at first runs muddy, pass it through the same filter a second time. Drain away as much as possible, and when it has become quite cold, drop in first the Nitric Acid and then the Alcohol.

The above operation is very simple, but two or three causes of failure must be guarded against. The Nitric Acid will sometimes oxidize the Iron, and make it red, and it may also act on the Alcohol. Do not therefore mix the Nitric Acid with the Alcohol, but add them separately, and drop the required quantity of Nitric Acid first into a few drachms of water, to dilute it down and prevent any chance of oxidation. Lastly, fill up with water to the proper bulk.

The solution so formed will contain in each ounce *about* 30 grains of Nitrate of Iron, and 10 grains of Sulphate of Iron; but the Nitrate is so feeble a developer, that 5 or 10 grains additional of the Sulphate may be needed to prevent the formation of spangles on the shadows when the weather is cold or the bath very acid.

This developer will keep for two months in cold weather, and probably longer, if the bottles are filled to the neck; hence a stock can be prepared beforehand. It becomes weakened by a partial decomposition, but produces sufficiently white pictures, if a little Protosulphate be added. Acetic Acid is purposely omitted from this formula.

Formula No. 3.

Make a saturated solution of Gallic Acid in water, filter and add to it, little by little, a thirty grain solution of Protosulphate of Iron, with constant stirring, till the mixture turns into a thin ink. Now add Nitric Acid, still stirring, till the solution becomes of a sea-green colour, when it is ready for use. No Acetic Acid is required. The peculiarity of this developer is that it reduces the light-affected portions of the sensitive film in brilliantly fine particles of metallic silver.

THE FIXING SOLUTION.

Cyanide of Potassium	10 grains.
Water (common)	1 ounce.

This solution decomposes slowly by being kept, but it will retain its solvent power for several weeks or longer. As it is highly poisonous, the bottle containing it should be distinctly labelled "POISON," and when not in use placed carefully out of the way of children and others unacquainted with its deadly properties.

VARNISHES.

Two kinds of varnish are usually employed for Positives on glass—viz., a clear varnish for protecting the film, and black varnish for backing up. As the preparation of the best Photographic varnishes is surrounded with much difficulty and can only be satisfactorily accomplished on a large scale, it is better to purchase the varnishes ready made, as any instructions for its manufacture might lead to disappointment. Moreover, varnish-makers are extremely secretive in the modes adopted by them for its preparation.

CHAPTER III.

FORMULÆ FOR NEGATIVE SOLUTIONS.

1st. *The plain Collodion.* Take of—

Ether, sp. gr. ·725	10 fluid ounces.
Alcohol, sp. gr. ·805	5 ,, ,,
Pyroxyline	120 grains.

As before directed (p. 35) shake up the Pyroxyline in a bottle with the alcohol, then add the ether and again shake till all the Pyroxyline that will dissolve has passed into solution.

2nd. *To Bromo-iodize the above Collodion.* Take—

Iodide of Ammonium	40 grains.
,, Cadmium	40 ,,
Bromide of Cadmium	20 ,,
Alcohol, sp. gr. ·810 to ·815	5 fluid ounces.

Shake in a clean bottle till dissolved, and add to the above proportion of plain Collodion; or the Bromo-iodizing salts may be dissolved along with the Pyroxyline in the stock bottle. But in this case the formula will be slightly altered, and stand thus—

Ether, sp. gr. ·725	10 fluid ounces.
Alcohol, sp. gr. ·805 to ·815	10 ,, ,,
Pyroxyline	120 grains.
Iodide of Ammonium	40 ,,
,, Cadmium	40 ,,
Bromide of ,,	20 ,,

Put the Bromo-iodizing salts first into the bottle, then add the Alcohol and afterwards the Pyroxyline. Shake well up until the salts are dissolved, complete solution being much favoured by the rubbing action of the Pyroxyline. Lastly add the Ether, and again shake until all that is soluble of the Pyroxyline has been taken up. This is the plan which the writer invariably adopts in his own practice.

As the Iodide and Bromide of Cadmium are exceedingly stable salts when exposed to vicissitudes of temperature, &c., and even in the presence of acids (although when used alone they are apt to render Collodion too viscous), they are of immense value in correcting the tendency which other Iodides, &c., have to undergo decomposition when dissolved in Collodion.

Various other formulæ for Bromo-iodizing Collodion for negatives have been proposed to suit different conditions of light, temperature, &c., but the above may be considered excellent for a good normal Collodion suitable for general purposes. If the heat of the weather and also the light are very intense, more Bromide may be used with advantage, probably because Bromide of silver is less liable than the Iodide to be over-acted on by strong impulses of bright light and by high temperature.

As a rule, Bromo-iodized collodion is best adapted for an iron developer, but occasionally a Pyrogallic developer is used when the finest possible deposit of silver is required. The latter developer, however, acts with less energy than iron, and therefore a longer exposure is required.

SIMPLY IODIZED COLLODION.—To each fluid ounce of the plain Collodion formulated in last page, add three fluid drachms of either of the following solutions—

FORMULA NO. 1. (*Potassium Iodizer.*)

Iodide of Potassium	135 grains.
Alcohol, sp. gr. ·816	10 ounces fluid.

Pulverize the Iodide, dissolve by agitation in a bottle and filter if necessary. Solution is much assisted by placing the bottle for a short time in warm water, say about 120° Fahr. If the Alcohol be too strong, all the Iodide will not be dissolved.

FORMULA No. 2. (*Cadmium Iodizer.*)

Iodide of Cadmium	170 grains.
Alcohol, sp. gr. ·810 to ·816 .	10 ounces fluid.

By agitation this Iodide will dissolve readily in the cold.

FORMULA No. 3. (*Mixed Iodizer.*)

Iodide of Ammonium	60 grains.
Iodide of Cadmium	90 „
Alcohol, sp. gr. ·810 to ·816 .	10 ounces fluid.

By agitation these Iodides will also dissolve readily in the cold.

Remarks on Formula No. I.—In the earlier days of Photography, this is the one which was generally used; but as the Collodion Iodized with it is very apt after a short time to turn red by the liberation of free Iodine, which renders the Collodion less sensitive, it is recommended to Iodize only a small quantity of Collodion at one time.

This Iodizer usually remains colourless if kept in a dark place, but on exposure to light a trace of Iodine is liberated, tinging the solution yellow. On again removing the Iodizer from the action of light, reabsorption of the liberated Iodine generally takes place.

Remarks on Formula No. II.—This is the most stable of all Iodizing solutions; and the only drawback to its general use, is its tendency to render the Collodion glutinous, and thus preventing the possibility of an even coating of Collodion on large plates in warm weather. It exhibits no tendency to decomposition either when in alcoholic solution, or when mixed with plain Collodion, hence, as in the next formula, it is used to correct the opposite tendencies of another Iodide.

Remarks on Formula No. III.—No Iodizer equals this for general utility. Collodion when Iodized with the Ammonium salt alone speedily decomposes, although at first the Collodion works remarkably well. In the formula, the proportion of Cadmium has been so arranged, from careful experiment, as to correct the tendency to decomposition of the other salt, even in the hottest weather. A light sherry colour after a time is imparted to the Collodion, which will remain constant for many months, even in the presence of a slight amount of acid, or in bright daylight.

Another variety of Iodizer similar to the last may be made by mixing equal parts of Formulæ Nos. 1 and 2.

THE NITRATE BATH FOR NEGATIVES.

1*st. For Bromo-iodized Collodion*—

Pure Nitrate of Silver	35 grains.
Distilled Water	1 ounce.

Make in the above proportions the required quantity of solution and Iodize it as directed at p. 36. If the solution be neutral to test paper, that is to say, if blue litmus paper immersed in it is not changed in colour after, say, fifteen seconds immersion, it is quite certain that the Nitrate bath in this state will not yield Negatives free from fog, unless the Collodion has become quite red by the liberation of free Iodine. But as such Collodion is very insensitive, and soon disorders the bath, it is better not to use it.

To rectify the solution, pour it into the glass bath or trough, and, supposing we have twenty ounces of solution, thoroughly stir up with it four drops of dilute Nitric acid (equal parts strong acid and distilled water) and test again with Litmus paper. After a few seconds the blue colour of the paper will probably assume a slightly reddish hue. If so, the solution may be fit for work. That fact, however, can only be ascertained by a practical trial with a Collodion known to be good. If the developed Negative is not free from a deposit of silver in the deepest shadows where Light has not acted, or from *fog*, as it is technically called, add two more drops of dilute acid and try another plate. Most likely a nice blooming Negative will be the result. If not, try the effect of another drop or two of acid.

The operator, however, must be very careful not to add too much acid, which has the effect of diminishing the sensitiveness of the film, and at the same time giving a very feeble image. For this reason the writer recommends, and in his own practice invariably adopts, this progressive and tentative method of acidulating the Silver bath.

If by inadvertence too much acid has been added, there are two ways of remedying the mistake. By far the best plan is to add to the bath by degrees some Nitrate solution of the same strength, which has not been acidulated, practically testing with plates, as before, between each addition.

The second and more troublesome plan consists in correcting an over-acid bath with Oxide of silver. Proceed thus. Dissolve say five grains of caustic Potash or Soda in an ounce of water, add to this a solution of Nitrate of silver till no more precipitate falls. The precipitate is Oxide of silver. Whilst still freshly made, throw the whole into a filter till the liquid has run through. Afterwards wash the precipitate by passing through the same filter two or three ounces of distilled water. This, besides washing away impurities, will dissolve a little of the Oxide, but the small quantity dissolved is of no consequence. Next pass the overacid silver solution through the same filter, when it will be found that the acid has dissolved a considerable portion of the Oxide, and the filtered solution will now, when tested with Litmus paper, be found to be neutral, or perhaps slightly alkaline. Try it as before with collodionized plates, and correct more carefully this time with dilute Nitric acid.

2nd. *For Iodized Collodion—*

Pure Nitrate of Silver	30 grains.
Distilled Water	1 ounce.

Dissolve and Iodize as before.

It will sometimes be found that this sensitizing solution works very well for Iodized Collodion without any addition of acid. In this respect much depends on the Collodion. A sample of Collodion which has become highly coloured by the liberation of free Iodine, works best when excited in a neutral bath; but it is obvious that a Nitrate solution cannot long remain neutral if films containing free Iodine are sensitized in it, because the Iodine combines directly with the silver, liberating the Nitric acid, which having no displaced base wherewith to combine, renders the solution more and more acid by the sensitizing of every successive plate. Such Collodions, when much discoloured, should not be used, as they invariably and quickly injure the bath. To acidulate the sensitizing solution for a good Iodized Collodion the best acid to use is the Acetic, and it should be added tentatively, as described in the instructions for acidulating the bath for Bromo-iodized Collodion, (see p. 43).

TO PRESERVE THE NEGATIVE AND POSITIVE BATHS FOR COLLODION.

The following observations apply both to the Nitrate solutions for Negative and Positive processes by means of development:—

By dipping successively a large number of Collodionized plates into a bath, the silver solution becomes changed in various ways.

1st. The water absorbs some of the Ether and Alcohol which still remain in the immersed film.

2nd. When the Iodine, Bromine, &c., of the Collodion combine with the Silver, a corresponding quantity of Cadmium, Potassium, or whatever other metal is combined with the Haloid salt, is set free, and combines in its turn with the liberated Nitric acid, forming Nitrates of these metals, which remain in solution. These secondary Nitrates are not hurtful to the Bath, farther than that they weaken its power for sensitizing.

3rd. With every successive plate there is introduced into the Silver bath a greater or less amount of organic matter. This is partly derived from the fingers whilst handling the plate, and partly from the Collodion itself.

Nitrate of silver has a great affinity for these organic substances, and consequently the bath is liable after a time to become loaded with dissolved matter which is fatal to the production of a clearly defined Negative or Positive, unless controlled by a great deal of Nitric or Acetic acid. This remedy necessitates a very much longer exposure, which, for Portraits at least, is not admissible.

4th. One of the most potent destroyers of a Negative or Positive bath for Collodionized plates is the formation therein of Nitro-iodide or Nitro-bromide of silver. It will be necessary to explain this phenomenon shortly, as the facts have now been fully ascertained and the causes traced to their sources.

When an Iodized, Bromo-iodized, or Bromized Collodion film is being sensitized in the Silver bath, the first effect of the silver is to convert the soluble Iodide, &c., into the corresponding salts of silver. When that is completed the excess of Nitrate of silver begins to dissolve out or destroy its own offspring. After a time the Nitrate becomes saturated, and then the new compound crystallizes out in fine needle crystals in the Nitrate bath, or more generally in the Collodionized film. Alcohol and Ether in the bath much favour the deposition of these crystals, which are insensitive to Light and constitute one of the most fertile causes of *pin-holes* or transparent spots in Negatives. Simply Iodized Collodion is less liable to this influence than a Bromo-iodized.

If the Nitrate bath is otherwise working well, the best remedy is to add to it say one-third of its bulk of distilled water, which will throw down a large proportion of the Iodide and Bromide which it has taken up. Filter and then dissolve in it Nitrate of silver in proportion to the quantity of water added. Acidulate if necessary.

With reference to an excess of organic matter in the Nitrate bath, the best way to test for failure in that direction is to take a portion of the solution and make it slightly alkaline with Ammonia. If by exposure to strong light the liquid does not become turbid after two hours, then organic matter is not present in excess. This reducing power of Light on solutions of Nitrate of silver containing organic matter is taken advantage of to purify them. Proceed thus. Pour the impure Bath into a *transparent* wide-mouthed bottle, add Ammonia drop by drop till reddened litmus indicates, by becoming blue, that the solution is *slightly* alkaline. It is better not to stopper or cork up the bottle, as it is important to allow any Ether or Alcohol which the solution contains to escape. Dust may be kept out by placing loosely over its mouth a conical fold of thin blotting paper after the manner of a candle extinguisher. This does not materially interfere with the escape of vapour. The vessel is now placed in sunlight or strong diffused daylight, in a place where rain does not find access to the interior. After a few days' exposure most of the organic matter will be precipitated and reduced, in combination with part of the silver, to a black powder. The time of reduction varies, according to the intensity of the Light and the amount of Organic matter present, from five to thirty days. The bath should now be filtered, but if it is an old one fully saturated with Iodide and Bromide of Silver, it is better before filtering to add to it say one-third of its bulk of distilled water, the effect of which is to precipitate a portion of these salts in an extremely fine state of division, which will pass through a very porous filter. If, however, the weakened silver solution is well agitated and allowed to stand for a day or so, the particles will agglomerate and fall to the bottom. The solution should now run through the filter perfectly clear.

To render the bath again fit for work, dissolve in it pure Nitrate of Silver in the proportion of thirty-five grains Nitrate to each ounce of distilled water used in diluting. Acidulate it either with Nitric or Acetic acid as previously directed in making a new bath.

Such solutions, when the corrections have been properly made, work quite as well as new ones.

CHAPTER IV.

ON POSITIVE AND NEGATIVE COLLODION PHOTOGRAPHS.

We use the terms "Positive" and "Negative" so frequently in Photography to denote different kinds of chemicals and pictures, that it is important for the student to have a clear understanding of the meaning of these terms.

A Positive photograph may be defined to be a picture which gives a natural representation of the lights and shadows of an object as seen by the eye.

A Negative photograph, on the other hand, has the lights and shadows *reversed*, so that the appearance of the object is changed or *negatived*.

The following diagrams will serve to make this obvious:—

Fig. 1.

Fig. 2.

Fig. 3.

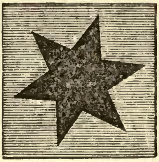


Fig. 1 is an opaque image drawn on a transparent ground; fig. 2 represents the effect produced by placing it in contact with a layer of sensitive Chloride of silver and exposing to light; and fig. 3 is the result of again copying this Negative on Chloride of silver.

Fig. 3 therefore is a Positive copy of fig. 1 obtained by means of a Negative. By the first operation, the lights are reversed; by the second, being again reversed they are made to correspond with the original; hence the possession of a Negative enables us to obtain Positive copies of the objects, indefinite in number and all precisely similar in appearance.

The same Photograph may often be made to show either as a Positive or a Negative. For instance, supposing a piece of silver leaf to be cut into the shape of a cross and pasted on a square of glass, the appearance presented by it would vary according to the way in which it is viewed.

Fig. 1.

Fig. 2.

Fig. 1 represents it placed on a piece of black velvet; fig. 2 as held up to the light and viewed by transmitted light.

Positives therefore should be viewed by *reflected* and Negatives by transmitted light.

All Photographs, however, cannot be made to represent both Positives and Negatives. In order to possess this capability it is necessary that a part of the image should be transparent and the other opaque, but with a bright surface. These conditions are fulfilled when an image on Collodion is developed by a reducing agent.

Every Collodion picture on glass is to a certain extent both Negative and Positive, and hence the processes for obtaining both varieties of Photographs are in most respects the same. The conditions of success will be fully described in succeeding chapters. All that refers to obtaining Positives on Silver-chlorized paper will be treated of under the head of "Positive Printing."

CHAPTER V.

THE PHOTOGRAPHIC DARK ROOM.

THIS is the room in which the sensitizing of Collodion paper, &c., and also the development of the image, is carried on. It need not be *dark* in a visual, but only in a Chemical sense. We have already seen that only certain rays of Light exercise a chemical effect on our sensitive compounds, hence it will be necessary to prepare them in a room so lighted as not to affect them. This may be done by lighting it with orange-coloured glass, and not working too close to the window. Red glass would be a more effective substitute, but as the working in that kind of light is exceedingly painful to the eyes, the other kind of glass is preferable. A lamp or candle for illumination is sometimes used, but as the rays proceeding from these are often of a very actinic nature, the direct light should be prevented from falling on the sensitive film, by interposing near the source of light a screen of orange-coloured glass. It is very easy to test the "dark room" for Chemical rays, and if this has been once done when the external light is very powerful, no more testing will be necessary. Sensitize a Collodionized plate in a Nitrate bath, both of which are known to be in good condition. Expose the plate for a few minutes to such Light as may find access therein. Pour on a developer and watch if there be any reduction of Silver or darkening of the film. Should reduction take place, even to a small extent, it is probable that some Actinic light, which might be troublesome, does exist in the room. But it is not always safe to conclude that such may be the cause of darkening, because the chemicals themselves may be in fault. Test again by a method, which although a little more troublesome, will infallibly point out the source of *fogging.* Excite a Collodionized plate in the Nitrate bath, and immediately place it in a *dark frame.* Pull out the slide gradually within the dark room at intervals of, say, one minute intervening between each. Ten intervals may be selected, which would represent in the maximum, ten minutes exposure to one minute in the minimum. A small portion of the plate should be left non-exposed.

Apply the developer, and watch closely for the following effects.

1st. If the film remains clear all over, then in all probability the chemicals are right, and also the dark room is sufficiently protected from Actinic rays.

2nd. If regular steps of gradation of darkening take place then the dark room and chemicals are certainly right, provided, as before, no deposit whatever takes place on that portion of the plate non-exposed in the slide.

The Photographic dark room should be well ventilated, otherwise the continued breathing of the pent-up fumes of Ether, &c., by the operator would eventually be prejudicial to health. It must be provided with a water tap and sink, or where these are not available, with a large pouring jug and basin for the reception of washings, &c.

No chemicals should be admitted therein which are not necessary for the purposes of sensitizing, developing, &c., a wet Collodion plate. And as the Photographer is necessarily working in a feeble light it is useful to have the various solutions placed not only in different positions, but also in differently shaped bottles, so that the operator by the sense of touch alone can put his hand on the solution required. Above all things, Ammonia must not find a place within a dark room intended for the wet Collodion process, because the fumes from it very quickly destroy a Nitrate bath, and in the development are very prejudicial.

With these preliminary observations we are now in a position to proceed with practical work.

CHAPTER VI.

MANIPULATIONS OF THE WET COLLODION PROCESSES.

CLEANING THE GLASS PLATES.

In selecting glass for Photography care should be taken. Common window glass will answer well enough for Positives taken direct in the Camera; but for Negatives it is not sufficiently flat, and is liable to break when screwed into the pressure-frame for printing. What is called "flatted crown" will suit for small Negatives, but unfortunately it is not always flat, and therefore a risk is run of its breaking when large sheets are used. "Patent plate," although much more expensive, answers better than any other kind of glass, especially for large sizes, and as it is perfectly flat no risk is run of its being broken in the Printing-frame if grit or sand is not interposed between the two glasses.

Before washing the glasses each piece should be roughened on the edges and at the corners, by passing round them a sharp file, or more quickly by making two plates do duty for each other. Hold their edges at an angle, taking care to keep the arms fully extended, to prevent spiculæ from flying off into the eyes, then successively draw the edges sharply along each other. This will be a sufficient protection to the hands from sharp edges.

It would not be safe to rely on glass being Photographically clean by washing it in water, and then wiping it with clean cloths or wash-leathers. There are often impurities on the glass which these will not remove. The safest way is to proceed methodically, by a plan which will insure a clean glass, if the glass itself contains no internal contaminations, which by oozing out might affect the Photographic Chemicals. Make a mixture consisting of one part of Hydrochloric acid and four parts common water. Lay the plate down on two or three folds of flannel laid on a flat table. With a dabber, which may conveniently be made of a *bung* or large cork, wrapped round with chamois leather, rub over the surface of the glass with considerable pressure a few drops of the Hydrochloric mixture. Wash off the acid under a tap, finally rinsing with distilled or filtered rain water, and rear up the plates to dry in a place free from dust; of course taking care to mark a corner of the cleansed side by any device which may be deemed most convenient. These glasses are ready for use at any time in the wet Collodion process, by simply brushing off with a broad camel's hair brush any dust that may have settled on the prepared surface.

Another method of cleaning Photographic glass which has not been previously used is very efficacious. Drop on the surface to be coated with Collodion a few drops of old Collodion, thinned with Ether or Alcohol, or preferably Tincture of Iodine. Instantly with a dabber, kept for that purpose alone, energetically work over the surface of the plate till the liquid has been rubbed off or has evaporated. Breathe on the plate, and with a fresh dabber or leather instantly rub off the condensed moisture. The glass is ready for use when, by again breathing on it, the condensed moisture evaporates regularly and not in patches.

The cloths or wash-leathers used for wiping Photographic glass should be kept expressly for that purpose. The cloths are best made of a material known as fine "diaper," and very free from flocculi and loosely adhering fibres. Wash them by soaking them for a night in tolerably strong solution of common washing Soda. Wring them out and wash them out in several changes, not less than ten of clean water; wring between each change, then hang up to dry. Wash-leathers are similarly prepared, but here the operator must be careful not to use warm water, as that would shrivel up the skins. They must be washed till all the Soda and "dressing" has been removed. It will take longer to remove the latter than the former, but as the dressing is insoluble in water, it is easy to see when the whole of it has been washed away. These leathers when dry are generally harder and less pliant than they ought to be. In that case roll them up into a ball, and beat them with a wooden mallet till they become soft and pliant.

Silk handkerchiefs for finally polishing the dry plates are not recommended, because in particular states of the weather the glass by being rubbed with them becomes strongly electric, and attracts any dust which may be floating in the immediate neighbourhood. Chamois leather does not electrically excite the glass so powerfully, and therefore is to be preferred.

To Clean Plates that have been previously used.—If on developing a plate the picture is considered a failure, it is best to wash off the Collodion, &c., at once and set aside to dry, when the glass may be considered as good as new. But if the Collodion film has been once allowed to dry, it is better to soak the glass for some time in a solution of common Soda and wash as before.

If the glass plate has been varnished, soak it for a night in a very strong solution of Soda, when probably the film and varnish after a little rubbing will break away in patches. But some sort of varnishes resist this treatment. They must, however, give way to the extraordinary solvent power of Pyroxylic spirit, or Wood Naphtha. To apply this solvent, lay the plate on a flat table, pour a little of the spirit on the varnish, rub with a dabber, when varnish and Collodion will both quickly be detached from the glass. These plates should then be soaked in Soda and washed as before.

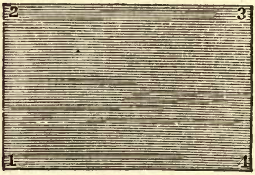
Strong acids too have a similar effect, and act very quickly. The writer, who in his practice with his students has often occasion to make Pyroxyline, and finds on his hands at the end of a year a large number of varnished negatives which are of no use, preserves the Nitro-sulphuric acid which has already served its original purpose. Into this the varnished plates are dipped one by one, by means of a glass dipper or clip, or a number of them are allowed to soak in the mixture of acids for a short time. When placed in water, the films are easily rubbed off. This plan is recommended only to those who have plenty of waste acids which otherwise would be thrown down the sink without doing this final service.

General Remarks on Cleaning Glasses.—Much time is often wasted in finally cleaning glasses for the reception of the Collodion by the operator's frequently breathing upon them violently, and thus projecting particles of saliva which require a great deal of rubbing for removal. Gentle breathing is all that is required, Again, the condition of the cleaning cloths or leathers for finishing should be carefully attended to. They should never be touched with moist hands, or hands contaminated with chemicals, and when not in use they should be stored away in a clean cotton bag, and in a dry place.

TO COAT THE PLATE.

When the salted Collodion has settled for some days, decant off a portion into a pouring bottle for use, taking care not to disturb the sediment. The best, and at the same time cheapest, pouring vessels are the tall *lipped* medical bottles, procurable at any druggist's. They must be fitted with the best corks so as to prevent the evaporation of the Ether and Alcohol. Now take a glass plate, previously cleaned, and wipe it gently with a broad camel's hair brush, in order to remove any particles of dust which may have subsequently collected. If it be a plate of moderate size, it may be held by the corners in a horizontal position, between the forefinger and the thumb of the left hand. The

Collodion is to be poured on steadily until a circular pool is formed, extending nearly to the edges of the glass.



By a slight inclination of the plate the fluid is made to flow towards the corner marked 1 in the above diagram, until it nearly touches the thumb by which the glass is held; from corner 1 it is passed to corner 2, held by the forefinger; from 2 to 3, and lastly, the excess poured back into the bottle from the corner marked No. 4. It is next to be held over the bottle for a moment, until it *nearly* ceases to drip, and then, by raising the thumb a little, the direction of the plate is changed, so as to give a rocking movement, which makes the diagonal lines coalesce and produces a smooth surface. The operation of coating a plate with Collodion must not be done hurriedly, and nothing is required to insure success but steadiness of hand and a sufficiency of the fluid poured in the first instance upon the plate.

In coating larger plates, the *pneumatic* holder, which fixes itself by suction, will be found the most simple and useful.

The presence of white light in the room does no injury until the plate has been placed in the Bath, and therefore the door may remain open during the operation of coating, since it would be difficult to apply the fluid evenly without plenty of light. Draughts of air, however, must be avoided as much as possible, since they promote too rapid evaporation, and carry along particles of dust which may adhere to the plate. If the dark room is illuminated by a yellow flame from a tallow candle or by a whiter flame surrounded with orange glass, be careful not to Collodionize the plate near these, nor to have an open bottle of Collodion near them, because, as the vapours of Ether and Alcohol are very inflammable, disastrous consequences might ensue.

Sensitizing the Film.—As soon as the Collodion on the glass plate has *set*, as it is called, or when by touching the draining corner the drop of Collodion does not adhere to the finger, and this time, according to temperature, &c., may vary from ten seconds to a minute, the plate is rested on the glass dipper and lowered into the solution by a slow and steady movement; if any pause be made, a horizontal line corresponding to the surface of the liquid will be formed. Then place the cover upon the vertical trough and darken the room, if this has not already been done.

Whilst the plate remains in the Bath, the operator may occupy himself in wiping out the corners and lower edge of the dark slide with blotting paper; next, in measuring a sufficiency of the developing solution, and in focussing the object. Then rinse the fingers an instant in water, to cleanse them from any traces of soluble impurity and return to the Bath.

The light ought to fall upon the plate at a sharp angle whilst it is lifted from the Bath, that the operator may see the greasy lines upon the surface. An immersion of from two to three minutes will usually be sufficient to remove them in warm weather; but when the temperature falls, the time must be prolonged. Something will depend upon the number of times the plate is moved up and down, and many adopt the plan of leaving it in five minutes, and then taking it out without any movement. When the liquid flows off in a uniform sheet, the decomposition may be considered to be perfect. The principal impediment in this part of the process lies in the difficulty with which Ether and Water mix together, which causes the Collodion surface on its first immersion to appear *oily* and covered with streaks. By gentle motion the Ether is washed away, and a smooth layer obtained.

When the Nitrate bath is in perfect order no harm will result from leaving the plate in it for a longer time; but the experience of all practical Photographers points to the fact that nothing is gained by a prolonged immersion, and much clearness of image may be lost.

The plate is next drawn gently up through the solution, removed from the dipper and held vertically over the trough for a minute to drain. To farther drain the plate some operators rest the lower edge for a short time on a few folds of blotting paper, and also wipe the back with the same material. These latter precautions are, however, not necessary if the dark slide is furnished with a well or trough at the bottom into which the solution may run. The plate is now placed on the silver wires of the frame, taking care that the draining end be towards the bottom. *In carrying the dark frame to and from the Camera, and at all times when the plate is inside*, make sure that the slide is kept in such a position that no liquid can run back over the film. If this precaution be not attended to many sorts of defects will be visible in the picture. The frame too should be carried very gently, else particles of dust and abraded wood might be set loose and settle on the surface of the film. These would give rise to spots in the picture either of a transparent or opaque character, according to the nature of the impurity which causes them.

All the observations contained in this Chapter apply both to Collodion Negatives and Positives taken in the Camera. In the next two Chapters we must make a distinction between the two processes and describe them separately, because in some respects the treatment which is best adapted for the one will not suit the other.

CHAPTER VII.

THE POSITIVE COLLODION PROCESS ON GLASS.

We have previously detailed the various operations and chemicals necessary before obtaining a Positive picture by development—viz., cleaning the glass (p. 52), the Collodion (p. 35), the Sensitizing bath (p. 36), the developers (p. 37), the fixing agent (p. 39), and the general observations contained in last Chapter. It now remains for us to describe those manipulations wherein the Positive process differs from the Negative. These consist mainly in the development.

In developing a glass Positive the solution of Sulphate of Iron should be scattered evenly over the film, and in some quantity, so as to wash off a portion of Nitrate of Silver into the sink. In the case of Negatives it is an object to save every trace of Nitrate, and precipitate it upon the image, in order to increase the density; but with Positives there is a fear of getting an excess of intensity, and if the Collodion film be tolerably creamy, it will always retain more than enough of the Nitrate to give a Positive free from the green or blue marks characteristic of deficient reduction. White stains at the margins of the plate are produced in great measure by the developer coming into contact with an excess of Silver.

Tilt the developing fluid backwards and forwards upon the film for about thirty seconds, or a minute, until the darkest shadows *begin* to be visible. Supposing the film to be well lighted with yellow light, there will be no difficulty whatever in ascertaining when the image is fully out; the developer must then be poured off immediately, and the plate washed with water, or the image will be rendered too dense by fresh precipitation of Silver, and the middle tints in the face will be lost in consequence. The blacks are rarely quite pure when the plate has been too much developed, but show either little spangles of Silver or a general clouding.

When the Sulphate of Iron is washed off before the proper development is complete, the whole image looks very thin and weak, with a blue or greenish tint: the details in the shadows may perhaps be visible, if the plate was fully exposed, but usually they are more or less defective. The difficulty, with the beginner, is to distinguish the effects produced by wrong exposure in the Camera, from others due to faulty development. A little care, however, will usually enable him to do so. If no details appear in the dark shadows, the image is either under-exposed or under-developed, but in the latter case the lights would be very poor and thin, as before described; whereas in the former they would probably be vigorous, especially if the operator kept the Sulphate of Iron for a long time upon the film with a hope of bringing out the shadows.

The finished picture in another case, the reverse of the last, may appear altogether too white and flat, without any deep shadows, every portion of the plate showing more or less of a deposit of Silver. In this instance it is either over-exposed or over-developed, but probably the former, and particularly so if the lights are not of a very good colour, but appear grey and feeble, *and if the whole image shows very fairly as a Negative when held against the light.* You may always calculate upon diminishing excessive density of the face and light parts by over-exposing in the Camera, but over-development makes them quite opaque, so that the black varnish, when placed beneath, does not show through. On the other hand, a prolonged exposure produces a far greater effect in clouding over the shadows, and giving a grey colour to black drapery, than any amount of over-development.

When all the Chemicals are in good working order, the finest Positives are obtained by giving a rather short exposure in the Camera, because the lights are then of a pure white, and the shadows transparent. With a Collodion not suitable for Positives, the image would be too intense when developed after a short exposure.

Wash the plate with water, to remove the whole of the Iron, before putting on the Cyanide, else a blue deposit will often be formed. The Cyanide may be used over and over again until exhausted.

In mounting glass Positives it has become a common practice to cover the back of the glass with black varnish, and to mount the picture with the Collodion side towards the eye. The image is necessarily reversed, but the whites are very bright, and the shadows sufficiently clear if the Collodion be of the transparent kind, and if the front is also varnished with a hard-drying transparent varnish, the image will not so readily fade away when thus protected from noxious fumes.

CHAPTER VIII.

THE NEGATIVE COLLODION PROCESSES ON GLASS.

SECTION I.

WITH IODIZED COLLODION.

THE manipulations connected with cleaning, collodionizing, &c., the glass are the same as those described in the previous Chapters; but the chemicals and the mode of using them differ in some respects.

As described in the last Chapter, the glass having been cleaned, polished, and with a broad camel's hair brush freed from adhering dust, is coated with Iodized Collodion made by either of the formulæ at p. 41. When the film has *set* it is introduced by means of a glass dipper into the sensitizing bath made and corrected according to the formula at p. 44. Extreme care must be taken to introduce into this bath, along with the plate or otherwise, as little as possible foreign matter, such as that of an organic kind, inasmuch as Iodide of silver *per se* is very much more liable to be disturbed in its action by such contaminations than are the mixed Iodide and Bromide.

When the plate is fully sensitized in the Nitrate solution, it is exposed in the Camera, usually for a longer time than that required for a Positive on glass, and the slide, with all convenient speed, removed into the dark room.

The image is developed by the following solution:—

Pyrogallic Acid	3 grains.
Distilled Water	1 ounce.
Glacial Acetic Acid	30 minims.
Or Citric Acid . .	2 grains.

In hot weather less Pyrogallic acid may be dissolved, if on trial it is found that the developer acts too energetically. Again, in cold weather the restraining Citric or Acetic acid may be diminished if the development proceeds too slowly, but still leaves the image clear.

On taking the plate out of the slide there will be some accumulation of Bath solution at the lower edge, which, if the glass be held horizontally for a short time, will be seen to work its way along the surface of the film; and the effect will be to produce *a transparent* mark on applying the Pyrogallic Acid. To prevent this annoyance, the film may be pressed vertically, for an instant, on absorbent blotting-paper, and the liquid drawn off by suction.

The Pyrogallic Acid solution having been previously measured out (about three drachms for a plate 5 × 4, one ounce for a 9 × 7, and twelve drachms for a plate of 10 × 8), hold the glass in the hand in the same manner as when coating it with Collodion, and throw the liquid on evenly. It must not be poured from a height on to one single spot, or the whole of the Nitrate of Silver would be displaced from that spot, leaving a transparent mark of non-reduction. The lip of the developing glass should be depressed until it nearly touches the film, so as to apply the liquid close to the edge of the plate, or to some part of the image which is of minor importance. Always pour out the whole of the measured quantity of developer, and then move the plate so as to keep it waving backwards and forwards upon the film. It will be quite necessary to have the source of light so arranged that it falls nicely upon the Collodion surface, because the operator has to tilt the glass until the developer runs into each of the corners, and to keep his eye upon the wave as it moves backwards and forwards, in order to prevent it from flowing off at the edges of the plate, or trickling down his sleeve.

The freedom with which the developer flows depends much upon the Collodion, and the length of time it was held before dipping, since if the film retain too much Ether it will repel aqueous liquids. It also depends upon the Bath in a measure, for when this solution is newly mixed, and comparatively free from Alcohol, it will be sometimes necessary to give the plate a sudden *jerk*, to prevent the Pyrogallic Acid solution from stopping short of the edge.

Notice whether the developer remains bright and clear, or becomes turbid before the image is fully brought out. In the latter case the heat is too high, or the chemicals are in fault, and the Chapter on "Failures" must be consulted.

Watch the course of the development for about thirty or forty seconds, and especially the behaviour of those parts of the film which at first remain yellow, but at length begin to evolve fine details corresponding to the shadows. Keep the Pyrogallic Acid on the plate until nothing more appears in these yellow parts, and then pour it off into a measure, and hold the plate for an instant against the light, so as to look through it and see the appearance of the Negative image.

At this point a failure very commonly occurs, from the operator being too tardy in his movements, and allowing the developer to run into oily lines, so as to produce diagonal black streaks upon the film.

Having decided that the image is sufficiently intense, proceed to the fixing; but if it appears too weak (and allowance must be made for the lowering action of the Hyposulphite), carry the development into the second stage. To do this, pour away the discoloured Pyrogallic Acid, and wash out the glass rapidly with water; then measure out a fresh portion, add to each drachm about five drops of a 20-grain solution of Nitrate of Silver, and apply it a second time to the film, until the desired intensity is obtained.

It is not recommended to add a few drops of the Nitrate bath to the Pyrogallic Acid, but to employ a weaker solution of Nitrate of Silver, not saturated with

Iodide. This Nitrate of Silver must also be very pure, else the developer will soon discolour and the shadows become stained.

As *time* ought to be economized as much as possible, observe the following :—If the image is well out before the Pyrogallic Acid becomes turbid, it will be unnecessary to throw away the first portion, but any amount of strengthening may be obtained by pouring the same developer back into the measure, and adding the Nitrate of Silver. Neither is it necessary to wash out the developing glass with water when it contains Pyrogallic Acid *simply discoloured*, but anything approaching *turbidity* will suggest an immediate change of solution, and a washing with water, both of the film and the glass. The addition of fresh Nitrate of Silver to a developer in such a state, is improper: the Silver then falls irregularly, and the chance of staining is increased.

With regard to the quantity of Nitrate of Silver to be added to the developer, nothing positive can be stated. At least three times as much will be required in cold as in hot weather, and something will depend upon the condition of the developer itself. The rapidity of discoloration or turbidity in the Pyrogallic Acid is the proper guide to follow; and the two liquids may be mixed even in equal bulks if it is found that the mixture remains clear for twenty or thirty seconds, so as to give time for pouring it over the image. As a rule, however, the less the quantity of Silver in proportion to the Pyrogallic Acid the better.

Convenient dropping bottles can now be had at most of the Photographic warehouses. Or a small thin-lipped phial may be used.

Appearance of the Negative image developed with Pyrogallic Acid, as a guide to the exposure to Light.—An under-exposed plate develops slowly. By continuing the action of the Pyrogallic Acid the high lights *become very black*, but the shadows are usually defective, nothing but the yellow Iodide being seen on those portions of the plate. After treatment with the Hyposulphite, the picture shows well as a Positive, but by transmitted light all the minor details are invisible; the image is black and white, without any half-tone.

An over-exposed Negative develops rapidly at first, but soon appears to blacken slightly at every part of the plate. After the fixing is completed, the image is indistinct, and very little can be seen by reflected light but a uniform grey surface of metallic Silver. By transmitted light the plates often show a red or brown colour, and the image is *faint* and flat. The half-shadows having acted so long as nearly to overtake the lights, there is a want of proper *contrast;* hence the over-exposed plate is the exact converse of the under-exposed, where the contrast between lights and shadows is too well marked, from the absence of intermediate tints.

A Negative which has received the proper amount of exposure, usually possesses the following characters after fixing:—The image is partially but not fully seen by reflected light. In the case of a portrait, any dark portions of drapery show well as a Positive, but the features of the sitter are scarcely to be discerned. By transmitted light the figure is bright, and appears to stand out from the glass; the dark shadows are clear, without any misty deposit of metallic Silver; the high lights black *almost* to complete opacity.

Collodion with strong organic reactions gives a Negative which often shows upon the surface of the glass nearly as well as by transmission. And if the light be at all good, the yellow creamy appearance which Photographers term *bloom* ought to be seen upon the image. Its absence in the case of a simply iodized Collodion, not containing Bromide, usually implies that some of the chemicals are out of order.

Fixing the Negative.—Fixing the negative, or in other words removing from it all the unaltered Iodide, is best done in the case of Pyrogallic developed images by a strong solution of Hyposulphite of Soda. Even a very weak solution of Cyanide of Potassium is apt to weaken the half-tones of such images on account of the exceedingly fine deposited particles of Silver, whereas strong Hyposulphite of Soda solution, unless allowed for a long time to act, exercises no such baneful propensities. The plate may be either dipped in the solution until the yellow appearance has disappeared, or the solution may be poured over the plate.

Washing the Negative.—This may be done in any place where there is abundance of water, only the washing must not be long delayed. The best place is under a tap running with a gentle stream—a violent stream would wash away the film altogether, and so would a gentle one if the still tender film is placed too far below it. Wash first the picture-side for a short time, and drain the superfluous water from a corner for an instant. Next do the same with the back of the plate, and allow the stream also to run over the fingers, to remove any soluble impurity resting on them; drain again, and for a minute at least let the water run on and off the picture-side. Finally, place the negative, slightly strutting, against a flat board, collodion side next the board (to prevent dust from attaching itself to the still soft and tender film) and resting on several folds of blotting paper, which absorbs the moisture as fast as it drains away, and prevents dust from creeping up by capillary attraction. In washing plates under a stream of water impinging on the films for the same time, there is a way of doing the operation thoroughly well and a way of doing it badly. Simply putting the plate under a stream of water or soaking in any amount of water for a few minutes will not remove all the fixing solution. The plate must be *drained* or allowed to drip by holding it perpendicularly every now and then for a few seconds. In this way all the fixing solution can be removed with little water and less trouble in a very short time.

The writer has seen a pernicious practice adopted by some operators busily occupied in studios—viz., that of standing up the newly fixed plates inside a large tub of water, leaving them to wash themselves whilst they were otherwise engaged. If a stream of water were running through the tub this plan would be effective; but if the water is not changed several times, such washing amounts only to a greater or less dilution of the fixing liquid, and consequently some portion of the fixing salt remains in the film, and eventually destroys the image.

SECTION II.

THE NEGATIVE PROCESS ON GLASS WITH BROMO-IODIZED COLLODION.

This is the process now generally adopted both for portraits and landscapes, inasmuch as there is less liability to failure from impurities of the chemicals; and not because the process itself possesses greater sensitiveness to luminous action.

The constitution of the Collodion has been given at p. 40, and of the Nitrate sensitizing bath at p. 43. Here, also, the cleaning of the plate, the collodionizing, the sensitizing, &c. are the same; but the mode of development is somewhat different from the two processes already described.

The primary developing solution consists of:—

Protosulphate of Iron	15 grains.
Glacial Acetic Acid	30 minims.
Water	1 ounce.

Filter if there be any turbidity.

According to temperature this normal solution may advantageously vary in the proportion of its constituents. One constituent will alter all the rest, water being the most convenient.

In very hot weather, or when the developer acts with uncontrollable energy, weaken the solution by increasing the amount of water. Or, again, in cold weather, when Chemical action is less powerful, decrease the proportion of water.

The mode of applying this developer is the same as that given at p. 64. But since Iron, as a rule, acts more rapidly than Pyrogallic acid, more manual dexterity is required in applying the solution so as to prevent unequal development.

It will seldom be found that sufficient density of negative can be obtained by the first development. A secondary stage, or reinforcement of the image, must therefore be had recourse to.

To effect proper density, the first developer is washed off—a slight rinse with water will be enough—and while the film is still moist, a fresh solution of Iron is poured into a clean cup, into which a few drops of Nitrate of Silver, acidulated with Acetic acid, have been previously put. Instantly apply this mixture to the film, and spread evenly. Tilt the plate about gently to keep the solution in motion; after a few seconds pour the redeveloper back into the cup and look through the negative held up between the eye and the orange window or lamp of the dark room. If sufficient density of deposit is not manifested, rinse the film with water and again apply in the same way a fresh solution.

Mr. Wilson, of Aberdeen, who has been exceedingly successful in his Photographic practice, adopts a slightly different method of intensifying the image. After washing off the first developer, he scatters over the film itself a few drops of Nitrate of Silver and redevelops with a fresh dose of Protosulphate of Iron.

Another mode of intensifying a feeble iron-developed image is frequently adopted. This plan is very efficacious, and the only danger attending its adoption is the carrying of the redevelopment too far.

Pyrogallic Acid	1 grain.
Citric Acid	2 grains.
Distilled Water	1 ounce.

When the iron-developed image has been *well washed*, and before it has had time to dry, a few drops (more or less according to the size of the plate) of *Aceto*-acidulated Nitrate of silver is stirred up with *quant. suff.* of the above Pyrogallic solution and poured on and off till by looking through the negative sufficient opacity of deposited silver has been obtained.

It must ever be borne in mind that all these reinforcing appliances, before the plate is fixed, must be made in the dark room, as the film is still sensitive to Actinic light.

The plate is now fixed in a weak solution of Cyanide of Potassium, or in a strong solution of Hyposulphite of Soda, and afterwards carefully washed, as already described, and set up to dry.

Intensifying after Fixing.—It will sometimes be found after the finished Negative has been taken out into a strong light and examined, that the density of the deposit is not sufficient. In that case, take the plate back into the dark room before it has had time to dry, and reintensify by the Pyrogallic Acid formula and silver. This may be done in daylight, but the developer decomposes more rapidly. No more perfect test than this for a thoroughly washed Negative can be found. If the fixing solution has not been entirely eliminated, brown patches will be developed in those places where the least traces of Hyposulphite of Soda or Cyanide still linger. Of course the plate must be again thoroughly washed and set up to dry on blotting paper.

VARNISHING THE NEGATIVE.

Before printing *positives* from the *negative*, it is essential that the latter should be varnished or protected from injury, because a dried Collodion film is easily scratched, and is very absorbent of moisture, which would render it still more tender, or maybe detach the film altogether from the glass.

The composition of the best Photographic varnishes is kept a profound secret; but even were all the materials known, so much success depends on the method of compounding them that it would not be worth the Photographer's while to manufacture them on a small scale for his own use, as the most efficient kinds can be purchased cheaper and probably much better than he himself could make them. It is not recommended to use those varnishes which may be applied without first warming the negative, because it has been found that they afford a less efficient protection to the film than some others which require the glass to be heated.

Hold the picture-side of the glass in front of a clear fire, until the back of the glass feels hot, but not unbearably hot, when laid on the back of the hand. Gently brush off, with a broad camel-hair brush, any particles of dust which may have settled on the film, and at once pour on the varnish, exactly in the same way as is done with collodion, returning the excess into the stock bottle. Move the plate backwards and forwards edgeways for a few seconds, taking care to keep the draining end lowermost. While the last drop is still hanging at the lower corner wipe it off with the finger or a piece of blotting paper, and at once hold the plate again towards the fire, but not too near, because the vapour of the alcohol or other solvent of the varnish might ignite, and the flame leap to the surface of the plate and instantly destroy it, besides, probably, seriously burning the hand. The varnish should dry in a few seconds into a glassy surface. Should it dry *dead*, as it is called, or without gloss, either the varnish is bad, or the plate has not been sufficiently warmed. Waves or streaks on the film show that the varnish has not been properly applied, or that the plate has been too hot.

Varnished negatives should not be printed from till some hours after the varnish has been applied, because a slight *tackiness* will be apparent for some time, and this might cause the paper to adhere to the surface and pull off with it portions of the film.

STORING OF NEGATIVES.

The preceding instructions would be incomplete without some observations on the best methods of storing Negatives so as to prevent the film from cracking or peeling off by vicissitudes of temperature or moisture, or becoming scratched. For this purpose grooved plate boxes are generally used, the grooves serving to keep the plates apart. There can be little objection to this plan, provided the boxes are always kept in a dry room and at an equable temperature; and a great advantage in its favour is, that if each box is numbered and the contents tabulated, the operator can with little trouble lay his hand upon any Negative that may be wanted for printing.

When operations are carried on on a large scale it is usual to have a room fitted all round with grooved shelves, divided into compartments, each compartment being marked with a letter of the alphabet and each groove numbered. A catalogue of the Negatives, describing the subject, is kept in the room, and to each entry is attached an alphabetical letter and number corresponding to the position of every Negative. Thus it will be very easy to lay one's hand at any time on any particular Negative which may be required.

A series of cupboards running round the room, and fitted with grooved shelves in the same way, would be an advantage, because thus the Negatives would be protected from dust. In damp and cold weather a fire or stove in the room would be desirable. Indeed, as a general rule, the storing place should be kept at as equable a temperature as possible, and free from dampness.

Another plan of storing Negatives, which has much to recommend it, may be advantageously adopted by amateurs who only work occasionally. Pack up the

Negatives by the dozen, or any other convenient number, the plates resting on one another, and having a piece of clean blotting-paper interposed between each to prevent scratching of the film. Tie the package tightly up in cartridge or brown paper, and attach to it a catalogue of the contents. Stow away in a dry cupboard.

CHAPTER IX.

PORTRAITURE.—POSITIVE AND NEGATIVE.

The Glass-house.—We commence this chapter by remarking upon the advantages, or the contrary, to be expected from the use of a glass-house in Collodion Portraiture; adding at the same a few hints on the mode of its construction. Those who are accustomed to work beneath glass are often at fault on trying to take a picture in the open air, and obtain under such circumstances a hard and unpleasing portrait, with exaggerated contrast of light and shade. It is, without doubt, somewhat difficult to secure fine gradation of tone when the object is brilliantly illuminated, partly on account of the actinic power of the lenses which are employed in portraiture; and, therefore, unless the Chemicals are prepared purposely, the subdued light of a glass studio is likely to give the best effect.

Great diversity of opinion prevails as to the best mode of constructing a glass-house. There are, however, some principles generally agreed upon which may be here stated. The glass-house should, when practicable, have its greatest length in the direction of North and South, so that the sitter may be placed facing the North. It should be glazed with a pure colourless glass, as window-glass has usually a green tint, and when exposed for many months to the air becomes also more or less yellow, and absorbs the actinic rays. The glass should extend nearly to the ground. This is not so necessary for half-length portraits as for the *carte de visite* form, where equal illumination down to the feet is required. A complete system of black-and-white curtains must be provided both for the roof and sides, to throw the light on that side of the sitter which seems to be most desirable. The roof over the sitter and the sides, to the distance of about three feet from the background, must also be opaque, since a vertical light on the head is apt to solarize the hair, so as to make it appear grey, and will also give strong shadows underneath the eye. The end of the room where the Camera is placed had better be darkened, to prevent diffused light from falling on the lens, and also to relieve the eyes of the sitter from the painful expression often caused by too much light falling on the retinæ.

The background may be varied according to the taste of the operator, but to produce a neutral tint, the colour should be somewhat like that of common brown paper. Unless, however, the surface is quite dead, the effect of the background will depend upon the amount of light which shines upon it, so that it will produce a different colour in the open air from that given in the glass-house.

Proper ventilation is of the utmost importance, the heat being excessive in the summer months.

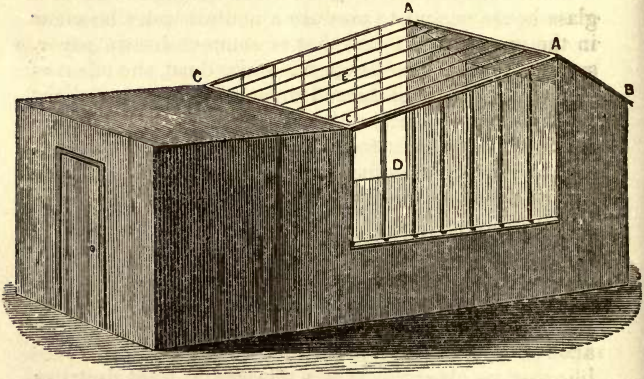
The developing room is frequently made smaller than is advisable, the consequence of which is, that it becomes almost unbearable in hot weather. It ought also to be more generally known that the vapour of Ether, when continually inhaled, has an extremely depressing effect upon the nervous system.

It may be observed that a horizontal light destroys the shadows entirely, and is suitable in the case of deep sunken features; but a light falling obliquely, partly from above and partly from the sides, and striking more upon one side of the face than the other, is the best in the majority of cases.

Some operators prefer to work in a ridge-roofed glass studio, regulating the light by means of a series of blinds. Others again select what is called the tunnel system, of which the accompanying illustration will serve to give some idea.

The tallest end of the background, B, is square—

a great advantage in taking groups—while all the rest of the room not actually wanted for light may be built of any opaque material, to keep out the heat. The quantity of glass surface need bear very little proportion to the size of the room, as ten feet of glass from the sitter (or from A to C) is sufficient, no matter how long the room may be. If the room is sufficiently wide, there need be no side-lights at all. About three or four feet from the background of the under surface of glass, from A to B, may be blackened or built of opaque material, as shown in the drawing. Supposing the room to be twelve feet wide, the highest part of the roof, A, should be about ten, sloping down for about eight or ten feet from the sitter, or A, to the lowest part, C, which may be a flat roof, leaded or tiled, or other opaque material, and which need be no higher than convenient to walk under. The sloping part just over the head of the sitter, A, B, may be hinged as a flap, to be lifted up when the weather will admit, as the warm air ascends to this, the highest part. This makes an admirable ventilator, even in this country, in summer. The back, B, should be placed against a tall house, if possible, while the rest should be placed so as to



have no obstructions. The interior of the room should be coloured a pale green colour, without pattern of any kind, as a pattern would distract the eye of the sitter.

The blinds on the top lights, E, may be made to pull down from A to C ; spring blinds are best, if good. The side-lights, D, may be managed with curtains.

Many operators prefer to work in what is called a *ridge-roof* studio ; but obviously the light is more difficult to control on account of the many fittings of blinds which will be required under different conditions of illumination. On the other hand the ridge roof studio possesses some advantages.

Directions for Working in the Open Air.—When a glass-house is not at command, portraits may be taken in the open air. Indeed, a glass-house is only necessary as a protection from the wind, dust, and the inclemency of the weather. By selecting a proper situation, and by a judicious arrangement of screens, portraits with as much roundness and delicacy of detail can be taken out of doors as in. Mr. Shadbolt, who has given much attention to this subject, gives the following directions :—

"If we can find a spot where an angle is formed by two walls of a building—the walls standing respectively north-east and north-west—we have in fact nearly all we require; for by making a light wooden frame of about eight feet square, and covering it with stout unbleached calico-sheeting, we form a roof or canopy that can be readily fitted into the angle formed by the two walls, and that will give the requisite shade over the heads of our subjects. This square frame can also be readily raised or lowered at pleasure by a little ingenuity : and further, by posing our subjects so as to look towards either the north-west or north-east—that is, making each wall alternately the background—*either* side of our subject can be the most strongly illuminated; and the walls may either be painted of a suitable colour for backgrounds, or covered temporarily with such materials as we may select for the purpose. The aspect indicated is not only preferable on account of uniformity of the light, but, as a rule, it will also be one most sheltered from wind in the summer time, when amateurs are most addicted to photographic pursuits.

"With regard to the point of holding the canopy in position, we have only to attach cords to each corner and gather them to a central point above it, so as to convert the frame into a kind of scale. To the point of convergence of the cords from the angles we attach a somewhat stouter single cord, and this, drawn through a small pulley, or even a ring, attached to the wall above, will enable us readily to raise it. The cord can be run through a second ring or pulley to enable us to draw it conveniently without interfering with the canopy itself; and the weight of the same may be counterpoised by a piece of iron, or even by a large stone. Lastly, a couple of long nails partly driven into the wall at the proper height may be so arranged as to prevent the frame from assuming other than a horizontal position. It is evident that with the aspect above indicated it will never happen that the sitter is exposed to the direct rays of the sun; but when from variation in the aspect this inconvenience does arise, it is so difficult a matter to apply an appropriate screen out of doors, that it will generally be better to modify the arrangement altogether."

When the desired conditions of a high building cannot be obtained, portraits may be taken in an open courtyard or garden by attending to the following precautions:—Always back up the sitter, if possible, by a dark ground, not less than seven feet square, to prevent diffused light from entering the lens. To make an effective screen, construct in the first instance a strong deal framework, consisting of a central portion, with two lateral ones hinged to it. Cover the whole with oil-cloth, painted of a suitable colour, and as free from gloss as possible. By bringing one of the two sides forward, you are enabled to throw a shadow on the face of the sitter, and by turning the other side back the whole arrangement may be fixed and rendered firm. Probably a screen will be required above to cut off the vertical light; and if so, the apparatus may be still further strengthened by constructing this part of a deal framework made to bolt down against the side which projects forward.

When everything is complete, stand in front of the lens and look in through the glasses from below upwards, to see if there be any reflection from the sky, or other bright objects. Unless the lens be placed very near indeed to the sitter, it is almost certain that there will be something of this kind, and if so a foggy picture will result. A large funnel of cardboard, lined with black velvet, should in such a case be carried out to a distance of about a foot in front of the lens, and the mouth of this funnel should be contracted as far as possible until it begins to cut off the corners of the field. This will render the image very clear, and will wonderfully improve the quality of the picture. Before exposing the plate, throw a black cloth over the end of the funnel, which will be found sufficient to exclude the light.

It is on account of the size of the glasses in a portrait combination, and the fact of their presenting so large a reflecting surface, that the above precautions are required. If small diaphragms were used, the sitter might be arranged with the open sky for a background without producing fogging.

It is beyond the scope of this manual to give instructions for *posing* and lighting the sitter, our main object being to describe the various Chemicals and apparatus, and to teach the student how to use them. They who desire valuable information on what may be called the Æsthetics of Photographic Portraiture, are referred to Lake Price's* valuable work, in which he treats of the composition of subjects with great clearness and artistic ability.

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* "Manual of Photographic Manipulation." By Lake Price. J. Churchill and Sons, New Burlington Street, London.

CHAPTER X.

LANDSCAPE PHOTOGRAPHY WITH WET COLLODION.

SECTION I.

The Apparatus.—We have already (page 20) stated generally the essentials of a good Camera, and described the method of testing it for admission of white Light. For landscape work, however, the Camera should be made as light as is consistent with efficiency, because, when travelling, portability is a great object, and often one has to scramble over very rough places to reach his selected subject. For small sizes of plates, what is called the rigid Camera will not occupy much space, and is easily carried about; but when we come to large sized plates then a folding Camera is preferable.

The most convenient and portable form of Camera is the bellows-bodied or Kinnear Camera, which folds up into little space when not in use, and when extended, is not more liable to vibration from a gust of wind than a heavier instrument. The focussing arrangement in small Cameras usually consists of a rack and pinion movement worked from the side, and in larger Cameras of an endless screw turned from behind the focussing glass. When folded up, the Camera should be carried in a leather case.

The *Tripod stand* should be firm and unyielding, because it is generally from gusts of wind blowing on this that vibration is communicated to the Camera, the effect of which vibration during the exposure of a plate is to render the outlines of the image hazy and indistinct, just as if the image were out of focus. The legs of the stand should be about five feet long, so that when extended, to secure stability, the Camera screwed on the gun-metal top may be at least four feet from the ground. In fact, the Camera should be placed as near the level of the eye as possible, in order to give a correct representation; but as that necessitates inconveniently long legs to the stand, we must strive to get as near to the truth as we conveniently can. Folding stands are now made on such good principles, that when set up they are quite as rigid as the ordinary tripod stand, and a great deal more portable.

The lens for general landscape work may be the ordinary Single view lens, Doublet, Orthoscopic, or Triplet combination; but when Architectural subjects are prominent in the view, neither the Single nor the Orthoscopic lens should be used, as, at the margins of the picture, they give rise to sensible distortion of the image. Perhaps of all lenses the single combination gives the clearest representation of pure landscape, inasmuch as there are fewer reflecting surfaces on the glass of the lens.

It is usual, however, for Photographers who are travelling in search of the picturesque to carry with them several lenses of different focal lengths and of different construction, so as to meet the necessities of any case which might occur. These lenses should all be capable of being screwed into the same flange of the Camera by means of *adapters* supplied by the optician. Of course it is necessary before fitting a Camera with a variety of lenses to ascertain whether it is possible to bring the ground glass near enough for a short focussed lens and far enough away for a long focussed lens. The Kinnear or bellows-bodied Camera gives the greatest latitude in this respect, and is generally used.

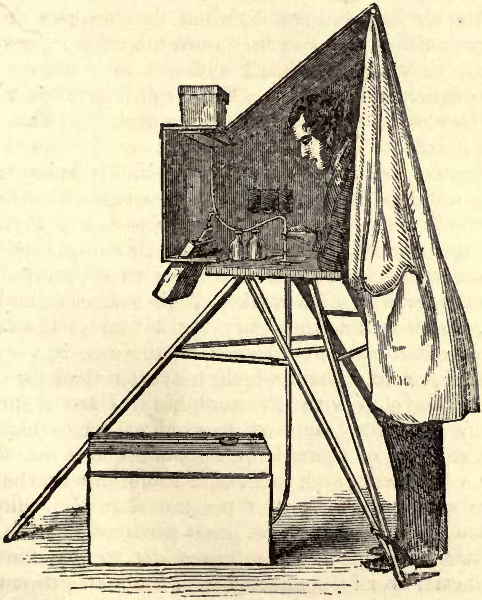
The Nitrate bath may be carried in a glass trough with a tight top of india-rubber screwed down on it, and mounted in a wooden case for protection. The glass dipper should not be carried inside the trough, because on the least violence it is apt to crack the trough, but in a case or wrapped up in clean paper.

These are called "water-tight baths." Many Photographers adopt another plan of carrying the sensitizing solution. Taking all contingencies into consideration, this second plan is the better. The glass trough is fitted with a spout at one of the upper corners, so that when the operator has finished his work at one place, the solution is returned to the stock bottle, and carried therein with little risk. Or the solution may be drawn off into the bottle by means of a syphon.

It is advisable when travelling to be provided with a greater stock of Nitrate solution than is required for filling one trough, because accidents *will* sometimes occur, and the Photographer may find himself in a position when he has not, and cannot procure the materials for a new one. In an emergency, filtered rain water will generally answer tolerably well for dissolving the Nitrate, but it should be collected from a clean roof and not allowed to stand long in the water-butt, which contaminates it with organic matter. As a rule river water will not answer well. The water from a spring rising through granite or slate is often very pure; water through limestone or chalk is loaded with lime salts in solution, but seldom contains much organic matter. To precipitate these lime and other salts add a little Nitrate of Silver, shake up well and expose to daylight for a short time before filtering. A sensitizing bath made from this filtered water often works very well. In making this emergency bath, we presume that the unfortunate Photographer has not also lost his crystals of Nitrate of Silver.

The portable dark room or photographic tent is a great hindrance; but when working the wet process far away from a fixed dark room, it cannot be dispensed with. Rouch's Photographic Tent, taking all things into consideration, is perhaps the best model that has yet been submitted to the public. The following figure illustrates its appearance when set up, the near curtain being purposely withdrawn to show the interior construction and the mode of using it. It may be called a "self-contained" dark room, as the hinged boards which give it rigidity also form the packing-box for all the materials connected with it, except the tripod stand. A small water-can placed on the top, with india-rubber pipe fitted with tap, and passing inside, serves to rinse the plate between developments, the waste water passing through the bottom to the ground through a similar pipe.

There should be no more chemicals inside than are absolutely necessary. These are the Collodion, Nitrate bath, Developing solution, and a small dropping-bottle, containing silver solution for intensifying. The fixing solution had better remain outside, because after development, if the plate is slightly rinsed with water inside the tent, it may be taken out and immediately fixed and washed in plenty of water.



The setting up and taking down of this tent occupies exceedingly little time. It may therefore be shifted without much trouble several times in the course of the day to enable the operator to be nearer his Camera. If a stream or well of water be near, pitch the tent close to that for obvious reasons.

Thus there will be three principal packages to be carried into the field for a day's work. 1st, The Camera, folded in its leather case; 2nd, the tent; 3rd, a box of leather strengthened at the corners and lined with green baize, or a rectangular wicker-basket, containing the Nitrate bath and dipper, glass plates in grooved box, and chemicals. In addition to this are the tripod legs for Camera and tent, strapped together, a can for fetching water, and the lenses in a leather case slung across the shoulder.

The bottles of solution, when they require it, may be replenished at home in the evening from the stock, and fresh glasses polished and put into the grooved box for next day's work. The Negatives taken should also be closely examined, and if approved of, varnished by a bright fire.

General Remarks on the Chemicals.—It is better not to complicate matters by having to carry about more chemicals than are absolutely necessary. For this reason the writer recommends that Bromo-iodized Collodion should be used in preference to simply Iodized. The former will often work well in a sensitizing solution, which would hopelessly fog a film of the latter. More particularly would such be the case in very hot weather, or in a bath which has been used for some time. Develop with Protosulphate of Iron, and intensify with the same as directed at page 68. Fix with solution of Cyanide of Potassium, as a little of it goes a long way, and, what is of some importance, it is more easily washed out of the film than Hyposulphite of Soda, which clings with great pertinacity.

There are various little *dodges*—let us say, for want of a better word—connected with the management and mixing of the chemicals, which cannot all be particularized, but which the student after some experience will find out and accommodate to his own particular mode of working. He will find, for instance, how important it is in hot weather, or when he has to go some distance from his dark room to the Camera, not to keep the plate in the bath after the greasy-looking lines have disappeared from the surface, and how advantageous to hasten this consummation by moving the plate about in the solution; he will find out how it is necessary sometimes to strengthen his developer, and at other times to dilute it, &c.

Arrangement of the Camera.—As before stated, it is not the object of this work to enter into the artistic principles involved in Photography; but it may be remarked that it is in the arrangement of the Camera and the light that the chief distinction lies between the Artist-photographer and the mere manipulator. The former selects his point of view with the object of attaining the best effects of light and shade of which the subject is capable; and having once selected it, is ready to sacrifice time and patience in waiting for the best moment of exposure. The mere manipulator, on the other hand, places his Camera anywhere and anyhow so as to include the subject, without reference to that which constitutes the greatest charm of a picture—viz., a nice balancing of light and shade. As a rule, after selecting the best point of view, and having ascertained by looking on the ground glass, whether the subject *composes* well, that is, whether the objects in it are grouped to the best advantage, then it will be necessary to watch the time when there are the best effects of illumination. After all care in this selection, a sudden gust of wind might come during the exposure and spoil the whole. Then it must be a case of try and try again, for a truly artistic Photographer is generally possessed of much patience.

Exposure.—With respect to the time of exposure, no definite rule can be laid down, so much depending on the light, state of chemicals, and the aperture and focal length of the lens. For instance, with the same lens, the exposure may vary from less than a second for a well-illuminated bright object, to half an hour or more for a feebly lighted interior. Beyond the latter time it is scarcely possible to keep a wet plate without injury, as the Nitrate solution on the surface becomes concentrated by evaporation, and eats out or dissolves the Bromo-iodide of silver in the film. Various plans have been suggested to overcome this difficulty; such as covering the plate with diluted honey, solution of deliquescent salt, or glycerine; but all these plans give rise to much uncertainty by diluting the free Nitrate on the surface of the plate, and thus detracting from its sensitiveness. Some kinds of Collodion will keep moist under long exposure better than others. A spongy porous Collodion keeps better than a horny or imporous sample, and as a rule Collodion salted with the alkaline and earthy Bromo-iodizers such as Potassium, Ammonium, or Magnesium are the best in this respect.

Miscellaneous Observations.—In all cases where a considerable time elapses between the exciting and developing of the plate, also in very hot weather under any circumstances of exposure, the developer will flow over the film much more uniformly if for each ounce of it there is added about a drachm of alcohol. When a plate has been kept long after being sensitized, it is sometimes recommended to redip it in the Nitrate bath before developing. This is a capital plan for the plate, but a very bad one for the bath, because the plate carries with it into the Nitrate any contamination which it may have received while in the dark frame. If this plan is to be adopted at all, a better way would be to keep a separate solution for this purpose only.

In out-of-door Photography, where a plentiful supply of water cannot be had, it is not necessary to complete the washing of the plate at the moment. The plate may be slightly washed, and immediately stowed away in a close grooved box, so as to preserve it in a moist state. The washing may be finished some hours afterwards where there is the convenience of abundance of water. Take care that this box be not again used for storing fully washed negatives until it has been thoroughly soaked in plenty of water. Even then it is not safe, for the wood will retain traces of the fixing salt in spite of any amount of washing. The box should be used for one purpose only, and that its original one.

Some photographers, in order to save time when the Light is favourable, after the developer has been applied and when it is seen that the Negative is good, at once rinse it with water, and shut it up in a Light-tight grooved box. Afterwards, the remaining operations are performed when the operator is more at leisure in the evening. This plan is not to be commended, for unless the developer has been entirely washed away, it will go on acting slowly but surely so long as the film remains moist. Far better would it be to secure one really good Negative than ten indifferent ones.

SECTION II.

COPYING OF ENGRAVINGS, PHOTOGRAPHIC PRINTS, PAINTINGS, &C.

In this branch of Photography, although entirely of a mechanical nature, there is much room for skill and judgment in the arrangements. The best lenses to use are the Triplet or the non-distorting Doublets of Ross, Dallmeyer, or Steinheil, if exact fidelity of outline is required. The ordinary single or Portrait combination may be used when exactitude in the marginal parts of the picture is not a *sine quâ non.*

General Directions suitable for all sorts of Copying.— The Camera should be so placed as that a line passing from the centre of the focussing glass, through the Lens, to the centre of the object to be copied, shall fall perpendicularly on this latter surface. The mode of ascertaining this is very easy. Having fixed up the flat object to be copied in a suitable light, place the Camera opposite and move the latter backwards or forwards until the image on the ground glass is of the required dimensions. Now focus for the centre of the picture. If the object is of a rectangular shape, it should appear so on the ground glass; but as the eye is not a reliable judge in such matters, apply a pair of compasses to measure the upper line on the ground glass. The lower line should exactly correspond. In like manner measure the side lines. The Camera will be easily adjusted if we bear in mind the facts—viz., that the shorter line on the ground glass is farther from the Camera than the other, and that on the ground glass the shorter side is represented by the opposite side of the picture. The corrections may be made right by either slightly twisting round the Camera or picture as if on a pivot, without altering the distance between the centres of the Lens and object, and again focussing.

All this seems troublesome, and undoubtedly does entail a great deal of careful labour. Photographers who make a speciality of such kinds of reproductions adopt a different plan by a fixed arrangement which may be thus briefly described.

A flat boarding is erected in a place where the principal light falls as far as possible perpendicularly on its surface. The boarding is fitted with holes and pegs, after the manner of a painter's easel; so that a cross board laid on the pegs may support a painting laid thereon. In the case of a drawing or engraving on paper, it is pinned down on a board with drawing pins at the corners so that it might lie quite flat; or if the paper has been folded up and creased so that it cannot be stretched out without showing seams which would throw shadows, let the drawing, &c. be pressed up against the glass of a frame similar to the ordinary printing frame, and the Photograph taken through the glass. In this case, however, it is important that the glass should be very clean, transparent, and free from scratches. Care also should be taken that no reflected light from the glass should fall on the lens. This is easily seen by inspecting the image on the focussing screen.

The copying Camera is laid on a flat table or stand, resting on four legs, fitted with castors, or rather flanged wheels, which run backwards or forwards on a kind of railway running quite perpendicular to the board on which the drawing, &c. is placed. When the picture is focussed, the wheels are clamped by means of a screw, so that picture after picture may be placed in the same frame or attached to the board, and negatives taken to the same scale without having again occasion to disturb the arrangement farther than taking a *peep* on the focussing glass to make sure that all is right.

The writer had an opportunity, some years ago, of witnessing an arrangement of the above kind, most perfect in details; but, unfortunately, it was too often used for the reproduction of engravings, &c. which were copyright.

In reproducing Daguerreotypes or Positives on glass, there are sometimes difficulties which cannot be altogether overcome, especially with the former, inasmuch as there are reflecting surfaces which interfere. Any one will understand what is meant by this reflecting interference, when he finds that it is only by turning about either himself or the Daguerreotype so as to get the image in the proper light that he can see a picture at all. When a Daguerreotype has to be copied without flare or reflections, the best way is to take it in the hand, after removing the glass which is usually placed over it, put the picture at arm's length in the studio or place where it has to be copied, walk round and observe the point where there are the fewest reflections. Fasten the Daguerreotype up there, and arrange the Camera to suit. There is much less difficulty with glass positives, the principal reasons being because the glass is flatter and the image of less metallic lustre.

Oil paintings can only be copied properly in a direct front light, because the colouring matter is often laid on in thick daubs, which throw a shadow downwards, or in a position opposite to the source of light. Then, again, in reproducing the outlines and shading of coloured pictures, another difficulty occurs. Shades which appear dark to the eye may be very light to the eye or lens of the camera. A dark blue will be white to the Camera's eye, and a bright yellow will be a dark patch. Hence it is impossible, under our present system of Photography, to give anything like a passable idea of a coloured painting. A photograph from a blazing, glorious painting of Turner's, for instance, becomes, at the best, a mere smudge of incoherencies. Hence it has become a custom on the Continent for Artists of eminence to paint in monochrome *fac similes* of their coloured paintings, and submit these to the Photographer, instead of having them engraved. The advantage of this plan is that large or small copies can be faithfully rendered, and none of the Artist's effect is lost by being filtered through the hands of an engraver. Artists ought to adopt this plan of redrawing in monochrome for the Camera, because, by the new modes of printing in the press in carbon or any other pigment, an exact *fac simile* can be produced at a lower price than is otherwise possible.

SECTION III.

STEREOSCOPIC PHOTOGRAPHY.

In the olden times of Stereoscopic Photography only one lens was used, mounted on Latimer Clarke's principle of taking first one picture of the object, and then, by shunting round the Camera fixed on a pivot, taking another picture on the other side of the plate. This is undoubtedly the correct principle of Stereoscopy, because it exactly represents what occurs in looking at an object with two eyes. The only objection to this plan lies in the fact that objects might move in the interval between taking them; thus the two pictures might be different, and would not coalesce when viewed in the Stereoscope. Latimer Clarke's plan, therefore, has been abandoned, and the Camera, fitted with two equi-focal lenses separated about three inches from each other, universally adopted.

It is very easy to give exaggerated relief to a Stereoscopic picture, or to give too little. The best distance for true relief of an object is the average distance between the eyes—from 2½ to 3 inches. If we decrease that distance, the relief or distance is too small, and if we increase it they are too large. For instance, if we take a photograph of a statue, say at 20 feet from it, and then move round the camera in a circle for 2 feet or more, so that no second focussing is required, and take another photograph, these photographs, when placed together in the Stereoscope, will appear solid, but not true to nature. *The image is pulled out in depth*, the distance from the tip of the nose to the back of the head appearing as great as that from the crown to the toe.

Pictures printed from the double Stereoscopic Camera have to be reversed in mounting; that is, the right-hand picture must be pasted on the left side of the mount, and *vice versâ.*

SECTION IV.

INSTANTANEOUS PICTURES.

So-called Instantaneous pictures have never been produced, unless we may believe the statement that the Father of Modern Photography, Mr. Fox Talbot, many years ago, photographed by an electric spark the spokes of a quickly revolving wheel, so that they could be individually distinguished. A flash of lightning is instantaneous, although it does not appear so to our eye, which retains the impression for a very short time; but it will not illuminate any object by its reflected light sufficiently long to give a Photographic impression. The flash itself in the dead of night gives a distinct impression on a Collodionized plate, and its zigzag character is clearly marked, but the illuminated clouds near it leave no impression. The writer spent a whole night, during a thunder-storm, in verifying this fact.

Nevertheless, in a bright summer light, when the Photographic Chemicals are in perfect condition, certain subjects, such as sea-waves, &c., may be photographed as quickly as it is possible to open and close the Lens.

The apparatus for uncovering the sensitive plate for the so-called instantaneous pictures may be either in front of the Lens or immediately in front of the sensitive plate. Mr. Wilson uses the former, and Mr. England the latter plan, both by simple arrangements which a sensible photographer can undertake for himself without a detailed description. The great matter is not to give a momentary vibration to the Camera during exposure. It is hardly necessary to add, that the aperture of the Lens must be the largest that is compatible with fair definition.

SECTION V.

PHOTOGRAPHY IN HOT CLIMATES.

Since the almost universal adoption of Bromo-iodized Collodion, Photography in the hottest climates is not so difficult as it was when simply Iodized Collodion only was used for Negatives. In India, the Collodion being necessarily sent from Europe, suffered decomposition in its transit to such an extent as sometimes to be thin and limpid, like water, and highly insensitive ; at other times, from the evaporation of the solvents, it became semi-gelatinous, and consequently useless. Collodion makers, taught by experience, can now manufacture and pack up Collodion in such a way that it may be Bromo-iodized in this country, and will retain all its good properties, except extreme sensitiveness, for many months in the hottest climates. It is important, however, if a large stock is in hand, to store it in the coolest possible place, and in the dark ; for it has been proved that both heat and light, even supposing there be no escape of the volatile solvents, have a great tendency to decompose Collodion. The fact remains, but the reason why is not very obvious. Experience teaches us another important fact—viz., that Collodion, although salted exclusively with the two most stable of all the salts,—viz., Iodide and Bromide of Cadmium, decomposes by heat and light much more rapidly than plain Collodion. Hence it has become the custom to send, to hot climates, the plain Collodion in bottles luted up or hermetically sealed, and the Bromo-iodizer in separate bottles with instructions for mixing.

The Iodide and Bromide of Cadmium are, so to speak, the *sheet-anchor* of the Photographer in hot climates, by reason of their less susceptibility to decomposition by ozonized or acid Collodion and light. But when used by themselves they are apt to render the Collodion too glutinous, so that it does not flow evenly over the plate. This tendency is particularly observable if the Pyroxyline has been made in acids at a low temperature. But if the Pyroxyline has been made in acids registering 150° Fah. or upwards less tendency is manifested.

The alkaline Iodides, such as those of Ammonium, Potassium, &c., are not suited for hot climates unless their tendency to decomposition is controlled by the Iodide of Cadmium. The alkaline *Bromides* show far less tendency to decomposition, and may be used ; but they possess no advantage over the Cadmium Bromide.

Upon the whole, therefore, it would appear that a judicious combination of Iodide of Cadmium with an Alkaline Iodide and with any Bromide, fulfils, in the most complete manner, the requirements of the Photographer in hot climates—always supposing that the plain Collodion has been properly prepared. More Bromide than the proportion given at page 40 is useful, inasmuch as under circumstances of high temperature, bright light, and a sensitizing bath not acid enough to give the Negative too much of a Positive character, there is less disposition to fogging of the image under the action of the developer.

With respect to the Nitrate bath, it may sometimes be necessary to reduce the strength as low as twenty grains of Nitrate of Silver to the ounce of distilled water; but this can hardly occur except under peculiar conditions of temperature and chemicals. Moreover, the Bromide exercises a controlling effect on the action of a strong Nitrate solution.

In regard to the developer, Protosulphate of Iron is by far the best; not only because it is, under any circumstances, the proper developer for Bromo-iodized Collodion, but also because its action is not so much influenced by temperature as Pyrogallic acid. In very hot weather and bright light, Pyrogallic acid, however dilute or controlled by acid, will sometimes cause what is called *red solarization* of the Negative; that is, the deposit is red, and no difference of opacity seems to exist between the high-light and the half tones. Such Negatives yield very *flat* proofs. The iron developer, under the same circumstances of exposure and light, shows no such disposition. It should be made weak, and its action controlled with an extra dose of Citric or Acetic acid if necessary.

Another difficulty that the Photographer in tropical climates has to contend with is the ever-varying actinic nature of the light. It often changes within an hour, while no seeming difference can be detected by the eye. Photographers in this country must have often observed this fact, although in a much less marked degree.

Apparatus and Package.—In selecting a Camera for a tropical climate, thorough seasoning of the wood is of the utmost importance. Teak wood is preferable to mahogany, being less liable to be attacked by the white ants. The Camera should be brass-bound, and the dove-tail joints secured by small brass screws. The sliding adjustments, which move within each other, should be accurately constructed so as to work very easily, while at the same time they give no access to light. For, since extremes of moisture and dryness prevail in tropical countries, the sliding adjustments are apt to jam at one time and be too loose at another.

Special care should be taken with the dark frames, to prevent the rays of the vertical sun from penetrating at the top when the shutter is drawn up to expose the plate.

The ordinary bellows or Kinnear Camera, which, on account of its lightness and portability is much in vogue everywhere for field work, is soon rendered useless in India by the ravages of cockroaches and other insects. These animals, however, do not seem to have much appetite for the strongly-scented Russia leather; and if the bellows part of the Camera be made of that material, they will keep aloof from it and everything touching it. Sandal-wood, too, is a complete protection, but this wood is too expensive, and the pieces so small, that a Camera made from it would be almost an impracticable idea.

It has often been remarked that expensive sets of apparatus have been sent abroad with an ill-assorted supply of chemicals, altogether inadequate to the work intended to be done; some being omitted altogether, or in very short quantity, others being in great excess.

The following list comprehends a well-balanced stock of chemicals and apparatus for a Camera adapted for plates 8 × 5:—

One gross No. 2 patent plate-glasses, roughened at the edges. Plate-box for twelve plates. Ditto for twenty-four plates. Two pneumatic plate-holders. Broad camel's-hair brush. Three wash-leathers, very soft. Five pints plain Collodion. Iodizing or Bromo-iodizing solution for ditto. Sulphuric Ether, sp. gr. 725, one pint; and Alcohol, sp. gr. 805, one pint, for thinning Collodion when necessary. Spirits of Wine for adding to the developer, &c., two pints. Water-tight Bath, enclosed in well-seasoned wood, brass-bound or dovetails fastened with screws. Spare glass bath for ditto. Two dippers in case. Fifteen ounces of best recrystallized Nitrate of Silver for making bath solution. Twenty ounces of common Nitrate of Silver for printing. Pyrogallic Acid, two ounces. One pound of Protosulphate of Iron. Glacial Acetic Acid, two pounds. Citric Acid, four ounces. Cyanide of Potassium, commercial, two pounds. Hyposulphite of Soda, eight pounds. Varnish for Negatives, two pints. Five flat-bottomed porcelain dishes, 10 × 8. Three quires of plain Saxe or Rive paper (medium thickness) for printing. Four quires albuminized ditto. Chloride of Gold, three drachms. Acetate of Soda, eight ounces. Four ounces of Bicarbonate of Soda. Half an ounce of Iodide of Cadmium. Bromide of Cadmium, half an ounce. Iodide of Ammonium, half an ounce. Iodide of Potassium, one ounce. Iodine, a quarter of an ounce. Kaolin, two ounces. Two quires filtering paper. Two glass or porcelain funnels. Scales and weights. Drachm (divided into Minims) and eight-ounce glass measures. Pure Nitric Acid, one ounce. A few stoppered, or better, corked bottles of different sizes for decanting Collodion and holding solutions. Tripoli, two ounces. Emery powder, fine, one ounce. Two printing frames with thick felt pad 9 × 7, inside measurement. Litmus paper. Argentometer. Dark tent, if required.

If the focussing screen should by mischance get broken, one may be made quite as serviceable as any that can be bought at the Camera-maker's, by rubbing two of the glass plates together with some fine emery-powder and a few drops of water placed between, and fixing one of them, when ground fine enough, in the focussing frame.

Albuminized paper will soon deteriorate unless kept in a dry place. It is usually sent out in an hermetically sealed tin case, which, unless the weather is dry, should not be opened till it is required for use.

Dry Plate Photography has been practised with much success in tropical climates. If the operator prepares his own plates, he will require to add to the above stock of chemicals those which are suitable for the particular process which he means to adopt, and to have his Camera fitted with double dark slides.

But as dry plates, which will keep in good condition for years, are now an article of commerce, and can be sent safely to any part of the world, the amateur Photographer need be at no loss for the requisite material if he has not convenience for preparing his own. The dry plates that keep the best are those prepared with Bromized Collodion, because when the alkaline developer is used as it ought to be with such films, every trace of the disturbing element, Nitrate of Silver, is washed away, or ought to be. In the next chapter instructions for preparing and developing dry plates in any climate will be given.

CHAPTER XI.

DRY PLATE PHOTOGRAPHY.

It is obvious from what has already been said that a sensitive Collodionized plate cannot be preserved in its sensitive condition for but a very limited time after it has been taken from the Nitrate bath. The Landscape photographer has, therefore, no option when using the wet process, but to carry about with him all the chemicals, &c. necessary for his work. This cramps his operations by entailing an amount of baggage which cannot always be carried into difficult positions. Were the dry processes as rapid and as sure as the wet, no one would ever think of using the latter—except, perhaps, in the studio, close to his dark room. Unfortunately, such is not yet an accomplished fact, although matters are all tending in the right direction since Major Russell discovered and described his rapid dry Collodion process with alkaline development. Without describing the various suggestions relative to keeping a sensitive Collodion film moist for a considerable time, by means of a deliquescent salt or a non-drying inert body like glycerine, all of which have turned out more or less failures, we shall content ourselves with describing a few of the dry Collodion processes which have been found to work the most satisfactorily for field work.

Section I.

THE COLLODIO-ALBUMEN PROCESS.

Many modifications of this process have been proposed and practised with more or less success. Mr.

Madd, of Manchester, has perhaps, of all operators, been the most successful on large plates. The following is his mode of procedure.

Coat the cleaned glass with Bromo-iodized Collodion in the usual way. After allowing the film to set well, sensitize in the ordinary Nitrate of Silver bath. If the Collodion should give a very thick and creamy film, it must be reduced by adding Ether. After sensitizing for the usual time, the plate must be well washed and then placed in a dish containing a weak solution of Iodide of Potassium and water (about one grain to the ounce of water) for two or three minutes, gently moving the dish in the meanwhile. Rinse with tap water and drain a minute.

To the whites of ten eggs add:—

50	grains Iodide of Potassium
10	„ Bromide „
100	minims Liquid Ammonia
2½	ounces Water.

Dissolve the Iodide and Bromide in the Water, then add the Ammonia. Mix all together with the Albumen, and beat the whole into a froth. Let it settle until the froth has subsided into the liquid form. Filter through muslin into a stock bottle.

Decant off a portion, and to the previously washed and still wet film, apply the solution twice. Now allow the plate to drain for five or ten minutes, then dry it rapidly before a clear bright fire, and make it quite hot. These plates may be kept till required for sensitizing.

To re-sensitize the plate, it is only necessary to dip it for one minute into the Aceto-nitrate bath, composed of:—

40	grains Nitrate of Silver.
½	drachm Glacial Acetic Acid.
1	ounce Distilled Water.

Warm the plate slightly before immersion for a minute or less, drain a moment, and then wash a few minutes in two or three changes of water. It is better not to dry the plates artificially, but to set them up on end, in the dark room, on several folds of blotting-paper which absorbs the drainage.

Collodio-albumen films dipped in solution of Nitrate of Silver soon discolour the bath although kept in the dark. This discoloration is prejudicial to clean development of the image. Shaking up the solution with Kaolin and filtering makes it again clear; but some operators prefer to pour a little of the Nitrate solution on and off the plate for a few times, and then throw the residue into the waste-silver jar.

Plates so prepared will keep in good condition for six or eight weeks in cold weather; but in hot weather it is advisable not to trust to their efficiency for more than a fortnight.

They are developed as follows. Take the exposed plate and pass over the surface a little clean water till the film is thoroughly moistened; then take a plain Pyrogallic solution, say two or three grains to the ounce of water, and pour it on the plate. The sky and high-lights will appear almost immediately, if the exposure has been rightly timed, and ultimately feeble indication of details. The picture now requires intensity, which is given by the following solution:—

Pyrogallic Acid	2 grains.
Citric Acid	2 grains.
Nitrate of Silver	2 or 3 drops (20 grain solution).

Pour *quant. suff.* of this on and off the plate until the requisite printing density is obtained.

Numerous modifications of this excellent dry process have been devised and worked, but the above may be considered a good starting point for the Photographer to alter according to his tastes.

The Negatives should be fixed with Hyposulphite of Soda, because Cyanide of Potassium will always weaken or destroy the semi-organic deposit, just as surely as if the image were a Positive print on paper.

SECTION II.

THE PROCESS WITH TANNIN, &C.

This group of dry processes is, of all, the most simple, and, with the exception of the Preservatives and the edging, requires no addition to the Chemicals used in the wet process.

The plate having been cleaned and polished as usual, receives an edging of thin India-rubber or Albumen, &c., to prevent the film from slipping during the washing and other subsequent manipulations. The best edging solution is a very thin one of India-rubber dissolved in Benzol. Two or three grains of *white* rubber to the ounce of Benzol forms a thick enough edging. The rubber should be taken from the interior of the piece, because the *black* oxidized external part does not dissolve so well. It is then cut into shreds and added direct to the Benzol in a bottle. After standing for a day or two the rubber swells up and will now readily dissolve if the bottle is placed for a short time in warm water and well shaken up. It will keep any length of time.

With a Camel's-hair brush dipped in this solution, make a thin border, to the depth of about one-eighth inch, all round the edges of the polished side of the plate. The edging dries immediately, and the plate is now ready for coating with Collodion.

Some dry-plate workers cover the whole of the plate with such a solution by pouring it on and off like Collodion. This is not a good plan, because it will sometimes be found that the Negative in drying cracks into very fine lines. Doubtlessly this arises from the two films of Collodion and India-rubber possessing very unequal expansive and contractile properties by moisture and dryness.

Thin Albumen, or any similar organic body having strong affinity for Nitrate of Silver, is not advisable as a substratum for the Collodion, unless one wishes to have his Nitrate bath permanently injured for wet work. Because, although the Albumen is covered and seemingly protected from contact with the Nitrate solution, yet in reality it is not protected; and the operator after a while will find his bath darkening in colour, and altogether unsuited for the wet Collodion process.

When the film is sensitized in the Nitrate bath, the plate is drained for a minute and placed Collodion-side upwards in a flat dish containing distilled or filtered rain water. After a few minutes it is transferred into another dish containing clean spring or river water, where it remains for about the same time. It is next transferred into another fresh bath of water, where it lies for about the same time; and as a final washing it receives a rinse under the tap, or from a jug of water. The intelligent operator will easily devise other modes of washing if he has not the conveniences here hinted at. *The principle consists in washing as evenly as possible, so that no part of the film receives more than another.*

If all the Nitrate has not been washed away, a Tannin preservative will make the film brown at those spots where Nitrate exists. Such plates are useless. Again, excessive washing must be avoided, because by that system, not only will all the free Silver be removed, but also the trace of soluble haloid salts which should exist in the back of the Collodion film. The latter salts seem to be necessary for the prevention of *fogging* under the action of the developer.

A Solution of Tannin, Gallic acid, or Pyrogallic acid, all of which are used as preservatives, applied to a freshly sensitized and washed plate, will, after a few minutes, indicate whether the washing has been sufficient. If the washing is insufficient, brown patches on the film will be discernible; but there is no test for excessive washing except that already indicated—viz., the proneness to fogging of the image by the developer, after exposure.

The Preservative or Organifying Solutions.—The name of these is *Legion*, and their functions in the film ill understood. All that we know practically is, that solutions of certain organic bodies applied to a sensitized and washed Collodion film, *resensitize* it, so to speak, and that in such a way that the dried film, under certain conditions, can be kept for days or even years and still retain its sensitiveness unimpaired. The following are a few of the most approved formulæ :—

Tannin	5 to 10 grains
Sugar	1 grain
Distilled Water	1 ounce

Tannin seems to be the principal resensitizer. The object of adding the sugar is to render the film more pervious to aqueous solutions after it has been once dried. Especially is sugar useful in very dry or hot weather. It adds nothing to the accelerating effects of the Tannin. A drop of Glycerine added to each ounce of the Preservative or organifying solution prevents the film from becoming *bone dry* and thus prejudicially interfering with the action of Light.

The above formula is sometimes modified by the addition of a little Gum Arabic, which is decidedly useful; but it must be added very sparingly, inasmuch as it has a tendency to cause blistering of the film during development.

A strong infusion of tea or coffee makes a good Preservative.

A decoction of malt, about four ounces to a pint of water, has been highly spoken of.

Plates thus prepared should be allowed to dry *spontaneously*, by resting them on end in the dark room, on several folds of clean blotting-paper, which absorbs the moisture and prevents it from running back, by capillary attraction, over the film, carrying with it any dust which may have settled on the paper. When dry they may be stored away in light-tight plate boxes in a *dry* place; or, if they have to be carried or sent to a great distance, they should be packed up in parcels (p. 116).

Exposure in the Camera.—This will vary from about four to ten times the exposure required for a wet plate; much depending on the nature of the light; for it has been found that, in a feeble light, the relative time of exposure is much prolonged, dry films of this kind being comparatively less sensitive to weak radiation. The best plan is to give a full exposure and to depend on the controlling power of acid in the developer. . . . .

The Development is best effected with Pyrogallic acid. The following formulæ may be considered good normal solutions which can be modified to suit circumstances of over or under exposure:—

(1)	Pyrogallic Acid	3 grains
	Citric Acid	1 grain
	Distilled Water	1 ounce
(2)	Nitrate of silver	20 grains
	Acetic Acid	2 drachms
	Distilled Water	1 ounce

The latent image is apt to fade away altogether or at least get weakened unless developed within a few days after exposure. To conduct the development the film is first moistened with water by rinsing it for a minute under a gentle stream, or by placing it for a short time in a dish of clean water. After draining for an instant, Solution No. 1 is poured on once or twice and returned to the developing cup. Two or three drops of No. 2 are now intimately mixed with the Pyrogallic and the mixture again applied to the film. If the image starts out evenly, clean and bright, continue pouring the developer on and off till by transmitted light sufficient density is obtained. But should the solution become turbid, it should be thrown away, the plate rinsed with water, and a fresh developer applied. Fix and wash as usual.

SECTION III.

A MORE RAPID DRY PROCESS.

In the process described in last Section, it has been assumed that the operator has been using the Collodion and Nitrate bath suitable for the wet process. So far this is an advantage, involving as it does only one set of Chemicals; but the highest sensitiveness of dry plates cannot be attained by the use of such materials. When rapidity of exposure, therefore, is a desideratum, we must operate differently and use a set of Chemicals for sensitizing the film which are not adapted for wet-plate Photography.

A plain Collodion made from equal parts of highly rectified Ether and Alcohol, in which are dissolved six grains of Pyroxyline, is selected, and Bromo-iodized by the following formula:—

Plain Collodion	1 ounce
Iodide of Ammonium . . .	1 grain
" " Cadmium	2 grains
Bromide of Cadmium . . .	3 grains

These salts may be shaken up in the Collodion until dissolved. After solution the Collodion is set aside for a few days to settle. The upper part is then decanted off for use. After Bromo-iodizing, it will keep in good condition for many months if properly stored. As Bromide enclosed in a Collodion film requires a longer time to sensitize than Iodide, and, when the bath is weak often bursts out on the surface of the film instead of allowing the nitrate to reach it inside, a strong bath is required. The following is the formula:—

Nitrate of Silver	40 grains.
Distilled water	1 ounce.

Dissolve in any quantity that may be required. Bromo-iodize as already described (p. 36). Filter and acidulate with Nitric Acid (p. 43); but here a considerable advantage is gained by having the bath decidedly acid, as the plates sensitize more quickly and are less liable to stains.

With such a large dose of Bromide the films require to be kept in the bath rather longer than is necessary in the wet process, and more than ordinary care must be taken in washing, because, as they have to be developed by the Alkaline method, free Nitrate of Silver is not admissible.

The preservative to be applied to them may be any one of those already mentioned (p. 103).

The exposure is about twice as long as that required for a wet plate. The developing solutions will be described under the head of *Collodio-bromide.*

SECTION IV.

RUSSELL'S METHOD WITH BROMIZED COLLODION.

Of all dry Photographic processes this is the most rapid, being equal in sensitiveness to wet Collodion. The following is a summary of operations:—

The Collodion.

Pyroxyline	4 grains.
Bromide of Cadmium . .	8 ,,
Alcohol, sp. gr. 810 . . .	4 drachms.
Ether, sp. gr. 730	4 ,,
Castor oil	1 drop.

The Alcohol and Ether should not be weaker. The quantity of Bromide may vary; that given is the minimum which will produce sufficient opacity on small plates. The larger the proportion of Bromide the more readily will the films be sensitized, washed, and developed, but the larger the spots caused by any specks of foreign matter.

The sensitizing bath consists of:—

Nitrate of Silver	60 grains.
Distilled Water	1 ounce.

Acidulate with Nitric Acid till blue litmus-paper is turned slightly red immediately after being introduced into the solution. The bath before filtering for use should be *Bromized;* that is, a few drops of a very dilute solution of a soluble Bromide should be added and shaken up with it.

An ordinary glass dipping-bath may be used, but the Nitrate solution soon becomes useless, from its tendency to the formation of crystals of the double salt called Nitro-bromide of silver. These being imbedded in the film, cause transparent pin-holes in the developed Negative. The chief incentive to their formation in this position is the Ether and Alcohol still existing in the film when the plate is immersed. The best plan for sensitizing such plates then, is undoubtedly in a *cuvette* or flat dish, because thus a large surface of sensitizing liquid is exposed to evaporation, and consequently these volatile bodies have free room to escape.

Purely Bromized films require a long immersion even in this strong bath—viz., from five to ten minutes, and they also require extra care in the washing to suit them for the Alkaline developer.

The Preservative used by Major Russell is Tannin, dissolved in the proportion of from five to ten grains in one ounce of distilled water, applied to the plate either in a bath or by pouring on and off several times.

Mr. Sutton recommends for these plates a Preservative which he considers superior to all others. It consists in an aqueous solution of Gelatine (about two grains to the ounce of water) rendered slightly alkaline. This is undoubtedly an excellent Preservative, but it is questionable whether it possesses any advantage over Tannin pure and simple.

The plates should be allowed to dry spontaneously (p. 100), otherwise *drying marks*, to which all dry plates seem to be more or less liable when subject to sudden changes in the rate of desiccation, will inevitably be the result.

These plates will remain in good condition for a very long time, for months or years, always provided that they are kept in the dark and sealed up from contact with moisture and silver-reducing agents.

The developer will be described at the end of next Section.

SECTION V.

THE COLLODIO-BROMIDE NEGATIVE PROCESS.

Of all dry processes this is the *ne plus ultra* of simplicity in some respects and complicity in others. It requires no Nitrate of Silver bath with all its accompanying messes and inconveniences. The plates can be prepared very rapidly, and require little washing to fit them for receiving the Preservative; they can be made highly sensitive, and when properly protected will keep for years in good condition. On the other hand, the utmost care is necessary in compounding the sensitive emulsion. Messrs. Sayce and Bolton, who first published a working formula comprehending all the details of manipulation, recommended the Bromized Collodion to be sensitized by adding finely-pounded silver, and shaking up the contents of the bottle in the dark room for a few minutes, until the emulsion, when poured on a glass plate, presented a creamy film. The great disadvantage attending this mode of sensitizing the Collodion arises from the fact that, pound the Silver as fine as you may, it will not readily combine with the Bromide. The reason is obvious. *Dry* particles of Nitrate of Silver, instead of dissolving in the Collodion before combining with the soluble Bromide, become incrusted with Bromide of Silver, which prevents the internal part from being acted on at all. Mr. Carey Lea saw this defect, and devised the plan now universally adopted of adding the silver in a state of solution. Mr. Lea also showed how the films, which under the old system of working were comparatively insensitive, could be made to possess a sensitiveness nearly equalling wet plates. By the old system it was necessary to have the soluble Bromide in excess before it was possible to get a clean picture by means of alkaline development. By Mr. Lea's method, the Nitrate of Silver may be in considerable excess in the emulsion, and thereby greatly enhanced sensitiveness is gained. Many changes have been rung on this system, all depending on the same modification.

Colonel Wortley introduces into the Collodio-bromide process another method, not only of increasing sensitiveness, but also of giving the power to keep the emulsion in good working condition for a lengthened period. The writer can testify to the keeping qualities of this emulsion, having preserved it in good condition for many weeks. An emulsion with a Chloride, according to Mr. Lea's plan, also keeps well. In either case, however, the emulsions are in the best state for work in from twelve to twenty-four hours after mixing. They must be occasionally shaken up in the dark room.

Practical Details.

1st. *The Pyroxyline.*—It has been found that the Collodion which answers well for the wet process may not be the best adapted for this, unless the Collodion has been kept for a long time in a dark place, to *ripen*, as it is called. The writer dispenses with this ripening process by using a special Pyroxyline, which, after its solution in Ether and Alcohol has settled clear, will give the best results, inasmuch as the Collodion is of a highly porous and structureless character. The following is the formula for making the Pyroxyline:—

Sulphuric Acid, sp. gr. 1845	12 fluid ounces
Nitric Acid „ „ 1450	4 „ „
Water	12 „ drachms
Bleached and dried Sea Island or Egyptian cotton wool	270 grains
Temperature of mixed acids	165° Fah.
Time of immersion of Cotton	10 minutes.

For further details of procedure consult p. 31.

Pyroxyline made by the above formula will be considerably disintegrated—almost powdery—and should, when dried, nearly correspond with the weight of the original cotton. It leaves considerable residue in the solvents, and the Collodion takes a week or more to clear up, but no ripening by age is required. As Collodion made from this Pyroxyline is extremely fluid and porous, a more than ordinary quantity of the latter will be required to give sufficient body to the film.

2nd. *To make the Bromized Collodion; take in the following proportions:—*

Sulphuric Ether, sp. gr. 725 .	6 fluid drachms
Alcohol „ „ 805 .	2 „ „
Pyroxyline, made as above .	7 grains
Bromide of Cadmium (anhydrous)	8 „

Weigh out carefully the Bromide, put it in a bottle without waste, pour in the Alcohol, then add the Pyroxyline. Cork or stopper up the bottle, and shake well for a minute or more. Lastly, add the Ether, and continue shaking until all the Bromide and all that is soluble of the Pyroxyline has been dissolved; allow the solution to settle until the supernatant liquid is quite clear; when that takes place, decant off the clear portion into a stock bottle for use when required.

To Chlorize the Collodion.—Unless the Collodion contains a little Chloride, or similar developing restrainer, it will be impracticable to impart to it the highest sensitiveness. The plan adopted by Mr. Lea is by far the best, viz., the addition to the Collodion of a little *aqua regia* or Nitro-hydrochloric acid. It is asserted by some that this powerful acid renders the film exceedingly rotten. Such is not the case if the Collodion has been properly prepared and if the acid has not been in contact with the Collodion for a long time. All acids will decompose any Collodion by acting on the Ether and Pyroxyline which it contains. Therefore, the best plan is to decant off the portion of Bromized Collodion that may be required for immediate purposes, and to add two drops of *aqua regia* for each fluid ounce. The acid will fall to the bottom, and require some shaking of the bottle to enable it to disseminate itself through the Collodion.

To Sensitize the Collodion.—Since the combining weight of anhydrous Bromide of Cadmium is 136, and that of Nitrate of Silver 170, it follows that eight grains of the former salt will require exactly ten grains of the latter; but as the Chlorine in the Nitro-hydrochloric acid must also be kept in view, two more grains of Nitrate of Silver must be taken. The silver having been previously reduced to a fine powder by trituration in a mortar, is weighed out in the proportion of thirteen grains to each fluid ounce of Collodion. Supposing we are about to sensitize four fluid ounces of the Bromized Collodion, the latter is carefully measured out into a wide-mouthed stoppered bottle, and placed in the dark room. Fifty-two grains of the pounded Nitrate are introduced into the bottom of a test tube by means of a folded piece of cartridge paper or thin cardboard by holding the tube horizontally with one hand, passing the cardboard down, and tilting the whole upright. The silver should be laid near the bottom of the folded paper, to prevent particles from adhering to the upper part of the glass. The tube should be lipped, or, better still, have a pouring spout, because, afterwards, when introducing the silver solution little by little, into the Bromized Collodion, some of the sensitizing liquid is apt to run down the outside of the glass, thus disturbing the balance of Chemicals. With all possible care some silver is always wasted, and we are never sure, even if all our Chemicals are everything that could be desired, both in respect of quality and measured or weighed quantity, that this disturbing element, viz. the impossibility of getting all the Nitrate of Silver into combination with the Haloid salt, may not upset our preconceived notions of the proper period of exposure in the Camera.

For the above quantity of silver, pour into the tube twelve drachms ($1\frac{1}{2}$ fluid ounces) of Alcohol, sp. gr. 825. Twist a piece of paper or soft chamois skin round the top to act as a holder and non-conductor of heat. Apply heat, gradually at first, to the bottom of the tube by means of a spirit lamp or Bunsen's gas-burner; soon the Alcohol will boil, and by gentle tapping on the side of the tube with the finger, the whole of the Silver will come into solution.

Whilst the solution is still hot carry it into the dark room, pour a little, *straight down*, into the wide-mouthed bottle containing the Bromized Collodion. Put in the stopper and shake for a few seconds. Pour in a second portion and again shake up for the same time; then pour in the remainder, and continue shaking for a minute or more. At intervals of half an hour or thereabouts, give another good shaking. At the end of three hours after the silver has been added, the emulsion is ready for work; but it will keep in good condition for a considerable time.

Before coating plates with the emulsion, filtration is necessary, as clots of Collodion and particles of other bodies are tolerably sure to be present in a complex solution of this nature. The writer at one time adopted the plan of filtering the sensitive emulsion through a tuft of clean cotton wool, stuffed loosely into the throat of a small glass funnel. This is not the best method, because the cotton, however evenly spread or stuffed down, rises up and allows the emulsion to run through unfiltered between the cotton and the conical sides of the funnel. The better, if not the best, plan to adopt is to filter the sensitive emulsion through fine cambric or linen fabric, folded in the usual form of filtering paper. Collodio-bromide of Silver runs through this substance very quickly; at the same time the pores or interstices between the threads are too small to admit of the passage of large particles which might do much harm.

Preparing the Glass for Collodio-bromide of Silver.—

To prevent the film from slipping from the glass in the course of the various manipulations required in this process, it will be necessary to give the plate a preliminary coating with some substance which not only serves that object, but also does no injury to the sensitive Collodion. A simple edging all round the plate is not sufficient, because the Collodio-bromide, already holding as much water as it can bear, is too rotten in structure to withstand the various solutions and washings which are afterwards applied to it. Very dilute Albumen is the best substratum. It is prepared thus:—Take the whites of three fresh hen's or duck's eggs, put them into a Winchester quart bottle half filled with distilled water, and shake up violently for a few minutes, or until the Albumen is dissolved. Two or three drops of Ammonia are useful in assisting solution. In order to keep the Albumen from mould or decomposition, two drachms of an aqueous saturated solution of pure Carbolic Acid will be necessary, if the albumen has to be kept for many months. This should be added *after* the albumen has been beaten up and before filtration. When the froth has nearly subsided fill up the bottle with distilled water.

The process of filtering is very tedious, because the porous paper soon gets clogged, and must be renewed over and over again. The best way is to have several filters at work.

If the glass plate is new, the writer knows no better method of washing it than that described at page 52; only in this case a final rinse in distilled water is unnecessary. His plan of working is this:—An assistant rubs one side of the plate with dilute Hydrochloric Acid (p. 53), and hands it still wet and draining downwards to another operator, who immediately pours on a little of the Albumen along the upper end of the cleaned surface. The wave drives down the water and is allowed to go to waste. Another portion is poured on, and after traversing the plate is returned to the pouring glass. When applying an albuminous substratum care must be taken not to pour the solution from a height, because thereby air bubbles are formed abundantly, which should at once be removed from the glass by means of a moist camel's hair brush or small piece of blotting paper. To avoid them the lip of the pouring glass should almost touch the surface of the plate.

When the plates are coated they are set up first to drain and afterwards to dry in a place free from dust. The draining is best done by having (say four) short wide-mouthed bottles, arranged on a table or bench, at about three inches distance from a perpendicular boarding. The draining corner is placed into the mouth of this bottle, and the opposite corner is strutted against the board. By the time that No. 4 bottle receives its plate, No. 1 has been tolerably well dripped, and is set up to dry, draining end downwards, on several folds of blotting-paper, which absorbs any residual liquid that may run off. In order to economize space when a large number of plates have to be prepared, they should, after draining, be set up on end, and at a little distance apart, on a wooden shelf.

Care, however, must be taken to see that the albuminized sides are all placed in the same direction, otherwise mistakes might occur in coating the plate with Collodion on the wrong or uncleaned side. Should any doubt arise about which is the right side of the plate for receiving the Collodion, breathe gently on the glass; the breath will not condense on the side which has been coated with Albumen. When dry the plates are stowed away in bevel-grooved plate-boxes, with their albuminized surfaces all in one direction, for future use; or they may be placed in plate racks in a similar way, but in the latter case special care must be taken to keep them from dust.

The coating of the glass with the Collodio-bromide is rather more difficult than in the wet process, because, under the same conditions of temperature, the film *sets* more rapidly, and is apt to run into cloudy waves unless adroitly managed. Since, also, the developed image is *in* and not on the Collodion, such irregularities show themselves very markedly after development.

Immediately after the film has *set*, the plate is placed Collodion-side upwards in a flat, shallow porcelain dish containing clean spring or river water. Whilst the Collodion is setting on the next plate the first one is transferred into a similar dish, and so on until the plate has passed through at least four changes of water. To insure even washing the water should be changed after each plate (or at least two plates) has passed through it. After draining for an instant, the Preservative or Organifying solution is applied, either by pouring it on and off two or three times, or by dipping or immersion in the Preservative bath for about a minute. For this purpose the writer prefers a solution of Tannin (p. 103), while others adopt various solutions.

The plates, after draining for a short time into wide-mouthed bottles (see p. 114) are set up in the dark room to dry spontaneously on folds of blotting-paper (see p. 114), and are then backed with a coating of paint to prevent what is called Optical halation or blurring of the image.

A good formula for the backing pigment is the following:—Take of burnt Sienna, as sold at the oil and colour shops, and ground in water, *quant. suff.* Put it into a mortar with water, add some British gum and a little glycerine. With the pestle grind up the whole into a paint sufficiently thick to prevent rays of light from passing through a piece of glass. A little Carbolic Acid or Kreosote is an antidote against mould. With a broad camel's-hair brush apply this to the back of the plates, and set them up again to dry.

If the sensitive plates are required for home use they may be stored in plate-boxes, or kept in the dark room till required. But care must be taken to protect them from the effects of Actinic light, and Sulphurous or other fumes which have a tendency to reduce Bromide of Silver.

If they have to be sent or carried to a great distance, or abroad, it will be safer to tie them up in packets of a dozen by the following excellent method, for which the writer is indebted to Mr. Henry Cooper, jun.

Some narrow strips of cardboard must be first cut, one eighth of an inch wide and about two inches long. These are to be glued or gummed on to silk ribbon three-eighths of an inch wide, one touching each edge, so that there is a space of one-eighth of an inch between them. It will readily be perceived that we can fold these strips of ribbon or card over the ends of a plate, in such a manner that one strip of card is on the film side and the other on the back, the uncovered ribbon between them allowing for the thickness of the glass.

To pack the plates, lay one of them on the table, film side uppermost, having previously placed a rather long piece of string underneath; then take another, and folding one of the prepared pieces of card and ribbon over each end of it, lay it film side down upon the other; the strips of card at each end effectually preventing contact.

Now lay another plate, film side up, upon those already on the table. This third plate will not require the ribbon, as No. 2 is protected by the strips already placed upon it.

No. 4 is to be armed in the same manner as No. 2, and placed, face downwards, on No. 3. This order is to be followed until a sufficient number of plates are laid one on the top of the other, face to face and back to back. From six to twelve are a convenient number for a single packet.

By means of the string that was passed under the plates in the first instance, tie them together. Now wrap them in a sheet of thin paper; or, what is far preferable, very thin sheet gutta-percha; then in tin or leadfoil; and lastly, in stout brown paper. By adopting this plan, the plates are most effectually shielded from light and air, and, moreover, occupy the smallest possible space.

Before putting the plates in the dark frame, brush the front lightly with a broad camel's-hair brush to remove adhering dust.

The exposure in the Camera.—In a bright light plates prepared as above should be exposed about twice as long as the most sensitive wet films; but in a dull light four times as long will be nearer the mark. Great latitude, however, is permissible in this respect, for, as will be presently seen in the instructions for conducting development, the action is very much under control. As a rule, it is far better to give a full exposure than otherwise, for in the latter case the image will be *hard* and full of violent contrasts of light and shade, manage the development as we may. When the correct time of exposure has been hit, the development is a very easy matter indeed, if the plates have been carefully prepared.

Developing Solutions for Bromized Films.

A.—Equal parts of alcohol and distilled or common water.

Keep this mixture in a well-corked or stoppered pouring-bottle. It does not spoil by keeping or frequent use if occasionally filtered to remove sediment.

B.—

Bromide of Potassium	10 grains
Distilled or common water	1 ounce

May be preserved in a dropping or other bottle for any length of time.

C.—

Pyrogallic Acid	3 grains
Distilled water	1 ounce

This solution should be made just before use. An excellent plan to avoid frequent weighings, is to dissolve in the ratio of 100 grains of pyro to 1 fluid ounce of strong alcohol, sp. gr. 805. The solution will keep well for at least six months, and 15 minims of it will represent (allowing a little for waste) 3 grains of pyro. Mix *quant. suff.* of this with clean water before commencing development.

D.—	Carbonate of Ammonia	60 grains
	Distilled or clean common water . .	1 ounce

A large stock may be made up, and preserved in an air-tight bottle for several months. When required for use pour a quantity into a rather large-sized dropping-bottle. Dry Carbonate of Ammonia cannot be kept long if wrapt up in paper, because the active agent, Ammonia, would in that case be constantly escaping; therefore keep the dry stock also in a well stoppered bottle.

To Conduct the Development.

Supposing we are about to develop an 8½ by 6½ inches plate, which has received just the right amount of exposure, proceed thus:—

1st. Pour over the film sufficient of mixture A to moisten it well, and at once return the excess into the pouring bottle for future use.

2nd. Rub the pigment from the back with a wet sponge or rag, and place the plate in a basin of water, or rinse under the tap till all greasy-looking lines have disappeared.

3rd. Into a clean developing cup pour as much of the plain Pyrogallic solution C as will flood the plate well. Drop into this six drops of the Bromide B. Mix intimately and apply to the film two or three times, for not longer than half a minute, taking care not to pour the solution always on or near the same spot, as that causes insufficient development at that point. Next pour back the developer into the cup, and mix with it eight drops of Carbonate D. Apply to the film again. In about half a minute the high lights of the image will begin to appear, and gradually some of the best lighted details. After the latter have pretty clearly indicated themselves, more Carbonate may be added and also more Bromide, provided always the Carbonate is considerably in excess. *Recollect always that soluble Bromide is the restrainer, and alkaline Pyrogallic the active agent, of development.*

The plate during development may be supported in the hand, on a pneumatic plate-holder, or on a levelling-stand; but the best plan of all is to have a very shallow glass dish rather larger than the plate, and in this to conduct the development. A piece of strong thread or thin tape placed across the bottom of the dish will prevent strong adhesion when the exposed plate is put inside, and will also enable the operator to pull out his negative at any time for examination. By these means two or three plates may be developing at the same time in as many dishes, because it is not necessary to roll about the solution after development has fairly commenced. To level the dish on any sloping table it is only requisite to cut one or two wedges for insertion under the bottom of the dish. When the solution covers the plate evenly the levelling is correct.

In most instances the development can be completed in from five to fifteen minutes by these means, but it is better not to attempt hastily to force density by adding a great deal of Carbonate to the Pyrogallic solution without a corresponding quantity of Bromide, because that might cause fogging, which, when once set in, cannot be stopped nor even remedied by any treatment. Should there be any difficulty in obtaining a negative of sufficient printing density by the above method, it is recommended—

4th. To stop the action of the alkaline Pyrogallic as soon as all the details of the image have shown themselves; then to wash the plate well under a tap, or in plenty of clean water, and proceed to intensify by the following solutions:—

No. 1.—	Pyrogallic Acid	1 grain.
	Citric Acid	2 grains.
	Distilled Water	1 ounce.
No. 2.—	Nitrate of Silver	30 grains.
	Distilled Water	1 ounce.
	Acetic Acid	2 drachms.

Pour *quant. suff.* of No. 1 on and off the washed film three or four times, to neutralize the last trace of alkali; then add a few drops of No. 2 to the Pyrogallic acid, and proceed with the intensification in the usual way by pouring on and off, and carefully watching progress by transmitted light. When the details of the image are well brought out by the alkaline developer, this reinforcing method produces density very rapidly—much quicker than alkaline Pyrogallic—and that, too, without danger of fogging, if every trace of alkali has been destroyed by the intermediate washing, and by soaking the film with an acid solution of Pyrogallic before adding the silver.

5th. Fix in a solution of Hyposulphite of Soda containing not more than from 4 to 6 ounces of the salt in a pint of water. Cyanide of Potassium might be used, but it is apt to weaken the image. This same property, however, renders it useful for reducing density when, by inadvertence, the development has been carried too far.

N.B.—The reinforcing of the image with acid Pyrogallic and silver can be done effectually after the alkaline developed negative has been fixed and thoroughly washed, either while the plate is still moist or at any time afterwards. With an albumen substratum there is little danger of these films slipping. After intensifying, wash off the developer.

Hints for Emergencies.

When using the alkaline developer as directed above, if the image flashes out with great rapidity on applying the first dose of ammoniacal Pyrogallic, this indicates too prolonged an exposure. In that case, instantly plunge the plate into a basin of clean water, or thrust it under a running tap. Now prepare a fresh developer containing double the amount or more of Bromide (B) and half or less of Carbonate (D) to the same quantity of Pyrogallic (C), and proceed as before. By these means a film which has been exposed four or five times longer than necessary can often be made to yield a first-class negative, provided the first developer has been washed off before fogging has set in.

If, on the other hand, when the first dose of Bromo-ammoniacal Pyrogallic is applied, little trace of the high lights appears after about a minute, here we have evidence of under-exposure. At this stage, without waiting a moment longer, wash the plate, and mix a new developer containing only a trace of Bromide, but double the amount of Carbonate, the proportion of Pyrogallic remaining the same. By proceeding as before with this modified developer, and adding a little Carbonate when required, a moderately good, although seldom a fine, negative will often be the result.

As several solutions are required in this mode of development, it is recommended to place them on the table of the dark room in the order in which they have to be used, and also to have the bottles of different shapes and sizes, so that one can readily distinguish between the solutions in a very dark room by the sense of touch alone, without being compelled to strike a light to read the labels.

The above mode of development is also applicable to Major Russell's rapid dry process with Bromized Collodion sensitized in a strong Nitrate bath (p 106).

COLONEL WORTLEY'S EMULSION PROCESS.

Mr. Lea's valuable contributions, towards rendering the Collodio-bromide process more sensitive, stimulated farther inquiry, and have resulted in Colonel Wortley's discovery of a process of exalted sensitiveness, beyond which it is scarcely possible to go. In 1871, Colonel

Wortley announced as the result of many experiments, that it was not possible to attain the highest sensitiveness in a Collodio-bromide emulsion unless the Collodion were *saturated* with Nitrate of Silver after all the soluble Bromide had been converted. Some time afterwards, with the object of producing an emulsion that should be serviceable for many months—if not for years—he proposed what has been proved in practice to be a very valuable modification, viz., the addition of a certain quantity of Nitrate of Uranium to the Collodion. By repeated experiment, he found that the double salt (if we may call it such) of Nitrate of Silver and Uranium thereby formed, was absolutely stable in an emulsion, even when not controlled by an excess of soluble Bromide. Colonel Wortley justly claims for this method of working, many valuable improvements on our older emulsion processes; but it yet remains to be tested how long plates so prepared will retain their full sensitiveness. As yet the writer has not had an opportunity of trying them after being kept for a longer time than two months. At the end of that time they were as good as they were at first, and probably they would remain so if properly protected.

The emulsion when once formed must, of course, be still kept in a dark place and occasionally shaken up, else the *particles* of Silver-bromide are apt to agglomerate at the bottom into *masses* which cannot again be made to resume their original fineness of division. If this precaution be adopted there seems to be no limit to the keeping properties of this emulsion.

The formula which Colonel Wortley is now using, and with which he has kindly favoured us, varies but little from the one communicated to a private Photographic club last year:—

THE COLLODION.

Pyroxyline	6 grains.
Ether	3½ drachms.
Alcohol (absolute)	1½ ,,

In the Alcohol seven and a half grains of *Anhydrous* Bromide of Cadmium (*see* Vocabulary) have been previously dissolved; or the Bromide may be weighed out and dissolved in the mixture along with the Pyroxyline.

SENSITIZING SOLUTION.

Alcohol, sp. gr. 825	$2\frac{1}{2}$ drachms.
Nitrate of Silver	15 grains.

The Silver is dissolved by the aid of heat in the Alcohol, and added to the Collodion little by little, shaking between each addition as described at p. **111.**

The Nitrate of Uranium can be dissolved either in the plain Collodion, or in the sensitized emulsion. Another plan is to make a saturated solution of this salt in Ether, and add one half drachm to the above proportions of Collodion, which will thus produce one fluid ounce of finished emulsion. The Uranium salt must be *acid*, and, if it is not so, two or three drops of Acetic or Nitric acid should be added to the Ethereal solution.

The Collodionized plates are washed in the usual way, and the organifier, or preservative solution, applied. Colonel Wortley informs us that this mode of working appears to be suitable for any kind of organifier, but he prefers a solution of Salicin which has been lately introduced.

In our own recent practice with the students at King's College, we have found the above process, or rather a modification of it, so simple, so certain, and so instructive that it commences the course of Practical Photographic work instead of being placed after the wet processes. The preservative used is a ten-grain solution of Tannin and a little sugar. The development is by the alkaline method.

To prevent Optical halation or blurring of the image Colonel Wortley dissolves a little non-actinic Aniline dye in the Collodion emulsion. This certainly prevents the passage of the *refracted* rays through the film to the

. . . .

back of the glass, whence they are reflected and cause the mischief. But on the other hand, the writer finds after many comparative trials, that this plan, if effective for the object aimed at, reduces the sensitiveness, or rather diminishes the amenity to development. For it must be borne in mind, that in a Bromized film reduced by the alkaline developer, the image is not merely on the surface, but reaches through it to a considerable depth in the high lights. The reason of this is that the *Bromide itself is reduced* and not a deposit formed as in ordinary development. The fact can easily be proved by dissolving off with weak nitric acid a freshly developed image, before fixing. A transparency is the result, the high lights being represented by clear glass, the shadows by the unreduced Bromide and the half tones in proportional gradation.

TRANSFERRING OF NEGATIVES FROM GLASS.

After trying many plans the writer has adopted the following as the most easy and efficient.

If the negative to be transferred has been varnished, dissolve off as much of the varnish as can be done with methylated alcohol or other solvent of the resin. When dry, the negative is fit to be transferred. If the film has not been varnished this operation is unnecessary. The next step is to coat the film with a solution consisting of four or five grains of India-rubber dissolved in an ounce of Benzol. When that has dried, the plate is put on a levelling stand and as much of a thick *leathery* Collodion poured on as will lie on the plate without running over the edges.

The Collodion which the writer finds to answer best is made with long-fibred Pyroxyline prepared in acids at a low temperature, and dissolved in the following proportions:—

Pyroxyline	20 grains.
Methylated Ether (highly rectified) . .	1 ounce.
" Alcohol " " . .	1 "
Castor Oil . . . . (about)	6 minims.

There is no necessity for being careful about the purity of the solvents. The cheapest kinds of Ether and Alcohol answer as well as any other, provided they be highly rectified. If they contain much water they will not readily dissolve the Pyroxyline, and will give rise to a tender film which will not bear handling after it has been detached from the glass.

When the transfer Collodion film is dry, which will be in from twelve to twenty-four hours (according to its thickness, and the temperature of the room) it is cut all round the edges with the point of a sharp knife and the plate immersed in a dish of cold water. After soaking for a few hours, the compound film will generally float off spontaneously in one unbroken sheet; but sometimes it will be necessary to use a little gentle force for its removal. Should there appear the least tendency to tearing while removing it, replace the plate in the water for a few more hours, after which the film may be detached without danger. Dry between folds of blotting paper.

When dry the film generally presents an opalescent appearance. This is removed by gently warming the film before a bright fire.

Instead of a primary coating of India-rubber solution on the negative, it has been recommended to use an aqueous solution of Gum Arabic. This plan has one advantage, viz., that the transfer Collodion seems to have no power of penetrating through this protecting coating and destroying the Negative underneath. Unless the India-rubber solution be tolerably viscid, this catastrophe will sometimes occur, whereas the gum, even when dilute, seems to afford a more efficient protection to the Negative film.

SECTION VI.

CLASSIFICATION OF CAUSES OF FAILURE IN THE COLLODION PROCESSES BY THE WET METHOD.

FOGGING OF COLLODION PLATES.—*Fogging* is a misty sort of appearance that covers the deepest shadows of the picture, and is the effect of many causes, one or other of which will produce the undesired result.

1. *Over-exposure in the Camera.* — The image in the Camera is rarely pure, but exhibits enough diffused light to produce universal clouding when the plate is at all over-exposed. Collodion newly iodized being more sensitive to a weak light, shows the fogging more than old coloured Collodion. When the objects are at a great distance, and brightly illuminated, or when Lenses of large aperture are employed, without a diaphragm, beginners are especially likely to over-expose the plates.

2. *Diffused Light.* — *a.* In the developing room. This is a frequent cause of fogging, and especially so when a naked candle is employed to illuminate, or the common yellow calico is used, which is apt to fade. Examine for cracks and crevices in the sides and floor of the room.—*b.* Mist in the atmosphere. When there is any vapour in the air, the shadows will be foggy unless the object be very near to the Camera.—*c. Diffused Light in the Camera.* To test for this, cap up the Lens, remove the ground glass, put the focussing cloth over the head and examine closely in the interior whether there may not be chinks which admit daylight. —*d.* Diffused light from the Lens when a powerful light falling at certain angles is *reflected* instead of being *refracted.*—*e.* Light admitted from without into the dark frame when the shutter is drawn up.—*f.* Light from the marginal pencils falling on the side of the Camera, and reflected therefrom on to the surface of the Sensitive film.

3. *Alkalinity of the Bath and over Acidity*, strange to say, produce fogging almost in the same ratio, especially if Nitric acid is the acidulating agent. This is easily tested by means of Litmus paper, and the remedy obvious.

4. *Organic Matter in the Bath* has been referred to at p. 47 and the remedy given.

5. *Heat of the Weather.* — Make the bath weaker and use a more acid or less strong developer.

6. *Vapour of Ammonia* coming in contact with the film before development. Banish Ammonia bottles from the dark room used for wet plates, or have them well stoppered.

7. *Sulphuretted Hydrogen.*—When the pipes leading the waste water from the sink are not well trapped, this noxious gas rising from the sewers will cause fogging.

Sundry other causes of fogging exist, but the above are the most common.

Systematic plan of Proceeding to Detect the cause of Fogging.—If the operator has had but little experience in the Collodion process, and is using Collodion of considerable sensitiveness and a new Nitrate bath, the probability is that the fogging is caused by *over-exposure.* Having obviated this and the film still fogs, proceed to test the bath. If it was made from pure and properly acidulated materials, a piece of blue Litmus paper dipped in it will indicate whether all is right in that direction.

Next prepare a sensitive plate and, after draining it for two or three minutes, pour on the developer, wash, fix, and bring out to the light; if any mistiness appears, either the operating room is not sufficiently dark, the bath was prepared from bad Nitrate of Silver, or the water was impure.

On the other hand, if the plate remains absolutely clear under these circumstances, the cause of error is most probably in the Camera; therefore prepare another sensitive film, place it in the Camera and proceed exactly as if taking a picture, with the exception of not uncovering the lens; allow to remain for two or three minutes and then remove and develop as usual.

If no indication of the cause of fogging is thus obtained, there is every reason to believe that it is due to vapour in the atmosphere or to diffused light gaining admission through the Lens.

In the case of old Nitrate baths which have been much used, fogging is generally attributable to an accumulation of Organic matter in solution; to remedy which see p. 47.

SPOTS, ETC., UPON COLLODION WET PLATES.

These are caused in various ways:—by particles of foreign matter in the Collodion, the bath, or developer, and often from the dark slide by the abrasion of wood or metal in drawing up and pushing down the shutter too violently. Other disturbing causes also intervene to produce opaque or transparent spots. We shall enumerate a few of the most potent.

1. *Freshly made Collodion.* — Unless the salted Collodion is allowed to settle for some time, particles of the salting solution, of undissolved Pyroxyline, or dirt, will remain in suspension, causing spots either transparent or opaque, according to the nature of the impurity. The same also will occur with old Collodion if recently shaken up.

2. *From the Bath.*—See that this solution is free from dust and insoluble particles. If not, filter it. Yet that is not always a remedy, for the bath may have been overworked and have supersaturated itself with Nitro-iodide and Nitro-bromide of silver, which crystallize in and on the film, and being insensitive to light give rise to *transparent* spots.

3. *From the dark Slide.*—It has been already enforced (p. 58) how careful one should be in carrying a wet plate to and from the Camera in case of dust, &c., settling on the wet film, and precautions have been given; but one source of mischief has been omitted. The drawing-up slide is usually fitted with brass hinges so that, during exposure, the shutter may fold over the top or along the side of the Camera. These hinges do not as a rule turn in the smoothest manner possible, consequently particles of brass or iron are abraded, and, like "matter in the wrong place," are tolerably

sure of finding their way on to the Collodion film. It is easy to detect whether these particles are the cause of spots, as they will always be found opposite, or nearly so, to these hinges. The old-fashioned sort of hinge, consisting entirely of flexible leather, was not very much better, as it harboured dust so badly.

4. *From the Developer.*—It is not very often that *spots* arise from the developer, because a glance will show whether solid and flocculent matters exist therein, which, by attaching themselves to the film, prevent developing action at those parts. To mention the disease is to suggest the remedy—filtration.

MARKINGS OF VARIOUS KINDS.

1. If a Collodion plate from the sensitizing bath is kept too long before development—that is, until the Silver Nitrate, by evaporation and consequent concentration, has begun to attack the sensitive silver haloid, it will be impossible to develop the image evenly. The upper part will be feeble and spotty, while the lower part, which is not so dry, may be vigorous.

2. Patches like the outlines and shading of oyster-shells, sometimes appear on the film during development. The predisposing causes of their formation are—impure Collodion, old Nitrate bath, new dark frames varnished inside with methylated or turpentine varnish. If, superadded to these, there are the concomitants of hot weather, and a considerable time elapsing between sensitizing and developing the plate, such defects are almost sure to occur.

3. *Streaks in the direction of the dip* are caused in various ways:—*a*, by immersing the plate too soon into the bath, or by making the immersion too rapidly; *b*, by not giving the plate a little lateral motion as soon as it is under the liquid; *c*, by having the ledge at the bottom of the dipper projecting beyond the glass plate resting on it. Practically this causes an irregular current of silver over the film while the

plate is being immersed, and consequently irregular sensitizing: remedy as before. *d*, by a bath over-alkaline; *e*, by a horny or repellent Collodion on which the Nitrate solution is apt to drain off in lines instead of in an even sheet.

4. Streaks *across* the direction of the dip are almost invariably formed by pausing for an instant while immersing the plate. They are always transparent.

5. A metallic-looking deposit between the film and the glass invariably arises from the latter being badly cleaned. Plates that have been previously used are particularly liable to this defect. If neither strong mineral acid nor solution of Soda makes the glass serviceable, it is better to break it and make the first annoyance the last.

Various other faults occur in Collodion pictures by the wet process on glass, some of which have already been referred to in the practical instructions for working. With the hints now before him, an intelligent operator will know how to discriminate between these defects and apply the proper remedies.

Defects on dry Collodion plates cannot be categorically described, because the processes themselves are so very numerous. It may be stated generally that they are liable to almost all the faults enumerated above, besides having a large class peculiar to themselves.

CHAPTER XII.

THE PRACTICAL DETAILS OF PHOTOGRAPHIC PRINTING.

SECTION I.

PRINTING ON PLAIN PAPER.

So far as the writer is aware there are at present in the market only two kinds of papers well adapted for this purpose—viz., Saxe and Rive, either of which may be adopted. In all cases there is a difference in smoothness between the two sides of the paper, and this is easily detected by holding the surface of each sheet in such a manner that a strong light falls on it at an acute angle. On the wrong side will be seen wire-gauze markings; or, in default of such being observed, the paper may be wetted at the corner, when one side will appear smoother than the other. The corner of the right side of the paper should be marked with a pencil to prevent future mistakes. This is not necessary when using albuminized paper, the right side of which is easily seen.

Salting the Plain Paper. Take of—

Chloride of Ammonium or Sodium	200 grains.
Citrate of Soda	20 ,,
Water	20 ounces.

Pour the solution into a flat glass bath, and immerse or float each sheet for about a minute. Hang them up to dry, by means of clips sold for the purpose, on a string stretched across the room. This operation need not be performed in the dark room. The *salted* paper will keep any length of time.

Sensitizing the Plain Salted Paper. Take of—

Nitrate of Silver	60 grains.
Distilled Water	1 ounce.

Prepare a sufficient quantity of this solution, and pour it out into a flat porcelain dish. Float the marked or smooth side of the paper on this for about a minute in hot weather and longer in cold. Pick up, by the corner, with a glass or wooden *clip*, and hang up in the *dark room* to dry spontaneously. It is then ready for use, but will remain clear and untarnished for twenty-four hours or more if the paper is of good quality. For further particulars see next Section.

Another method of Sensitizing is by means of Ammonio-nitrate of Silver, sixty grains to the ounce of distilled water, prepared thus:—Dissolve the Silver in one-half of the total quantity of water. Then take a strong solution of Ammonia and drop it in carefully, stirring meanwhile with a glass rod. A brown precipitate of Oxide of Silver first forms, but on the addition of more Ammonia it is redissolved. When the liquid appears to be clearing up, add the Ammonia very cautiously, so as not to have excess. In order still further to secure the absence of free Ammonia, a drop or two more of solution of Nitrate of Silver should be added, until a slight turbidity is again produced. Lastly, add the rest of the water.

To apply the Ammonio-nitrate Sensitizer, the paper should not be floated on it, because the solution soon gets quite black and the escape of Ammonia alters its character. Lay the sheet to be sensitized on blotting-paper, and apply the liquid evenly with a broad camel's-hair brush, kept for that purpose only, and carefully washed. Ammonio-nitrate sensitized paper requires no gold toning bath to get the print up to a bluish-black tone. In this respect it differs from all other printing sensitizers. The difficulty often is to get the print *warm* enough in tone to be pleasing.

The mode of conducting the printing, &c. will be described in the next Section.

SECTION II.

PRINTING ON ALBUMINIZED PAPER.

It is hardly worth one's while, nowadays, to prepare his own Albuminized paper, seeing that there are difficulties attending its manufacture which require special care and special appliances. Moreover, as this is an article which does not deteriorate very readily, unless subjected to moisture, it can be kept safely in a place dry and free from dust; or, if it has to be sent to tropical or far distant countries, stored in soldered tins. In fact, the professional albuminizer can supply this article, anywhere, better and cheaper than one who only works occasionally can do for himself.

It is the custom at present with albuminizers to add very little salt to the Albumen—from five to eight grains; whereas, in former times, sometimes twenty or more grains were dissolved in each ounce of Albumen. This change is advantageous in several respects. It requires a weaker sensitizing bath, gives less violent contrasts of image, the paper keeps better after sensitizing, and altogether is better suited for the modern class of negative.

In cutting up the albuminized paper into sizes suitable for the bath, use a *paper-knife*, and do not touch the surface except with exceedingly dry and clean hands.

This precaution also applies more forcibly after the paper has been sensitized.

To render the Paper Sensitive.—This operation is, of course, conducted in the dark room; but it is by no means necessary that the room should be so dark as it must be when preparing sensitive films for development; inasmuch as in the former case printing is completed by the direct agency of light and not by a developer. Any darkening that would be hurtful to

Silver-chlorized paper can therefore be detected by the eye. An amount of light short of this visible impression is permissible.

If the Albumen has not been salted at a higher rate than eight grains to the ounce, the strength of Nitrate solution given at p. 132 will be amply sufficient to sensitize it. Ammonio-nitrate of silver is not admissible, because Ammonia dissolves Albumen.

It is often difficult to avoid air-bubbles when sensitizing Albuminized paper, especially if the solution has been frequently used. The writer adopts the following plan, which, it is hoped, will be understood from a verbal description. The solution is poured into a clean glass or porcelain tray, after being filtered if necessary. The operator standing close to one end of the dish, takes a sheet of paper by two diagonal corners in both hands, lowers the end next to the body on the solution, and instantly with the hand thus set free seizes the upper corner and rolls, as it were, the sheet over the surface gently and evenly without allowing any Nitrate to get over the back of the paper. If the sheet is laid down rapidly, air-bubbles are sure to show themselves. They may easily be detected by examining the *back* of the paper after it has lain for about half a minute on the solution. There will appear a *puckering* up at those points, arising from the unequal expansion of the paper. To remove them, raise the sheet gently by one corner, and, with a twist of clean blotting-paper dipped in the solution, moisten the part; draw the bubble to the edge, or break it, and again lay down the paper.

If the room is warm, one minute's floating is enough; if cold, give two minutes or more. There is a disadvantage attending long contact with the Nitrate solution—viz., the printed picture will be too much in the *texture* of the paper instead of on the surface. This detracts much from its brilliancy. Besides, the pictures are more liable to fade, inasmuch as the silver having had time to penetrate, will come into contact with organic or other impurities which may exist in the texture. It is very difficult, if not impossible, to remove many of these afterwards by fixing and washing.

When the paper is hung up to dry there will still be considerable drainage from the lower corner. This should be collected and put into the jar for silver residues. After about two minutes' draining, a small piece of blotting-paper attached to the corner will absorb the rest. It will stick there until the Photographic paper is dry. These pieces should also be collected and preserved, because they contain an amount of silver well worth the trouble (see Appendix). The blotting-paper also serves another purpose, for, as the sensitizing paper curls up in drying, any surplus liquid at the corner will probably touch some part of the surface, and there give rise to a spot of extra sensitiveness.

It is better not to dry the paper artificially—that is, near a stove or fire—until the Nitrate from the surface has drained away. Even then, before printing, it should be placed for about a quarter of an hour in a position where it can imbibe the natural humidity of the atmosphere; else, when pressed in contact with the negative in the Printing frame, it will expand and give a blurred impression.

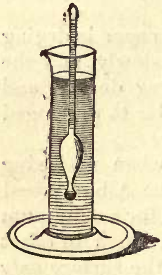
If the room in which the sensitized paper is drying be damp, the drying will proceed too slowly, and the Nitrate solution will go on penetrating deeper and deeper, thus producing an effect similar to prolonged flotation on the sensitizing bath.

The principles to be kept in view when preparing Positive printing paper are these. The Albuminized paper should be bone dry, and floated for a minimum of time on a Nitrate solution strong enough to effect complete decomposition of the salts on the surface *only* of the paper. The drying should be *uniform* and rapid, in a room where there are no sulphurous or other silver-reducing fumes; and afterwards the paper, if not required for immediate use, stored sheet over sheet in a close portfolio also kept in a dry place. A good quality of paper thus stored will remain bright and clear for at least a week.

Moisture seems to be essential to the reduction of Silver-chlorized paper. Hence various devices have been devised for keeping it thoroughly desiccated in boxes containing quick-lime or other absorbents of moisture. These contrivances answer very well; but before laying the paper on the Negative it will be necessary to leave the former for a short time in the dark room exposed to the free action of air.

Care of the Sensitizing Solution.—The strength of the Nitrate bath decreases rapidly by frequent use, and hence an addition of Nitrate of Silver must occasionally be made.

The following convenient little instrument, called a "Silver Meter," is now almost universally employed to ascertain the strength of Silver solutions. It is not quite accurate, but near enough for practical purposes. When greater accuracy is required, consult the sp. gr. table given in the Appendix.



It consists of a cylindrical vessel holding some three or four ounces, with an hydrometer of the common form. The Sensitizing Bath to be tested is poured into the glass, and the bulb floated in it, when the number of grains per ounce will be indicated by the part of the scale corresponding to the surface of the liquid. As these instruments are sold for a few shillings, and consequently are not made with much care, it is advisable to commence by preparing a 90-grain solution of pure Nitrate of Silver, to verify the correctness of the scale. Observe also that the indications of the hydrometer will cease to be trustworthy if the Bath contains Alcohol or Ether; hence an old Negative Bath, properly analysed, may be found to yield three or four grains of Nitrate per ounce over the quantity given by floating.

The solution of Nitrate of Silver becomes after a time discoloured by the Albumen, but may be used for sensitizing until it is nearly black. The colour can be removed by Animal Charcoal, but a better plan is to use the "Kaolin," or pure white china clay. Shake up twenty ounces of Bath with a quarter of an ounce of finely pulverized Kaolin, and filter through paper. Kaolin often contains Carbonate of Lime, and effervesces with acids: if so, it must be purified by washing in dilute vinegar, or the Bath may become alkaline, and dissolve off the Albumen.

When Kaolin cannot be obtained, the Bath may be decolorized by shaking it up with recently precipitated Chloride of Silver in the curdy state. This substance has an affinity for the brown Sub-Albuminate of Silver which produces the colour, and gradually carries it down, leaving the supernatant liquid clear; but it is inferior to Kaolin as a decolorizer.

Old printing Nitrate Baths often become somewhat alkaline from the reaction of the Albumen; and the proportion of Silver falls so low that the coagulation of the Albumen is imperfect, and a white precipitate falls away into the Bath. In such a case, add to each ounce ten grains of Nitrate of Silver, and a drop or two of Glacial Acetic or Citric Acid.

PRINTING FROM THE NEGATIVE.

The Exposure to Light.—For this purpose reversing-frames are sold, which admit of being opened at the back, in order to examine the progress of the darkening by light, without producing any disturbance of position.

The shutter at the back is removed, and the Negative laid flat upon the glass, Collodion side uppermost. A sheet of sensitive paper is then placed upon the Negative, sensitive side downwards; next comes a layer of thick felt; and the whole is then tightly compressed by replacing and bolting down the shutter. The amount of pressure required is not very considerable, but if the springs of the frame become too weak after a time, a few pieces of millboard may be placed beneath them.

This operation may be conducted in the dark room; but unless the light is very strong, such a precaution will be needless. The time of exposure to light varies much with the density of the Negative and the power of the actinic rays, as influenced by the season of the year and other obvious considerations. As a general rule, the best Negatives print rather slowly; whereas Negatives which have been under-exposed and under-developed, print quickly.

In the early spring or summer, when the light is powerful, about ten to fifteen minutes may be required; but from three-quarters of an hour to an hour and a half may be allowed in the winter months, even in the direct rays of the sun. It is always easy to judge of the length of time which will be sufficient, by exposing a small slip of the sensitive paper, unshielded, to the sun's rays, and observing how long it takes to reach the coppery stage of reduction. Whatever that time may be, nearly the same will be occupied in the printing, if the Negative be a good one.

In a dull light the writer has seen four days spent in getting one impression from a Negative; but pictures so obtained are not equal to others printed by a stronger light. The organic matter of the size reacts more or less upon the Nitrate of Silver, and causes yellowness of the whites of the paper; the toning process is also interfered with, as will presently be shown.

A light of excessive brilliancy is objectionable in printing, and especially so when the thermometer stands high. Complaints of unmanageable bronzing, with obliteration of details in the shadows, are frequent at such times, the reducing process being carried on with too much activity. Hence it is advisable, in the summer months at least, not to print by the direct rays of the sun. This point is further important, because the excessive heat of the sun's rays often cracks the glasses by unequal expansion, and glues the negative firmly down to the sensitive paper. An exception may be made in the case of Negatives of great intensity, which are printed most successfully upon a weakly sensitized paper exposed to the full rays of the sun; a feeble light not fully penetrating the dark parts.

When the darkening of the paper appears to have proceeded to a considerable extent, the frame is taken in and the picture examined. This, however, may be done in the open air, with care and expedition.

If the exposure to light has been correct, the print appears *slightly darker* than it is intended to remain. The Toning Bath dissolves away the lighter shades and reduces the intensity, for which allowance is made in the exposure to light. A little experience soon teaches the proper point; but much will depend upon the state of the Toning Bath, and albuminized paper will require to be printed somewhat more deeply than plain paper.

If, on removal from the printing-frame, a peculiar *spotted* appearance is seen, produced by unequal darkening of the Chloride of Silver, either the Nitrate Bath is too weak, the sheet removed from its surface too speedily, or the paper is of inferior quality.

On the other hand, if the general aspect of the print is a rich chocolate-brown in the case of Albumen, a dark slate-blue with Ammonio-Nitrate paper, or a reddish purple with paper prepared with Chloride and Citrate of Silver, the subsequent parts of the process will probably proceed well.

If, in the exposure to ordinary diffused daylight, the shadows of the proof became very decidedly *coppery* before the lights are sufficiently printed, the Negative is in fault. Ammonio-nitrate paper highly salted is particularly liable to this excess of reduction, and especially so if the light is powerful.

The Toning of the Proof.—No injury results from postponing this part of the process for some hours, provided the print be kept in a dark place. But it is not advisable to leave the print for a day or more before toning, since a chemical change may take place, the effect of which will be to interfere with the deposition of gold in the toning bath, and to destroy the purity of the whites.

The prints are first washed in a dish of common water, by immersing them one by one in a feeble light, but not necessarily in the dark room. After separating and turning them over two or three times, the water is poured off into the jar for preserving residues (see Appendix). More water is applied to them in the same way, and this also if very milky is consigned to the waste jar. A third portion of water will probably complete the washing. The symptom of removal of Nitrate of Silver is indicated by the hard water remaining clear. They are now ready for the toning bath, and their immersion therein should not be long delayed.

Formulæ for a Toning Bath.

We may premise that as the toning agent Chloride of Gold is usually sold in small hermetically sealed glass tubes containing stated quantities, and as a little of this very expensive salt goes a great way, the best mode of adding it to the bath is by measure, *not weight*. If the tube contains say thirty grains of Chloride of Gold, put it in the bottom of a clean and strong glass bottle. Break the tube by introducing a strong glass rod. Pour in fifteen ounces of distilled water, which will speedily dissolve the whole of the Chloride. *Each fluid ounce of this solution will therefore represent two grains of Chloride of Gold*, which should tone at least four hundred square inches of prints, or more than one full sized sheet of *Saxe* or *Rive* paper. But in this respect a good deal depends on the nature of the paper, the strength of the sensitizing solution, the nature of the

Negative, and the time that the paper has been kept after sensitizing.

Formula No. 1, *for two full-sized Sheets.*

Solution of Chloride of Gold	1 ounce or more.
Bicarbonate of Soda	4 to 6 grains.
Clean Water	40 ounces.

This solution will not keep well and should be mixed about an hour before use. After toning the prints, it should be thrown away.

Formula No. 2.

Solution of Chloride of Gold	1 ounce or more.
Acetate or Phosphate of Soda	100 grains.
Clean Water	40 ounces.

This solution will not work well until several hours after mixing. Indeed, it may be prepared several days previously, and will work all the better for keeping. After the prints have been toned, the solution may be bottled up and kept for future use. No more Acetate or Phosphate will be required; but it will be necessary to add more gold solution immediately, or an hour or two, before use.

Various other salts to add to the Chloride of Gold have been worked into formulæ; but either of the above leaves nothing to be desired.

The prints are taken from the last washing water one by one and immersed in the toning solution in a flat bath. It is better not to put many in at one time. They are kept moving about so as to prevent unequal action. After a short time they will assume a bluish appearance; but that is not a true criterion of what their ultimate colour will be. If they are held up between the eye and the light some correct notion is gained; but neither is that a trustworthy guide, because some papers lose more of their tint in the fixing bath than others. The best plan is to try one, which is supposed fully toned, in the Hyposulphite bath, and note how it behaves. The tone will redden considerably in about a minute or less, but afterwards will regain part of the colour which it has lost. Experience is the only guide in these matters. Generally it may be stated, prints on plain paper tone quicker than on an albuminized surface and lose less in the fixing bath.

The operator must be exceedingly careful not to allow a trace of the Hyposulphite solution to touch the toning bath, because this would infallibly produce prints covered with brown patches of Sulphide of Silver, which cannot be removed. A portion of the *toning* in the *fixing* bath does no harm farther than weakening the latter to that extent.

Toning should be conducted in a subdued white light, because in a yellow or monochromatic light it is impossible to judge of the depth of tone. The operator will notice that some prints from the same paper assume a rich colour more rapidly than others in the bath, while in some cases the best result that can be obtained is a feeble slaty blue. The tone depends a good deal on the quality of the Negative, all other circumstances being the same. Vigorous and clear Negatives give easily toned prints, and *vice versâ*. Temperature too affects the toning very considerably; hence it is recommended, in cold weather, to warm the solution, for, within certain limits, the sooner the required tint is got, the more brilliant are the prints.

Fixing the Proof.

The fixing bath is made in the following proportions:—

Hyposulphite of Soda . . .	4 ounces.
Clean Water	1 pint.

This also is poured into a flat dish placed at some distance apart from the other, in case of splashes falling into the toning bath.

In conducting this double process it is well, when convenient, to have an assistant whose sole duty is to attend to the prints in the fixing solution, while the principal conducts the toning. The latter throws the print on the Hyposulphite solution while the assistant instantly pushes it under, and so on until the whole have been immersed. But if an assistant is not at hand, one careful operator can do all the work. With one hand he moves about the prints in the toning bath, and as they get ready throws them one by one with that hand on to the fixing bath without touching it. The other hand instantly pushes them under.

While in the fixing bath the prints should be moved about to prevent them from sticking together and thus being irregularly acted on. In ten minutes the fixing will be complete; but as probably some of the proofs have been over-printed, pick out those which are too lightly or properly printed, and plunge them into a large basin or tub of clean water, leaving the others in the Hyposulphite until its solvent action on the image has reduced their intensity. Now an unpleasant difficulty occurs with prints immersed for a long time in Hyposulphite of Soda. The whites may become dingy yellow, and the half tones suffer whilst the deepest shadows seem unaltered. This arises from the instability of Hyposulphites in the presence of acids of any kind.

Without entering into Chemical particulars, it will be sufficient to say that Hyposulphites generate their own acids when they act on certain salts of Silver, more particularly the Nitrate and Organic. The Chloride and other Silver Haloids are simply dissolved in this menstruum when neutral, without any acid being set free from the Hyposulphite. But as the Photographic print is not altogether made up of *pure* Chloride reduced by light, but is partly organic in its character, it follows that the Hyposulphite is decomposed when placed in contact with the latter, and Sulphur or Sulphide of Silver deposited.

The moral to be drawn from these facts is this: *Make the fixing bath decidedly alkaline by adding to it a* *little Carbonate of Soda, which will counteract the pernicious influence of the acid, and not interfere in any way with the dissolving powers of the Hyposulphite.*

It is a wise plan not to use a Hyposulphite bath for fixing more than one batch of prints, for as the salt is exceedingly unstable, it may after awhile contract acid from the air, not to mention that which itself generates by decomposition.

Washing the Prints after Fixing.

This is a tedious operation, for unless all the soluble Hyposulphite is removed from the paper, fading of the Photograph will quickly set in. Various forms of self-acting machines have been devised for this purpose; but although they save a great deal of labour, it is doubtful whether the best of them are so efficient as a systematic course of procedure by handwork in successive changes of water. If only about a dozen prints have to undergo washing, it may effectually be done in an hour by the following method. They are first soaked in five or six successive changes of water, draining them between each change. This will remove all the Hyposulphite from the exterior of the prints, but not from the interior. A print is now taken and laid on a sloping glass or slate slab. A soft sponge saturated with water is dabbed, but not rubbed, with pressure on the upper side, the print is taken up for an instant while the slab is flushed with water, it is again laid down on the other side, and the dabbing process repeated. When every print has gone through this operation they are hung up, or laid down on clean blotting-paper, to dry spontaneously, or they may be dried by the fire.

There is no more efficient mode of washing than the above, and when proofs are wanted in a hurry, it is invaluable, although entailing a great deal of labour.

Washing in Dishes.—When removed from the fixing bath, the prints are thrown into a large dish containing clean water. The dish should be made of glass, porcelain, glazed earthenware, or slate. Wooden ones are sometimes used, and will answer very well if the pores of the wood are filled with varnish; if this precaution be not taken, the Hyposulphite will soak into the pores and continue contaminating the water for a long time. *Zinc dishes must not be used*, as that metal will soon destroy a moist silver Photograph placed in contact with it, by reducing the metal which it contains.

More prints should not be thrown into the vessel than can be conveniently manipulated and separated within it, in abundance of water. The dish filled with water is placed in the sink near the tap. The prints as they come from the fixing bath are thrown in one by one and pushed under the water. They are then moved about gently, with the hand, for about a minute, so as not to tear them nor double them up. The proofs are now gently pressed down to the bottom with the outstretched palm of one hand, while the other gradually tilts up the vessel into a perpendicular position so as to discharge the water, the prints remaining on the bottom where they will stick for a minute to drain. More water is let in from the tap, taking care that it does not fall on the pictures, and the same process is repeated four or five times. All this can be done in about ten minutes. The prints are now allowed to soak for an hour or more; and the above process repeated three or four times, before setting them aside to dry.

It is a pernicious plan, although unfortunately one too often adopted, to place a large quantity of newly fixed prints in a dish and allow them to wash themselves by means of a small stream of water running in at one end and out at the other. The prints *will* stick together, and no amount of soaking can remove all the Hyposulphite from those in the interior of the batch, if this mode of washing is employed.

The drying should not be effected, as is sometimes done, by hanging the prints over strings stretched across the room, unless these strings have been previously cleansed from soluble and probably injurious matter by boiling in clean water. The writer adopts the plan of laying each print separately on a large sloping board covered with two folds of clean *white* paper. Another plan is to pin each print up by one of the corners to a projecting shelf. This is good; but unfortunately some papers tear away by their own weight, allowing the print to fall on the ground. A third and perhaps the best plan, where space admits of its adoption, is to lay out the proofs on a sheet of clean linen or white calico stretched across the room.

Defects in Silver Positives on Paper.

1. *The Print Marbled and Streaky.*—These defects are often seen before the print is toned, if so, reject the prints. But more often they are only visible after the toning. *a.* The paper has been badly albuminized, the albumen having been allowed to drain off in streaks. *b.* The sensitizing solution sometimes flows off in the same way when the paper is hung up to dry, consequently the paper prints *deeper* where the current of silver has been running. It is easy to distinguish between these two causes of failure. In the first case the image is redder and fainter than the rest; in the second it is darker and deeper.

2. *The prints clean on the surface, but, when held up and examined opposite a light, spotty.*—This disease is called *measles*, and is sure to destroy the Photograph after a very short time. The appearance presented is a series of irregular small yellow patches. These consist of that deadly enemy to all silver prints—viz., Sulphide of Silver, and lie in the *texture* of the paper. Their predisposing causes are a too weak fixing solution, too short immersion, but above all, a bad sample of paper.

3. *The Print has a Cold and Faded Appearance when Finished.*—*a.* The Nitrate of Silver has not been in sufficient excess in the paper. *b.* The Negative has not sufficient contrast; for it is impracticable to get a

good print from a weak Negative. *c.* The print has been overtoned.

4. *Spots on the Surface.*—These, if white, arise either from particles of dust on the Negative or surface of the paper; if black, from holes in the Negative. Other causes may also intervene, notably metallic particles in the paper. The latter can always be distinguished from all other spots. *There is a small black nucleus surrounded with a circle of white.*

5. *Yellowness of the High Lights.—a.* The paper has been kept too long after sensitizing. *b.* The fixing bath has been acid, or the action of a neutral one continued too long.

6. *Intense bronzing of the deep shadows* usually arises from having a large excess of silver in the sensitizing bath, and printing from an intense Negative which requires a long exposure to light.

7. *Yellow spots on the surface or back of a print* arise from the paper, before or after sensitizing, having come in contact with Hyposulphite of Soda. The least trace of the salt is sure to cause the mischief. If it has arisen from handling the paper with imperfectly washed hands, the impression of the fingers will be distinctly marked. Too great care cannot be exercised in handling or laying down Positive paper. Everything that touches it must be dry and clean.

8. *Mealiness of the prints* is a peculiar disease which may arise from several causes. The appearance which goes under this name is represented sometimes by exceedingly small red spots, and at other times by similar white ones. Of course, opaque particles of dust, either on the Negative or on the surface of the Sensitive paper will, to some extent, account for these. But this is not always the cause. The red specks most probably arise from the Albumen. The writer has never seen a specimen of these on plain salted paper.

9. *The Print refuses to tone.—a.* Often the fault of the paper. *b.* Long keeping of the print before

toning. *c.* The toning bath has been kept too long and become inert. Add a little more solution of Chloride of Gold.

The above constitute the most important of the failures in Photographic printing on paper by direct contact. Various others exist, but the causes of them are so very obvious, that any one can readily see their origin and apply the proper remedy after he has acquired a little experience.

SECTION III.

OTHER MODES OF PRINTING.

Printing by Development on Paper.—This plan is sometimes adopted in very dull weather, or when it is necessary to obtain a picture by artificial light. The following method adopted by Mr. Sutton is perhaps as good as any. Use the thin Saxe or Rive paper. *Immerse* it in the following bath:—

Filtered Rain or Distilled Water	1 ounce.
Chloride of Sodium	6 grains.
Lemon Juice	1 drop.

The time of immersion may lie between one minute and twenty-four hours without producing any marked difference in the result.

Excite the paper by *floating* it upon a Nitrate bath made thus:—

Distilled Water	1 ounce.
Nitrate of Silver	30 grains.
Lemon Juice	6 or 8 drops.

A weak solution of Citric acid may be used instead of Lemon juice.

Hang up to dry and use as soon as possible.

Expose in the pressure frame until a faint trace of the picture is visible.

Develop it thus. Turn up the edges of the paper all round so as to make it into a kind of tray. Lay it with a sheet of blotting paper underneath, upon a horizontal sheet of glass, and pour upon the surface a little saturated solution of Gallic acid, and spread with a bent glass rod. The development commences immediately, and is complete in a few minutes.

The picture is now well washed and toned in alkaline gold if deemed desirable; but this is seldom necessary, because the blacks are generally very fine without this complication. Of course the pictures must be fixed in Hyposulphite of Soda and thoroughly washed.

Printing on Collodio-chloride of Silver.—This mode of printing was suggested many years ago by M. Gaudin of Paris, but remained in abeyance until worked into a practical shape by Mr. G. W. Simpson of London.

The following formula has been recommended:—

Alcohol and Ether equal parts	1 ounce.
Pyroxyline	8 grains.
Chloride of Lithium	1 grain.
or	
Chloride of Cadmium . . .	2 grains.
or	
Chloride of Strontium . . .	2 „
Citric Acid	1 grain.

To sensitize the Collodion, half of the Alcohol is reserved. Powdered Nitrate of Silver in the proportion of from five to eight grains to the ounce of Collodion is placed in the bottom of a test-tube (p. 111), and this reserved alcohol, which should be about the sp. gr. 830, is poured over it. By boiling over a spirit lamp, or Bunsen's burner, the silver is got into solution and is gradually poured into the Collodion, shaking well between each addition. In this way an excellent emulsion is obtained, which, with occasional shaking, will keep in good condition for many weeks. Being sensitive to light, it must be kept in the dark room, where also the plates or paper are coated.

The emulsion may be used for printing transparencies on glass, and for prints on opal glass, ivory, paper, or other suitable medium in the ordinary printing frame, or in specially made pressure frames which admit of examining progress.

In order to obviate the bad effects of free Nitrate of Silver on ivory, Mr. B. J. Edwards *transfers* the Collodion film after toning, fixing, and washing. The surface of the ivory is polished with fine cuttle-skin or pumice powder and then immersed for a minute in a warm solution of gelatine—not too thick. The print is made on glass coated with gelatine, and dried previously to pouring on the sensitive emulsion. After printing, toning, and washing in the usual way, the glass is immersed in warm water, when the film floats off. The film is then removed into a dish of cold water and floated on to the prepared surface of the ivory, which is set aside to dry.

Collodio-chloride of Silver when applied to paper will sink into the pores and give rise to great irregularities in the printing. To prevent this the paper should receive a supplementary sizing either by rubbing into it, with a soft sponge, arrowroot starch, or by dipping the sheets in a warm solution of gelatine in the proportion of about 200 grains to fifteen fluid ounces of warm water.

Rigid media for receiving the Collodio-chloride are coated in the usual way. The plan which the writer adopts for coating paper, is to make the sheet into a kind of tray by folding up the edges of the paper all round and modelling one of the corners into a kind of spout. The paper is then laid on a piece of flat board rather larger than the sheet, and pinned down flat at the two corners opposite the spout end. The board is then taken in one hand by the upper corner, and a quantity of the emulsion, more than sufficient to cover the paper, is poured in towards the end which is held. By adroit movements the wave of Collodion is brought down steadily and evenly towards the *spout*, through which it is poured into a funnel placed in the neck of another bottle. After a little practice, the coating of a sheet of paper evenly is not more difficult than the same process on a piece of rigid glass.

The paper will dry very quickly, and may be used after an hour, or it will keep bright and clear for weeks or more, if preserved in a dark and dry place.

The toning, fixing, and washing are conducted in the usual way.

Other Modes of direct Printing with the Salts of Silver have been proposed, and to some extent practised, notably Mr. Burnett's process of conjoining Nitrate of Uranium with Nitrate of Silver. Mr. Burnett impregnated a sheet of paper with Nitrate of Uranium. This was exposed under a Negative for a short time, and the image developed by brushing over it a solution of Nitrate of Silver or Chloride of Gold. The Wothlytype process was a modification of this. Plain Collodion is saturated with Nitrate of Uranium, and afterwards from five to ten grains of powdered Nitrate of Silver are shaken up with it until dissolved; or the Silver may be first dissolved in weak alcohol by means of heat (p. 111), and shaken up with the Uranic Collodion. Paper or glass is coated with this and exposed under a Negative. No development is required.

If silver alone is used with the Uranic salt, the image will require to be toned; but if a little Chloride of Gold is added, the prints will assume a very pleasing tone. Of course they will require to be fixed and washed as usual.

The high gloss conferred by Collodion is by some considered objectionable; but Collodion is not a necessary adjunct. Highly sized Photographic paper may be impregnated with an aqueous solution of the salts, and when dry printed on as usual. Or Chloride of Gold may be used without the Silver salt. In this case the image is slate-blue.

The rationale of the Uranium printing process seems to be this. A salt of the Sesquioxide of Uranium in contact with certain organic substances when exposed to light is decomposed, and the Sesquioxide reduced, to a lower Oxide of the same metal. This lower Oxide has such an affinity for Oxygen as to have the power of decomposing Nitrate of Silver and several other salts brought into contact with it, and of reducing them to the metallic state. In the Uranium process, therefore, the Photographic image is not Uranium, but simply Silver or Gold, or whatever the conjoined metal might be.

SECTION IV.

TRANSPARENT POSITIVES ON GLASS.

This style of picture is mostly used either for the Stereoscope or the Magic Lantern. There are two modes of producing them—viz., by superimposing a sensitive plate over a Negative in the printing frame, or by means of a lens in a copying Camera. By the latter method the image can be enlarged or reduced at pleasure; by the former the Positive image must necessarily be of the same size as the original Negative.

It will have to be borne in mind by those who intend practising this branch of the Art, that the best transparencies for the Stereoscope are not by any means well suited for the Magic Lantern, and *vice versâ*. The deposit in the latter must be thin, and, even in the darkest parts, translucent; because as the image has to be greatly magnified on the screen, the most intense artificial light that we can employ will not when diluted over a large area be sufficient to penetrate and thoroughly bring out on a large scale a mass of shadow which, when unenlarged, possesses well balanced detail.

Transparencies for the Stereoscope.—Perhaps the most exquisitely beautiful transparencies that have ever been produced were those of Ferrier and Soulier of Paris. It is said that these were done on albuminized glass. If so, no one has been able to rival them by using that sensitive surface. Nevertheless almost equally good results can be produced on Collodion, either used wet in the Camera or on dry plates by superposition in a printing frame. The former is the plan usually adopted by those professionally engaged in this branch of Photography. The Negative is fixed in an adjustible frame adapted to the front of the Camera, and so screened that only the *direct* rays of light can pass through it. The Lens is intermediate between the Negative and the focussing glass, and is so arranged that either it or the screen can be moved nearer or farther apart until the exact dimensions of picture are obtained. When one Positive has been taken and found absolutely sharp, plate after plate may be inserted in the same position without again having occasion to focus. The apparatus must be so arranged that the light falling on the Negative is from the sky, or reflected light from white linen or calico stretched at some distance opposite and parallel to the Negative, otherwise any external object of a different colour seen through the glass will be reproduced by the Lens.

By the wet Collodion process, when properly managed, transparencies surpassed by none can be obtained in the Camera. For this purpose the writer prefers an old, somewhat decomposed, and therefore structureless Collodion. It is not so sensitive as less decomposed Collodions, but that is a matter of little consequence when compared with the beautiful clearness of image imparted. The plate is coated and excited in the usual way, and exposed in the copying Camera. The developer should be a weak solution of Protosulphate of Iron restrained rather more than ordinarily both with Acetic Acid and Citric Acid; the former acid having a tendency to give a brownish tinge to the image and the latter a bluish colour. By adapting these two acids in varying proportions until the desired colour of deposit is obtained—and this can only be ascertained by looking through the transparency—the same proportions will always suit that sample of Collodion, but not necessarily one of a different nature. One thing must be studiously guarded against, and that is, having any deposit whatever on the deepest shadows except what should really exist there from a feebly lighted object.

If after the Positive has been fixed and washed the colour is not deemed satisfactory, the image may be toned to a bluer tint by pouring on and off it a weak alkaline solution of Chloride of Gold, but this will hardly ever be necessary if the iron solution is weak and its action properly controlled by Citric Acid. A good starting point for a developer is:—

Protosulphate of Iron . . .	8 grains.
Acetic Acid	20 minims.
Citric Acid.	2 grains.
Water	1 ounce.

If the weather be hot the quantity of acids may be increased, and *vice versâ*. Or again, if on looking through the picture it is of too cold a tone, that is, too blue, decrease the Citric Acid and increase the other. By regulating the Acids in this way, any desired tone from dark grey to bluish black is obtainable.

A two-grain solution of Pyrogallic Acid restrained in the same way may also be used for development.

A weak solution of Cyanide of Potassium is the best fixing agent, because it clears off any slight fogging that may occur to dim the transparency of the shadows. On the other hand, with such an intensely organic Collodion it is apt also to weaken the image. If such tendency should be manifested, fix with Hyposulphite of Soda.

In making Transparencies for the Magic Lantern the *colour* of the deposit forming the image is of little consequence, provided it be not too dense. The best Lantern slides that the writer has ever seen were made in the copying Camera and developed with the ordinary solution of Protosulphate of Iron and Acetic Acid, without any other complication.

Transparencies by Contact with a Negative.—Before attempting this method of reproduction it will be necessary to see that both the glass on which the Negative rests and the glass on which the Positive is to be taken are *perfectly flat*, otherwise when pressed up in the printing frame in close contact, one or both of the glasses may be broken. For this purpose therefore no glass except patent plate can be relied on.

Dry plates *only* can be used, and this for obvious reasons. An old decomposed Iodized or Bromo-iodized Collodion applied to the plate, sensitized in a thirty-grain silver bath, and afterwards well washed and dried, requires no Organifier or Preservative whatever, as it is already well provided in that respect. Newer Collodions will require to be treated with an Organifier after washing, else the image, at the best, will be but feeble and badly contrasted. Almost any of the dry processes already described for work in the Camera will answer, more particularly those in which an *acid* organifier has been used. Tannin, beer, &c., answer remarkably well. In the writer's hands dry plates prepared solely with Bromide are not well suited for transparencies, for the reason that with alkaline development it is almost impossible to obtain a pleasing tone with any treatment which he could adopt. After-toning with Chloride of Gold does not seem to mend matters much.

The exposure to *diffused* daylight in the Printing frame must be almost momentary—from two to ten seconds, according to circumstances. Or the exposure can be effected by artificial light, by placing the glass of the frame opposite and near to a gas or other bright flame, and moving the frame about, sideways, for about half a minute. The latter plan is better than the former, because as this light may be considered *constant*, there occurs less danger of over or under-exposure. A *blow*, so to speak, of strong daylight would hopelessly solarize such sensitive films exposed to its influence, and no after-treatment will remedy the evil. In this case the image will be either red or a feeble slate colour, according to the nature of the developer or the Collodion, and will also be devoid of contrast, although not necessarily fogged.

The development is best effected with Pyrogallic Acid :—

Pyrogallic Acid	2 grains.
Acetic Acid	20 minims.
Distilled Water	1 ounce.

Citric Acid, either conjoined with the Acetic or by itself, may be used, according to the tone that may be required. The dry plate is first moistened with alcohol and water, in equal proportions, to open the pores of the Collodion. The plate is rinsed in water and *quant. suff.* of the developer applied once or twice and poured back into the cup. A drop or two of a thirty grain solution of Nitrate of Silver is mixed with the solution, which is again applied, when the image will begin to appear. All other details have already been described.

Large transparent or translucent Positives for hanging against windows may be prepared in the same way, either on ground or opal glass. The effect on clear glass is not so good.

SECTION V.

PRINTING IN PIGMENTS.

One of the greatest drawbacks to Photography has been the great liability to fading of its products. Many and earnest have been the efforts to render silver Photographs permanent; but all of no avail, for by contact with air they must sooner or later fade away. Photographers have for a long time been painfully aware of this fact, hence the many attempts to rescue the Art from the stigma of evanescence. For this purpose Carbon or other suitable pigments are now to some extent employed in printing; and doubtlessly this plan would become universal were the processes unfettered by Patents.

As the future of Photographic printing lies in this direction, either by direct contact with the Negative or in the Printing press, it is deemed desirable to enter rather fully into particulars of manipulation and the principles on which the processes are based.

It was discovered many years ago by Mr. Mungo Ponton, of Edinburgh, that certain organic substances, notably solution of Gelatine, when treated with a Chromic salt such as Bichromate of Ammonia or Potash, spread over paper or other medium, dried and exposed to light, are no longer soluble in warm water. Light alone exercises no decomposing influence on these salts until they are brought in contact with the Organic body. The Chromic Acid is reduced to a lower Oxide of Chromium, and the liberated Oxygen unites with the Gelatine which is oxidized into an insoluble resinous substance, or only soluble in proportion to the duration and force of the Actinic rays.

Preparation of the Pigmented Paper.—This can be best done by those who make a speciality of the manufacture and have abundance of space for drying the product uniformly. It may be stated generally, that the operation is conducted on the jack-towel system—that is, a long web of paper is fastened round two rollers placed at a distance apart. The lower roller is arranged that the surface of the paper *just touches* a warm solution of pigmented gelatine in a trough. A crank on one of the rollers is gently turned until the whole sheet has been covered on the outer side. The rollers are then raised or the trough lowered, whilst the crank is kept gently moving to enable the Gelatine to set uniformly. After this the web is cut and hung up in the drying-room.

Sensitizing the Pigmented Paper.—It is of considerable importance *not* to use a strong solution of Bichromate for sensitizing, because, when the Gelatine is dry, crystals forming on the surface are apt to interfere with uniformity of printing. The following formula is the one which the writer is in the habit of using—

Bichromate of Potash	1 ounce.
Water	1 pint.

A sufficient quantity is made to fill a flat-bottomed dish to the depth of at least half an inch. The paper is cut into sizes rather smaller than the dish, which may be made of wood, porcelain, or glass. A piece of paper is slipped, pigment side downwards, underneath the liquid, and instantly turned over, taking care to see that it is covered with the solution, and that there are no air-bubbles on the surface. If any appear they must instantly be removed, either by a touch of the finger or a brush. The paper is almost certain to curl up above the solution, from unequal expansion; but this must be prevented by keeping it underneath, either by the hands or by means of brushes.

The temperature of the room in which the sensitizing operation is performed is of importance; for it must be borne in mind that Gelatine is soluble in warm water. Under ordinary circumstances, in this country, a temperature ranging not over 65° or 70° can be readily obtained. The pigmented paper, as usually prepared, will bear this degree of heat without the Gelatine slipping off, unless from prolonged immersion in the Bichromate bath. Should there be a tendency to solution of the Gelatine in hot weather, the writer has found Mr. Edwards's plan of cooling the Bichromate solution with ice and immersing the paper for a minimum of time, a perfect antidote.

As a rule the paper is sufficiently sensitized in about half a minute. A longer immersion in the Bichromate bath does no harm farther than rendering the paper so rotten that it could not be hung up to dry without danger of its falling from its supports.

If the sensitized sheets are small, they may be hung up to dry in the dark room by an American or glass clip attached to a string stretched across the room. If they are 10 × 8 inches, or a little more, two clips will be necessary, one at each of the upper corners. If the sheets are still larger this is not a safe course of procedure, because their very weight would tear them away. Under such circumstances the suspension is best carried out in the following manner. A number of thin deal laths, about three quarters of an inch in width and sufficiently long to stretch more than across the whole breadth of the sensitizing dish, should be provided. One of these is laid across the end of the bath, resting on the sides. As soon as the paper is sensitized, the corners nearest the lath are seized by the forefinger and the thumb of each hand, and the end of the sheet placed upon the lath. The other lath is placed over this, and both gripped together with a couple of American clips. By these handles the sheet is raised gently from the bath and held over it for a minute or so to allow the larger proportion of the liquid to drain off. It is then suspended in a cool and dry dark room between horizontal bars on which the ends of the laths rest *edgeways* in grooves. After the paper has again drained for a short time, another lath is attached to the bottom by clips. The object of this is to prevent the sheet from curling up as it dries.

The same Bichromate bath may be used frequently, and apparently is not weakened; but it is gradually changed in some way which practically amounts to the same thing. And this is not to be wondered at when we bear in mind the singular reactions which take place when Chromic acid and some organic bodies are brought together. Any speculative opinion on this subject would be out of place in this Manual.

A recent modification in the manufacture of pigmented Gelatine enables the sensitized paper to be dried at a higher temperature than was hitherto deemed possible; but this necessitates warmer water in the development of the image.

When the Gelatine tissue has been sensitized, the sooner it is dried and used up the better. It should be printed on within twenty-four hours if possible; but if kept thoroughly dry, it will remain useful for two or three days, and even longer if a weak solution of Bichromate has been used for sensitizing.

Printing the Picture.—To those accustomed to silver printing, this will at first appear a difficult operation, but in reality it is not so after one has gained a little experience. The reason why it *appears* difficult is because no *visible* impression is made on the tissue. Various kinds of *Actinometers* or measurers of Chemical light have been devised, none of which appears to the writer to be so satisfactory and simple as a piece of silver-chlorized paper sensitized on a standard solution. The mode of using this Actinometer will be explained as we proceed.

The Negatives, after examination by transmitted light, can be classified as a rule into four different degrees of printing density. On a corner of the glass is scratched with a diamond 1, 2, &c., as the case might be. This register will serve for future printings from the same Negative, but if a mistake in estimating the density has after trial been found to be committed, it can of course be easily remedied afterwards by altering the figure. After a little experience few mistakes will be committed in this respect.

Before printing on Gelatine from Negatives a precaution should be adopted, which is, however, not always necessary. A narrow strip of blackened paper is gummed all round the edges of the Negative; because it has been found that when light has acted strongly, the changed Gelatine will not adhere to the transfer paper with sufficient tenacity to resist the action of the warm water, which insinuates itself underneath and may destroy the picture. This bordering has been happily called the *safe edge*, as in truth it is.

The plan which the writer adopts for the exposure of the sensitive tissue is this. A dozen, say, ordinary printing frames are filled in the dark room. On each frame is a chalk mark representing the density of the negatives contained therein. All the frames are exposed to light, as near as may be simultaneously, and at the same time a bit of the silver-chlorized paper is subjected to the same actinic influence. When this paper registers, to the eye, a certain amount of darkening, all the frames marked 1 are turned over; when it registers a deeper colour the No. 2 set are similarly treated, and so on until the whole are supposed to be fully exposed. It may be stated, generally, that the time of exposure, with paper prepared as above directed, is about one third of that required for printing from the same density of Negative on the most sensitive silver paper. Thus an operator, who has been accustomed to the latter mode of procedure, may make an excellent Actinometer for his own guidance, by simply exposing a piece of standard silvered paper under a negative in the printing frame, and judging from an occasional examination of that, as to the time in which the Gelatine will be properly impressed.

Development of the Image.—In order to obtain a *non-reversed* print from an ordinary Negative, the exposed gelatine tissue must first be attached to a temporary support during development. For this purpose Mr. Johnson recommends a zinc plate slightly roughened; and, to prevent the image from adhering too closely, so that it cannot afterwards be removed, he smears the surface of the plate with a little wax and resin dissolved in turpentine. The excess of this is afterwards rubbed off with a clean rag. A quantity of these plates are prepared corresponding to the number of the prints to be operated on.

The next operation is to attach the exposed Gelatine to this support. Let us follow the progress of one example, which will explain all. The print is immersed in a tray containing cold and clean water. In a few seconds it has absorbed sufficient moisture to make it adhere firmly, but on no account must the print remain long in the water, else the attachment to the temporary support will be extremely feeble, because all the Gelatine might have had time to expand. The plate is now slipped under the water, the Gelatine side of the tissue pressed closely against it, and the whole drawn out in such a way as to avoid any possibility of intervening air-bubbles. Perfect adhesion is effected by expelling the superfluous moisture with a long slip of India-rubber inserted between two boards. This instrument is generally called a "squeegee" and is scraped with some pressure over the back of the attached print so as to expel as much water as thus can be driven out. After a few minutes, or longer, provided the tissue is not allowed to become dry, the development proper is commenced.

The plate, with the paper attached, is placed in a dish of warm water registering from 90° to 100° Fah., and remains there for a minute or two until the Gelatine expands and softens. Raise up gently one of the corners of the paper and notice if it leaves the plate easily. Should it not do so, allow a little longer soaking; for if violence be used, in all probability the print will be destroyed. The paper when removed is worthless, and is thrown away; the greater part of the Gelatine has left it, and the picture after a little farther treatment will be found attached to the zinc or other supporting medium. The plate is at once replaced in the warm water, when gradually the soluble Gelatine with its contained pigment is washed away and the picture appears. Now is the time to judge whether the exposure has been properly timed. If the image appears faint, the exposure has been too short. In this case there is no remedy. On the other hand if the details are too dark, hotter water will often clear them up. There is great room for judicious management in this respect. A final rinse in cold water removes any loose particles of pigment that may be lying on the surface.

The next step is to transfer the developed print from its temporary support on to the final one. For this purpose "transfer paper" is required. Ordinary paper is too porous to admit of being used, but it is fitted for the purpose by being coated with a thin layer of Gelatine in which a little alum has been dissolved. The object of adding the alum is to convert the Gelatine when dry into a substance analogous to leather, and hence to render it insoluble in even very hot water. A piece of this paper, rather larger than the developed print, is immersed in cold water for a minute or two until it softens, and is then at once laid on the zinc or other plate on which the image was developed, avoiding air bubbles. The "squeegee" is again applied to expel superfluous moisture and insure close contact. When the paper is dry, *but not till then*, it is stripped from the zinc, when it will be found that the picture has left its first support and is imbedded as it were in the paper. Occasionally it may happen, that the print even when dry exhibits a reluctance to leave the zinc plate. This arises from there being too much resin mixed with the wax used for smearing the plate in the first instance. A gentle heat applied to the back of the plate makes the picture leave instantly. On the other hand if there be too little resin on the plate, the transferred print may raise itself spontaneously at the edges, before the middle is dry. This causes unequal contraction of the paper and a general tendency to puckering up.

Should any wax or resin be visible on the surface of the finished print, it may be rubbed off with a tuft of cotton wool impregnated with Benzol.

The above instructions refer to what is called the "double transfer" process, whereby the pictures are seen in their natural position, that is, *non-reversed*. But the impressed Gelatine tissue can at once be attached to its permanent support and developed thereon. This is called the "single transfer" method, which is much simpler in details, and would be universally adopted were it not that in printing from a Negative on glass the transferred image is *reversed*, that is, the right-hand side of the picture is placed to the left, and *vice versâ*, just as in a Daguerreotype or a Collodion positive on glass. To obviate this palpable drawback to an exceedingly simple mode of printing, the writer *transfers* (see p. 124), all his Collodion films which are to be printed by this method, and which are worth preserving. By this plan a Negative can be printed from either side without any sensible loss of definition. One side would be placed in contact with Silver-chlorized paper, and the other with sensitized Gelatine, as the case might be.

The writer has been very successful in transferring these Gelatine pictures to wood blocks for the use of the engraver. The block is smoothed in the usual way. A weak solution of Gelatine in warm water containing a little alum is made. The surface of the block, also warmed, is rubbed over with a little of this, and all excess wiped away with a clean cloth. The exposed pigmented tissue after lying for about a minute in cold water is laid on the block, which is instantly pressed down on a smooth flat surface, such as glass, to expel air bubbles and secure perfect contact. The block is then set up edgeways, for a short time, till the tissue is ready for development, which is effected in a manner not materially different from that already described. The block is held in the hand so that the surface and no more touches the warm water. After a little time the paper tissue is removed and the image developed by holding the block in the same way.

A few precautions are necessary. First, the pigmented tissue should be of that kind which has a minimum of Gelatine and a maximum of colouring matter. The object of this is to prevent the graving tool from *slipping* while drawing the fine lines. Second, immediately before developing, the *back* of the block should be moistened to prevent unequal expansion and probable cracking of the wood.

Photographs laid down in this way, so far as position is concerned, are exactly what the engraver requires—viz., a reversed image. But, on the other hand, he has no *lines* to guide him.

SECTION VI.

MECHANICAL PRINTING.

1. *Photo-lithography.*

Many attempts have been made to render this process capable of reproducing Photographic half-tone, but all have been of no avail, or at the best have succeeded only very partially. The cause of failure lies in the fact that only *decided* lines will allow the greasy ink to *bite* or take hold of the stone. Mr. Osborne and Mr. Griggs have brought this art to a high state of efficiency. Before describing the process it will be necessary to observe that the operator should be conversant with the requirements both of Photography and Lithography.

Supposing that a map or any other outline, no matter how complex, has been drawn, and that it is deemed desirable to reproduce *fac-similes* or reduced copies by means of the Lithographic press, the picture is fastened up flat and a Negative taken in the Camera by a non-distorting lens. The Negative must be clear and bright in the outline of shadow, and quite opaque in the parts represented by white in the original. Intensifying agents in the development are used for this latter purpose.

The following is Mr. Osborne's mode of procedure.

A sheet of plain positive Photographic paper is now coated on one side with a mixture consisting of Gelatine, softened and dissolved in water, to which a quantity of Bichromate of Potash and Albumen has been added. The paper, evenly covered with this fluid, is dried in the dark, when it will be found possessed of a smooth glassy surface, and a brilliant yellow colour. This surface is still further improved by passing it through the press in contact with a polished plate.

A suitable piece of positive Photo-lithographic paper thus manufactured is now to be exposed to the action of light under the Negative of the map already described. This is accomplished in an ordinary pressure-frame, the time required varying from ten to fifteen seconds to several minutes, according to the brightness of the weather; but it is always short compared with that necessary for the production of a picture on paper prepared with Chloride of Silver. The positive thus obtained presents itself to the eye as a brown drawing upon the clear yellow of the sheet. If the prepared surface of the paper were now moistened with water, and the attempt made to apply printing ink to it, we would find a strong tendency in the Albumino-gelatinous surface to behave towards greasy and watery substances in a manner quite analogous to that peculiar to a lithographic stone while printing. We would also find that the solvent action of water at any temperature is quite incapable of removing the picture which the sun has imprinted upon it. The light, in fact, has so acted upon the chemical substances brought together upon the surface of the paper that the organic matter is no longer soluble. These are the characteristics of the change due to exposure which we have to remember.

But the exposed photographic copy of the original is not moistened, or subjected to any solvent action at this stage of the proceedings; it is, on the contrary, covered all over while dry with a peculiar kind of Lithographic ink, known as transfer ink, which is accomplished by running it through the press with its face in contact with a stone which has already received a coating of such ink. After it is separated from the blackened stone it will be found to have brought away with it an evenly distributed film of inky matter, forced by the pressure into intimate contact with the unexposed as well as the exposed portions of the surface. This operation is known as "blacking" the Positive print. That now to be described is called "coagulation," its object being to effect a change of that nature upon the

Albumen contained in the coating of organic matter. For this purpose moisture and heat are necessary, and both are applied very simply, by letting the blackened Photographic copy swim upon the surface of boiling water with its inky side upwards, for it is important not to wet that with hot water. After the lapse of a certain period, determined by the experience of the operator, he proceeds to the next step in the process, that of "washing off." For this purpose the print is laid upon a smooth surface, such as a plate of glass or porcelain, and friction with a wet sponge or other suitable material is applied to the black inky coating under which the Photographic image still exists, and to develop which is now the object in view. The operator soon becomes aware that the moisture which percolated through the paper from the back has exerted a softening influence upon the Gelatine in the sensitive coating, it has caused it to swell and to let go its hold upon the ink. But this change does not extend to those parts of the coating which were acted on by light; in other words, to those places which were unprotected by the opacity of the Negative; they remain intact, uninfluenced by the solvent or moistening effect of the water. Accordingly, the operator finds a *fac-simile* of the original map gradually develop under his hand as he continues the friction. This process is proceeded with till all traces of ink are removed save those required to form the picture, which must be clear and distinct in all its details. Abundance of hot water is then poured over it so as to remove every particle of soluble matter, and then it is finally dried, which completes its preparation. We are now possessed of a Photograph in Lithographic ink, identical in every respect with the original, not simply upon paper but upon Albuminized paper—a matter of much importance, as will presently be explained. The presence of the Albuminized layer under the picture is the result of the coagulation which took place while the print was swimming on the hot water; after that change no amount of washing could remove it, although the Gelatine was not proof against such treatment.

A stone to which a fine smooth surface has been imparted is now slightly warmed and put in the lithographic press. Upon this is placed inverted the Positive print, after it has been damped by lying between moist paper, and the whole is then passed repeatedly through the press. On examination the paper will now be found to have attached itself firmly to the stone, so that some force is required to separate the two. When the former is removed it brings with it the Albuminous coating, which gives to it while damp a parchment-like appearance. But the ink is gone; it has left the paper for the stone, and on the latter we find a reversed drawing of the map, one which, after it has been properly "prepared," will print as well as if it had been drawn by hand. The rationale of this method of transfer is easily understood: the greasy ink having a great affinity for the substance of the stone, combines with it to form a lithographic drawing in the strictest sense of the word, and while this is taking place the damp Albumen upon the paper holds the sheet in its proper place, so as to prevent a shift of any kind, and enables the pressure to be applied as often as the operator wishes.

The stone is printed from in the usual lithographic way.

PHOTO-ZINCOGRAPHY.

This process in principle is the same as Photo-lithography, but some of the details are different. It was invented by Colonel Sir Henry James, and is now extensively employed in the Ordnance Survey Department at Southampton for copying maps, &c.

A suitable paper is floated for two or three minutes on a warm solution (about 100°) of the following substances:—Bichromate of potash, 2½ oz., dissolved in 10 oz. of hot water, to which are added 3 oz. of the purest gelatine previously dissolved in 40 oz. of hot water. The paper, after becoming dry, should be again floated on the same solution, and hung up to dry at the opposite corner to that by which it was first suspended in order to distribute the sensitizing solution uniformly. This must be done in the dark room. This paper will not keep long in a serviceable state even in the dark room, because the Bichromate gradually oxidizes gelatine without the action of light. Two days are about the limits of its keeping qualities.

The sensitive paper is exposed to the solar rays under a Negative in the pressure frame as usual. One minute in bright sunlight is often sufficient. The general indications to judge of sufficient exposure, are the appearance of the parts where the light has acted most strongly. They should be of a deep tawny colour tinged with green, and the shadows yellow.

Now comes that part of the process where the lithographer steps in to complete the work of the photographer. The print is removed from the pressure-frame and *inked* by the following method:—

In an iron pot put 2 oz. of Burgundy pitch, 1 oz. of palm oil, and 1 oz. of bleached beeswax; place the pot over a fire, and as soon as they begin to melt, keep stirring the mass till they are thoroughly incorporated, which will not take place till the ingredients have nearly reached the point of ignition. Then remove the pot from the fire, and intimately mix with the contents 1 lb. of chalk, lithographic ink, and half a pint of what is called in the trade *middle linseed oil varnish*, both of which must have been previously thoroughly incorporated by pounding in a mortar.

When required for use, a portion of the ink is melted with sufficient turpentine to make it of the consistence of honey. A little is then placed on a printing roller, and a flat zinc plate inked with it in the usual manner. The print is then laid face downwards on the zinc, and the whole passed through a press, by which means it receives an even coating.

The print is then removed from the zinc plate, and laid back downwards on water at the temperature of about 100° Fahrenheit for a few minutes. It is next placed on a level slab, and all the superfluous ink removed with a soft sponge dipped in gum water. It is afterwards treated with repeated baths of warm water till the ground is quite clear. When dry, it is ready for transferring to zinc or stone.

Mode of Transfer, &c.—Colonel Sir Henry James's instructions on this part of the process are so very lucid and precise, that we cannot do better than quote them.

THE TRANSFERENCE OF THE PRINT TO ZINC, AND PREPARATION FOR PRINTING.

When the zinc plates are received from the manufacturer, the surface has to be prepared to receive transfers. They are first planed with a razor blade, the back of which is set in a wooden handle, the ordinary edge is ground down flat so that there are two edges to scrape with in turn, like the edges of a skate. The plate is thus cut down till all surface scratches, blisters, and other defects are obliterated. It is then ground down to a flat surface with pumice stone, and smoothed with snake stone, to take out any scratches made by the pumice stone. Finally, a grained structure is given to it by rubbing with fine sand and water, and a zinc muller. The muller is simply a disc of zinc, about half an inch thick, and four inches in diameter fixed to a wooden handle. It is grasped by the handle with the thumb uppermost, and rubbed over the surface of the plate with a circular movement.

The sand is brought to the requisite degree of fineness by sifting it through a wire sieve of from 80 to 120 holes to the square inch, according to the kind of grain required for the plate. The time required for two men to grain a zinc plate three feet long by two broad, has been found to be about an hour. As soon as this process is completed, the plate is thoroughly washed with water, and well dried. It should be kept from contact with any substance likely to communicate greasiness to it; and the sooner it is used for transferring the better, as the action of the atmosphere will tend to diminish the affinity of the surface for the greasy ink.

When it is desired to clean and prepare for receiving transfers a plate which has been used, the ink of the old transfer is cleared off with turpentine, the plate is then washed with strong alkali and cleaned with water, an acid is then poured over it. This is prepared by taking equal parts of Sulphuric and Hydrochloric acids, and to one part of the mixture adding twelve parts of water, and the plate is regrained in the manner already described.

The Photographic print is laid between sheets of damp paper for a few minutes, placed face downwards on the zinc plate, with two or three sheets of paper over it, and passed through the press.

If the transfer print is not more than three or four days old, it will be sufficient to pass it through once, but an old print on which the ink has had time to harden, will require to pass through the press two or three times.

The sheets of paper covering the transfer are then removed, and it is damped with a wet sponge for two or three minutes; this causes the gelatine in the lines to swell, and makes the ink leave them more readily.

The print is then pulled carefully off the plate, and nearly the whole of the ink should remain on the zinc.

The transfer is now etched; the etching liquid consists of a decoction of galls and a little Phosphoric acid, mixed with a thick solution of gum and water.

It is prepared as follows :—

Four ounces of Aleppo galls are bruised and steeped in three quarts of cold water for twenty-four hours; the water and galls are then placed in a vessel over the fire, and allowed to boil up. This decoction is then strained. The gum water should be about the consistence of cream.

One quart of the decoction of galls is added to three quarts of gum water, and to the mixture is added about three ounces of the solution of Phosphoric acid, which is prepared by placing sticks of Phosphorus in a pint bottle of water. This is stopped with a cork, in which is cut a small hole: the bottle is three-quarters filled with water, and the ends of the sticks of Phosphorus rise above the surface and become oxidized by the air admitted into the bottle.

The Phosphoric acid, as fast as it is formed, is dissolved by water. In a few days the solution is strong enough for use.

The etching liquid is poured on the plate, and wiped over the surface with a sponge or camel-hair brush. It is allowed to remain on for a short time, varying with the strength of the design. With fine work twenty seconds would be sufficient. Strong lines will bear the action a minute without injury. As soon as the solution has acted sufficiently, it is wiped with a soft cloth dipped in water, care being taken to remove all trace of it if there are fine lines.

The transfer ink is next cleared from the zinc plate with turpentine, or if the design is weak, with turpentine mixed with olive oil and gum water. It is then rolled up with printing ink, the roller being very thinly and evenly coated. Impressions can then be printed in the usual manner; 1500 is not an unusual number for the plate to stand without sensible deterioration.

The photographic print can be transferred to a lithographic stone in a similar manner.

When the subject admits of it, paper enamelled with zinc white should be used, as the impressions produced are most perfect.

It is prepared in the following manner:—

Four ounces of Russian glue are soaked in three quarts of water for some hours, and then heated till dissolved; a pound and a half of zinc white is ground with water on a slab, and then mixed gradually with he solution of glue and passed through a hair sieve.

A coating is brushed on the paper with a *pound* brush, and the streaks are obliterated by going lightly over the surface with a flat camel-hair brush. A second coating is applied in a similar manner, and hung up to dry. When dry it is ready for use.

III. WOODBURY'S PROCESS; OR PHOTO-RELIEF PRINTING.

Any good Negative suits for this process, but the details of manipulation are not very easy.

First Stage : Preparing the Tissue.—A clean glass plate is smeared over with beeswax, which is then rubbed with a clean cloth till the coating is infinitesimally thin. A strong-bodied and tough Collodion is poured over the waxed side of the glass in the usual way, and allowed to dry. The plate is coated on the Collodion side with a thick and warm aqueous solution of Gelatine, containing from fifteen to thirty per cent. of Bichromate of Ammonia or Potash, and is then laid on a levelling stand, in the dark room, to set in a uniform sheet. When the film has set, the plate is put into a closed drying box containing fused Chloride of Calcium, which soon desiccates the gelatine by absorbing the moisture. The compound film of Collodion and Gelatine can now be raised from the glass in one unbroken sheet by cutting round its edges with a sharp knife and gently raising it up. With as little delay as possible the tissue is subjected to the next operation.

Second Stage : Impressing the Tissue.—The Collodion side of the tissue is placed in contact with a Negative in a common printing frame, and subjected to the *direct* solar rays, which should fall perpendicular to the surface of the glass, otherwise the image will lose much of its sharpness, for the following reason :—As the actinic impression has to be made through an appreciable thickness of insensitive Collodion intervening between the surface of the Negative and the sensitive Gelatine, and has also to penetrate through the latter to some considerable depth, any parallax or change of relative positions of the different parts of the Negative, arising from various obliquities of the light, would seriously affect sharpness of definition, and, to some extent, truthfulness of delineation. The above remarks will be appreciated by those who, by inadvertence, have made a print from the wrong side of a Negative on glass. The image is all confused. But if any one tries the experiment of printing from the wrong side of a Negative on very thin glass, by placing and keeping it quite perpendicular to the sun's rays, at the same time excluding, as far as possible, all diffused light, he will find his print nearly, if not quite, as fine as if the sensitive paper had been in immediate contact with the Negative image itself.

The above are the principles which must be attended to in impressing the sensitive gelatine film. Artificial light from the charcoal points of a powerful magnetic battery may be used; but in this case, as the printing frame must be placed near the source of light, there will be considerable parallax.

Third Stage: Making the Mould.—When the exposure is completed, the unimpressed Gelatine is washed away. To do this, the Collodion side of the tissue is pasted down flatly with a Benzolic solution of India-rubber on a piece of clean glass, and the edges varnished. The whole is placed in a dish of warm water, which dissolves off all the gelatine where light has not acted, and the rest exactly in proportion to the actinic impression, leaving a *depressed surface* in the high lights corresponding to the densest portions of the Negative, and a gradually increasing *relief* through all intermediate tones up to the deepest shadows. The film still attached to the glass is dried, and can then be easily detached in one unbroken sheet by cutting round the edges and gently raising it.

At this stage the value of a little Prussian blue, mixed with the Bichromated gelatine, is obvious. Pure gelatine, when in thin stratum, is transparent, and the inequalities on the raised surface corresponding to the lights and shades of the Negative could hardly be appreciated without some pigment being mixed with the Gelatine. Prussian blue is the best to use, because it offers little obstruction to the Chemical rays during exposure.

The mould is now complete.

Fourth Stage: Making the Printing Die.—For this purpose a composition of lead and type metal is used. On a block of this composite metal, about a quarter of an inch thick, the Collodio-gelatine mould is laid, gelatine side downwards, placed in a hydraulic press, and subjected for a few minutes to a pressure of over a hundred tons. The result is a sharply defined and reversed relievo image on the metallic surface. The high lights are, of course, now raised and the shadows depressed. Strange as it may appear, the gelatine mould, although thus squeezed with such enormous pressure against a metallic body apparently harder than itself, has not suffered in the least, and may be used for taking many similar impressions, all as sharp as the first one.

The metallic die is now trimmed to the size of picture required and bevelled on the upper edges, when it is ready for casting out the *bas-relievo* proofs on glass, paper, or other suitable medium.

Fifth Stage: Casting or Printing from the Die.—To get proofs on glass and other rigid media, the die is placed on a level slab and rubbed over with a little oil. A small pool of aqueous solution of gelatine, impregnated with Carbon or any desired pigment, kept ready at hand in a warming apparatus, is poured on the middle of the die. Immediately the glass or other plate, also warm, is pressed thereon with the hand for an instant, and left in position till the gelatine sets, which might be in about two or three minutes. After that, the glass or other medium, with the picture firmly attached to it, may be removed, and the superfluous pigment round the edges scraped off. The whole is then varnished. As one man can work several dies, and as the die requires oiling only once for five or six impressions, the prints can be turned out at the rate of about one per minute.

When paper or other flexible porous medium is used to receive the picture, the process of printing is slightly different. The paper must first be impregnated with some substance which renders it *non-absorbent*, else some of the pigment would be squeezed into the pores of the paper instead of being pressed away from the parts of the die in highest relief. A pressure frame is also required to press the pliant medium in close contact with the pigmented die.

The rationale of the final *casting* on glass, paper, &c. of this ingenious process, is very easily understood. The die, or metallic impression from the gelatine mould, is something analogous to a Queen's head on a coin, but not in such high relief. The most elevated portions of the die corresponding to the high lights of the picture squeeze away the *whole* of the pigment, and those less elevated press it out in proportion to their greater or less elevation. Thus perfect gradation of tone is secured.

Two or three drawbacks to the extensive use of this process exist. First, the die cannot be printed from along with letter-press. Second, no means have been devised whereby the crushed out pigment should not smear the borders of the paper, &c. on which the picture is impressed. And third, the production of large images seems to be an impracticable operation.

COLLOTYPE PRINTING.

The method of printing from a film of Gelatine by means of printers' ink, has received various trade designations, such as Lichtdruck, Heliotype process, &c.

The principle on which the process is based is analogous to that of Photo-lithography, with this important difference—viz., that in Collotype printing the sensitized Gelatine is so changed by the action of Light that it takes the printers' ink exactly in proportion to the actinic impression made.

Mr. Sawyer, who has been eminently successful in this mode of printing, furnishes the following details of manipulation :—

A mixture is made of Gelatine, Albumen, and Bichromate of Potash, the ingredients being well beaten together; when the froth has settled down the mixture is filtered. The plate, having been previously levelled in a drying-box and warmed up to a temperature of 100°, is coated with a portion of the preparation, which is made to flow all over the plate and a portion over each edge; the plate is restored to its drying-box, and in about two hours or so the first coating is dry. The second preparation is composed of Gelatine, one to six, and a small portion of Albumen, and sensitized with a Bichromate. When these are thoroughly dissolved they are whisked well together, and whilst being agitated a small quantity of an alcoholic solution of resinous gum is added; an emulsion is instantly formed, the particles of the gum being entangled with the gelatine. There is added a trace of Nitrate of Silver, with a small quantity of a solution containing an alkaline iodide. The whole, after being well stirred together, is filtered; the plate is again levelled in its drying-box. When all is ready the plate is placed in a porcelain dish of warm water, the excess of Bichromate of the first coating is washed away, the heat of the water and the residue of the chemicals remaining coagulate the albumen, and produce a very delicate, slightly-porous surface admirably fitted for the reception of the second preparation, which is poured on the plate whilst still moist. Care is taken to let it drive off the superfluous water, and a portion of the preparation itself is allowed to escape over each edge, which has the effect of binding down the film firmly to the glass. The plate is restored to its drying-box, and at a temperature of 90° or 100°

becomes dry and ready for use in two or three hours. When dry and cool a Negative is laid down upon the plate-glass of the pressure-frame, and the plate-glass bearing the sensitive surface laid upon it. The progress of the printing can be easily ascertained by looking through the plate from the back. When the picture appears well, and all the detail visible, it is done enough. After exposure the plates are washed with cold water, rinsed thoroughly, and allowed to dry spontaneously; they are then ready for the press. Plates prepared by this method have exceedingly thin films, not exceeding the thickness of writing-paper, and to this fact perhaps is due the exquisite reproduction of fine and delicate detail. In thick films there is an appreciable and, very frequently, a strong relief, requiring enormous pressure to force the paper into it; in these thin films the process is exactly analogous to that of lithography, and the pressure required is comparatively trifling.

The plate, when dry, is levelled on the bed of an ordinary lithographic press. A little plaster of Paris is run on a lithographic stone, and the glass plate is laid upon it whilst it is still fluid. No plate laid down in this way will ever break, whatever pressure may be applied to it. This plan, however, being rather troublesome, the following is usually adopted:—Venice turpentine thickened with a little wax is smeared on a slab or lithographic stone, and the plate is worked down upon it for a few seconds; it soon becomes set, and may be printed from without the slightest risk—only beware of any grit between the glass and the stone. Having, in one or other of these ways, got the plate upon the bed of the press, it is carefully levelled up, and well sponged with cold water, dried off with blotting-paper, then wiped with a piece of fine soft muslin, and ink rolled into it with a lithographer's leather roller. If the plate is over-exposed, or under-exposed, a judicious use of thicker or thinner ink will still produce good results. Sometimes two or more inks of the same or varying degrees of stiffness are used in colour-printing, frequently only one. The operation of printing is one requiring delicacy, taste, and skill in the rolling; and the reason that the productions of Berlin and Munich are so exquisite is that they are able to command the very finest trained skill in lithographic printing.

CHAPTER XIII.

MISCELLANEOUS PHOTOGRAPHIC PROCESSES.

I.—*The Daguerreotype.*

This process is now rarely practised, nevertheless, as it possesses peculiar beauties of its own, and was the starting point from which more modern practice has developed the greater part of our present resources, it is deemed advisable to give a short description.

The Daguerreotype plate consists either of a sheet of pure silver, or, what answers just as well and is less expensive, an electro-silvered copper-plate. It is polished, just previous to being used, by the following process. The silvered surface is first rendered quite smooth and free from scratches or inequalities by rubbing it hard with a mixture of fine rotten-stone or precipitated chalk and alcohol, just the same as when polishing dirty glass plates. It then receives the final polish with what is called the *soft buff.* This buff consists of two or three folds of the softest Chamois leather, smeared over with a little jeweller's putty (finely divided Peroxide of Iron). The *buff* may be either worked with the hand, which is the most convenient on a small scale, or a *buffing* wheel may be used.

Sensitizing the Plate.—To get the highest sensitiveness, it is necessary to use both Iodine and Bromine vapour. For this purpose two sensitizing boxes are necessary, the one to give off the vapour of Iodine and the other that of Bromine. The two Halogens may be placed in the same box and the vapour generated, but as only a very little Bromide is desirable, it is better to have two boxes. The plate is first placed, silvered side downwards, over an orifice or inside the Iodine box, heat is applied below, except in hot weather, when this is not necessary to generate the Iodine fumes. As soon as the silvered surface of the plate becomes of an orange colour, which will be in from two to eight minutes, according to temperature, it is then placed over the Bromine, the vapour of which is generated in the same way.

The exposure in the Camera must not be delayed long after the plate has been prepared. In this respect these *purely* silver sensitive surfaces seem to bear a close relation to wet Collodion films; but for a reason which we need not stop to explain, they are affected totally differently by prolonged keeping. A Daguerreotype properly prepared is, or ought to be, as sensitive as the best wet Collodion films.

The development of the image is effected by means of the vapour of Mercury. For this purpose a box is provided, having an iron bottom, and capable of being closely shut up. Into the bottom of this is laid a shallow evaporating dish—preferably of Berlin ware—containing Mercury. Inside the box are placed one, two, or more exposed plates, and heat applied from below by means of a spirit-lamp or otherwise. In the course of two or three minutes the development will be complete.

To fix the Picture, a weak solution of Hyposulphite of Soda is poured on and off the plate until the Iodizing has been removed. The picture is next washed in distilled water and toned with Chloride of Gold. For this purpose the following solutions are made.

(1)	Chloride of Gold	1 grain.
	Distilled Water	1 ounce.
(2)	Hyposulphite of Soda . . .	6 grains.
	Distilled Water	1 ounce.

Dissolve and mix the solutions, and cover the plate with as much as will lie on the surface. Take the plate by the corner with a pair of pliers, and holding it level over the flame of a spirit-lamp, apply the heat uniformly to the back, so as to insure even toning and watch progress. After a few seconds the picture darkens slightly and then begins to clear up; at the same time little bubbles will begin to rise to the surface of the liquid, or if they adhere to the plate touch them with the point of a fine camel's-hair brush, when they will disappear. When the tone is deemed satisfactory, immerse the plate in a basin of clean water, or wash under the tap, then rinse in distilled water and set up on end to dry spontaneously on several folds of blotting-paper or by artificial heat.

The Daguerreotype is now finished, and may be touched with colour if deemed desirable.

II.—*The Talbotype or Calotype Process.*

This process as practised at the present time is almost identical with that originally described by its inventor, Fox Talbot, many years ago. The object is to obtain an even and finely divided layer of Iodide of Silver upon the surface of a suitable kind of paper; the particles of the Iodide being left in contact with an excess of Nitrate of Silver, and usually also with a small proportion of Gallic Acid.

So far as the writer is aware, the old English papers made expressly for this process by Whatman and Turner are no longer in the market. These were sized with Gelatine, and made from the purest materials. They retained the picture on the surface, and in all probability the Gelatine itself assisted materially in forming the Photographic image. The foreign Photographic papers of the present day (notably thick Saxe), although sized with starch, answer very well; but in order to keep the picture on the surface they should receive a supplementary sizing, by being previously dipped in or floated on a warm solution of Gelatine.

There are two modes of Argento-iodizing the paper;

one by what is called the *single wash* and the other by the *double wash.*

By the first method the paper is laid on a board, with a piece of blotting-paper intervening, and is evenly brushed over with the following solution called "Double iodide," being a solution of Iodide of Silver in Iodide of Potassium. Dissolve twenty grains of Nitrate of Silver in about an ounce of distilled water. In another glass vessel dissolve the same weight of Iodide of Potassium in about the same quantity of water. The solutions are mixed, when a yellow precipitate of Iodide of Silver is immediately formed. Pour off as much as possible of the clear liquid which contains Nitrate of Potash, and also a little unconverted Iodide of Potassium. Next make a *strong* solution of Iodide of Potassium, say about two hundred grains to the ounce of water, and add it little by little with constant stirring to the still moist Iodide of Silver. The latter will be dissolved and form a clear solution called "Double-iodide."

When a sheet has been brushed over with, or floated on, this solution, it is hung up to dry, or it may only be drained for a few minutes before being immersed in a pan of clean water. This decomposes the double Iodide, throwing down that of Silver on the surface and in the pores of the paper as a yellow precipitate. When well washed the paper is dried and put aside for future use. It is not sensitive to light, and is even said to be improved by exposure to sunshine.

By the second method of *Argento-iodizing* the paper, the sheet is first floated for about a minute on a bath containing twenty grains of Nitrate of Silver to the ounce of distilled water, and is hung up to dry in the *dark room.* It is next *immersed* in a solution containing twenty-five grains of Iodide of Potassium to the ounce of water, where it remains for a minute or more. It is then drained and immersed in a dish of water, where it is allowed to soak for a short time, the water being changed several times until the whole of the excess of Iodide of Potassium is removed. These sheets, like those prepared by the previous process, may be kept in a dry place till required for final sensitizing.

To Excite the Paper. — Make two solutions, one a saturated solution of Gallic acid in cold distilled water (No. 1); and the other (No. 2) as follows:—

Nitrate of Silver . .	50 grains	*Aceto-Nitrate of Silver.*
Glacial Acetic Acid.	1 drachm	
Distilled Water . .	1 ounce	

In the dark room, lay the piece of Iodized paper on a slab of glass or flat board covered with clean blotting-paper. Mix in a clean cup, containing one ounce of distilled water, fifteen drops of No. 1, and the same proportion of No. 2. Apply the mixture to the surface of the paper either by means of a broad camel's-hair brush, a glass rod, or a tuft of cotton wool drawn partly into the neck of a glass tube (Buckle's brush). When evenly spread, hold up the paper by the corner to drain for an instant, then blot off superfluous moisture, attach the paper to the glass in the dark slide and expose in the Camera as soon after as possible; for if the paper is allowed to get dry, the Nitrate of Silver solution will become concentrated by evaporation and dissolve out the Iodide.

The proper time of exposure in the Camera can only be learnt by experience. Stated generally the case may be put thus:—*give five times the exposure required for a wet Collodion film.*

To Develop the Picture, lay it on a flat board or glass slab and brush over it, with a Buckle's brush, or spread with a glass rod, a mixture composed of equal parts of saturated Gallic acid (No. 1) and Aceto-Nitrate of Silver (No. 2) *freshly mixed.* If the exposure has been rightly timed, the image will begin to appear almost immediately of a black colour, and will gradually gain full intensity whilst the shadows remain quite clear. If the image is red and the shadows not clear, these effects show that the exposure has been too prolonged, or that sufficient restraining acid has not been used in the sensitizing of the paper. It is almost hopeless to obtain a good Negative under such circumstances, if the development has been carried to this extent. Nevertheless, if several other papers have been similarly exposed or prepared, they may make excellent Negatives by altering the proportion of the Aceto-nitrate of Silver (No. 2) used in developing. *Double the measure of Acetic Acid, and halve the weight of Nitrate of Silver.*

The picture is fixed in a weak solution of Hyposulphite of Soda, by immersion therein, until all yellow Iodide has been dissolved out. The strength of solution is not of much importance. Four ounces of Hyposulphite in a pint of water will clear up the image in from five to fifteen minutes, according to the temperature and the depth to which the Iodide has penetrated the paper. A concentrated solution should not be used, as this is apt to attack the half-tones of this partly organic image. The same solution will serve for several prints, and indeed may be used over and over again, if the precaution is taken to wash the developed prints for a short time previous to immersion in the Hyposulphite; because both free Nitrate of Silver and acids decompose the fixing solution.

The Negative is now washed in many changes of water and hung up to dry, after which it is *waxed*, or rendered more translucent, to fit it for printing and also to destroy the uneven grain of the paper through which the light has to permeate. Lay the Negative on a warm slab of glass or marble and rub it over with bleached beeswax, which will permeate the pores, leaving an excess which must be absorbed by placing the Negative between two or three folds of blotting-paper on a board, and ironing with a laundress's hot flat iron. A non-drying oil may be used for the same purpose; but this is apt to contaminate the sensitive paper with which the Negative is placed in contact during printing, causing the former to repel the after-solutions applied to it.

The above constitutes the "Talbotype" process pure and simple, and by it many of the most beautiful photographs have been produced, both in landscape and in portraiture; although, from the nature of the materials employed, there is not that absolute sharpness of delineation which some consider the greatest beauty of a Photographic image. Various simplifications and modifications of Talbot's process have arisen, some of which, for particular purposes, are practised at the present day when other Negative methods are unavailable or more troublesome. The most important of these is:—

III.—*The Waxed Paper Process.*

This modification of Mr. Talbot's discovery is very valuable to those who from circumstances cannot carry about with them large packages of glass, or other fragile materials; and besides, it possesses other valuable advantages which will be readily appreciated. The only drawbacks to its use are its comparative insensitiveness, and its not yielding such sharply defined prints as Collodion or other films on glass.

The best paper to use is thin *Saxe*, which should be carefully examined by transmitted light opposite a window, to see whether there are opaque spots or visible inequalities. The selected sheets are cut to a size rather larger than the dark frame of the Camera, so as to give space for handling them at the edges or corners. A flat-bottomed porcelain dish is filled to the depth of about a quarter of an inch with clean water, and placed on a sandbath, or over another vessel containing water. Some bleached beeswax is put in the upper dish and heat applied from below. The melted wax will float on the top. Lay a sheet of selected paper on this, and immediately remove it. Repeat the same with several successive sheets, bearing in mind that one of these is quite sufficient to fully impregnate at least five others. Supposing we wish to have one hundred finished sheets, lay twenty down on the melted wax. The next operation consists in driving the superfluous wax into the others.

Make a folio of three or four folds of thick blotting-paper, open the folio and lay down two sheets of plain paper, then one of waxed, above that again two of plain, and so on until there are altogether about thirty sheets. Close the folio on a flat table, and with a laundress's hot iron rub hard first on one side of the folio, and by turning it over, on the other. Whilst still warm open the folio, and where there appears to be an excess of wax (easily discerned by the glistening surface), insert another plain sheet. Repeat the ironing until all the superfluous wax has been absorbed. Should any sheets not be thoroughly waxed, they may be left over for completion till next occasion of working.

Care must be taken not to have the iron too hot, because that would cause decomposition of the wax. At the same time to facilitate the impregnation of the paper, this difficulty may be overcome by rapid rubbing and frequently turning over the folio.

Iodizing the Waxed Paper.—Make the following solution:—

Distilled Water	1 quart.
Sugar of Milk	400 grains.
Iodide of Potassium	300 „
Bromide of ditto	60 „

When the solution is made and filtered, pour it into a flat porcelain or glass dish. Immerse the sheets one by one, removing air bubbles with a soft brush. Twenty or thirty sheets may thus be put in and allowed to soak for half an hour, or longer, moving them about occasionally to promote even Iodizing. The sheets are now hung up singly to dry, when they may be kept in a folio for future use. The solution may be bottled up for another occasion.

The Iodized paper is sensitized in a solution made in the following proportions:—

Distilled Water	1 ounce.
Nitrate of Silver	35 grains.
Glacial Acetic Acid	35 minims.

This bath is poured into a flat porcelain or glass bath, each Iodized sheet is *immersed* separately, care being taken to avoid air bubbles, or to remove them with a brush; and also to keep the sheets from adhering together. After remaining here for two or three minutes, the sheets are taken out separately and immersed in a bath of distilled or filtered rain water, and moved about for a few minutes. They are then transferred into a pan of common water, and again washed for a short time; after which they are drained for a little, and blotted off separately in folds of clean blotting-paper for future use.

These sensitive papers may be used at once while still wet, or with proper care they will keep in good condition for many weeks. In the latter case, however, it is of the greatest importance that they should be well washed, else any Nitrate of Silver still clinging to them would by concentration dissolve out the Iodide and leave an insensible patch. The best way of preserving the sensitized papers for a long time, is to interleave a folio of clean bibulous paper with them, and shutting up in such a way that they have no access to light, and as little as possible to changes of air. In this way the writer has preserved them for more than six weeks both before and after exposure in the Camera, and whilst he was rambling about in distant parts of the country. When these papers are fully washed and dried, they are considerably less sensitive than when used in the damp state after a shorter washing; but they possess other advantages, one important one being that the development may be postponed for many days.

The development is effected by means of a saturated solution of Gallic acid in distilled water, or, in case of emergency, in clear river or spring water. The solution is made thus:—A quart or more of water is shaken up with an excess of Gallic acid—one hundred grains of acid being a considerable excess. After settling, the supernatant liquid is poured or filtered into a flat-bottomed dish, and say four or five exposed papers placed therein and moved about for a short time. The images will begin to appear, unless the paper has been excessively washed. Remove the papers for an instant, and mix with the above amount of Gallic solution about half a drachm of "Aceto-nitrate of Silver," the same as was used in exciting the paper. Replace the papers singly, as before, when, if the exposure has been right, the images will shortly begin to blacken up, and after a time will gain full intensity. Of course they must be moved about occasionally to prevent them from sticking together and to promote even development.

When rinsed in water the Negatives are fixed in a solution of Hyposulphite of Soda. Cyanide of Potassium is not admissible, because it destroys or at least greatly weakens this semi-organic image. A convenient strength of Hyposulphite is six ounces to a pint of common water, which will dissolve out all the *yellow* Iodide and Bromide in from ten to thirty minutes. This solution should not be used more than once, because it decomposes and stains paper with indelible markings.

The fixed Negative is now washed in many changes of water, and dried, when the appearance of the picture is much like that of a Negative on plain paper. But, by holding it near a bright fire, the wax is re-melted, and the deep shadows resume the original translucency of the waxed paper.

These Negatives, when made on thin paper, may be printed from either side without losing any appreciable sharpness, and consequently are eminently adapted for printing by the single transfer Carbon process.

We have said nothing about the exposure in the Camera, simply because this is so much a matter of experience that no definite rules can be laid down. If the sheets are exposed in the wet state after a short washing, or no washing at all, from three to eight times the exposure for the most sensitive wet Collodion plates will be required. But if the sheets have been well washed and dried, about from fifteen to twenty times that exposure will be nearer the mark. In any case the mode of development is the same.

IV.—*Willis's Aniline Printing Process.*

This exceedingly ingenious process is different from all other methods, inasmuch as it produces a positive from a positive, and *vice versâ*. Hence it is eminently adapted for the reproduction of engineers' plans and drawings without the aid of a Camera. The process is based on the fact, long ago ascertained, that Aniline with Chromic Acid strikes a deep blue colour. To utilize this fact the following plan has been found very efficient by the writer.

Paper.—Select a thick, smooth-surfaced, and highly-sized plain paper. The thickest quality of *Saxe* will be found about the best that can at present be obtained, but it can still better be adapted for this purpose by hot-pressing each sheet before applying the Chemicals. The object of hot-pressing is to compress the fibre into the most compact state, and thus to keep the chemicals as much as possible on the surface.

Sensitizing Solution :—

Bichromate of Ammonia .	50 grains, or less.
Phosphoric Acid (solution)	1 drachm (fluid).
Water	1 ounce.

The Phosphoric Acid to be used in the above formula is the tribasic form, not readily obtained at an ordinary chemist's shop, except in a very dilute form, and of uncertain strength. The following indications will guide the operator as to the strength or quantity of his Phosphoric Acid. If too little acid is present the picture will develop of a reddish tint; if too much the colour will be green. The best tint is a purplish black obtained by regulating the acid according to the above indications of colour. Yet after all one need not be very particular on this point, because the colour can be afterwards changed.

To Sensitize the Paper it is pinned down by the corners to a drawing board, and the above solution is spread over its upper surface evenly with a broad camel-hair brush, or otherwise, and dried quickly by the fire or in a warm room. The object of drying quickly is to prevent the solution from penetrating far into the paper. The colour of the dried surface should be of a deep and uniform orange tint.

The sensitive papers should, if possible, be used during the same day on which they are prepared. If kept for twenty-four hours or upwards, a considerable diminution of sensitiveness is apparent, and often they will not take the aniline vapour uniformly.

The Exposure varies according to the intensity of the light and the resisting medium of paper, &c., through which the light has to be filtered. The transparent or translucent picture is laid on the glass of the printing frame, and the surface of the sensitized paper is pressed in contact, just as in the ordinary printing process. The proper time of exposure is not, however, so readily detected by the eye as in silver prints; but a very short experience will render the matter easy. When exposed for the proper time, a well defined outline of all the *dark* portions of the print should be apparent in orange colour on a darker ground. Generally speaking, the time of exposure is about one-fifth of that required for the same subject on the most sensitive silver-chlorized paper. But the indications of over and under-exposure are easily discerned when we come to the—

Development.—A shallow woooden box (about two inches deep) with a lid of the same material, forms a very convenient developing dish. Pin to the inner surface of the lid two or three folds of bibulous paper. Moisten them with a solution composed of common commercial Aniline (four drachms), and Benzol (two ounces or more). About a drachm of this mixture will be sufficient to develop a print about two feet square. Place inside, on the bottom of the box, as many prints as will lie thereon, but not on the top of each other. Put on the lid. In about twenty minutes, more or less, the whole should be fully developed by the vapour of Aniline falling upon them. Now is the time to examine for over or under-exposure. If the exposure has been a little too long a feeble green, blue, or reddish image (the colour depending to a great extent on the amount of Phosphoric acid in the Bichromate) will be perceptible. But if the time of exposure has been greatly exceeded, no image at all, or at least a very feeble one, will be apparent, because the light has had time to penetrate through the dark parts of the intercepting medium and decompose the Bichromate.

The symptoms of under-exposure are just the reverse. In such cases the exposed papers develop all over, so to speak, the high lights being discoloured by the Aniline vapour nearly as readily as the shadows.

The development being complete, it is of little consequence whether the resulting image be red, green, or blue. The tone can be changed in the simplest manner. But before doing so it is advisable to *fix* the picture by washing off the soluble salts. This is done in common water. Immerse the print in water acidulated with Nitric or Sulphuric acid; quickly the original colour, whatever it may have been, will change to a deep bluish green. Wash the print and again immerse it in water containing a few drops of Ammonia, when, almost instantly, the picture turns to a rosy purple shade. Try the acid again. The green will be deeper than before. Wash once more, and immerse in a weak solution of Ferrocyanide of Potassium; then the green will be of the most delicate spring-leaf kind. These chameleon-like changes of colour may be made over and over again; but the most remarkable fact connected with them is, that after every change the colours are much improved, and a greater general vigour is imparted to the image.

CHAPTER XIV.

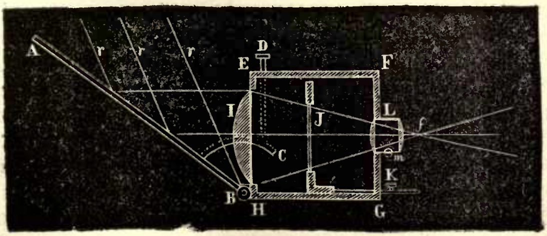
PHOTOGRAPHIC ENLARGEMENTS.

SECTION I.—*Enlargement by the Camera.*

THIS is a special branch of the Art, and consists in obtaining large proofs from small Negatives. For this purpose two methods have been adopted, one by direct printing through a *Solar Camera*, and the other by using a feebler light, and bringing out the enlarged image by development. The latter is the plan generally adopted in this country, because our solar light is very uncertain; and after all, the difference between the two modes of conducting the operation can hardly be detected in the proof, when everything is set about in the proper manner.

Woodward's Solar Camera.

The *principle* of the Solar Camera is very simple. The Camera is composed essentially of a large lens, I, called the condenser, at the principal focus of which an acromatic objective, L, is placed. A mirror, AB, throws the solar rays, *rr*, on the condenser, I; and the



negative, J, moveable by means of a rack, K, is placed between the two lenses at a distance which varies with that of the screen on which the image is to be formed.

The ordinary size of condenser is about eight inches in diameter, but it may be made larger with advantage. The reason for this is very simple; the larger the lens is the more light it collects, and consequently the more quickly is the Positive printed. For instance, if a condenser of nine inches is employed, and with it an exposure of half an hour is required to obtain an enlargement by *direct* printing on silver-chlorized paper, a condenser of *double the area* will print the picture in half the time. The focal length of the condenser should not be less than twice its diameter, nor more than three times. If a small condenser is used, sufficient light may not be collected to impress the image within a reasonable time. On the other hand, if a large condenser is used, the errors arising from spherical aberration become considerable.

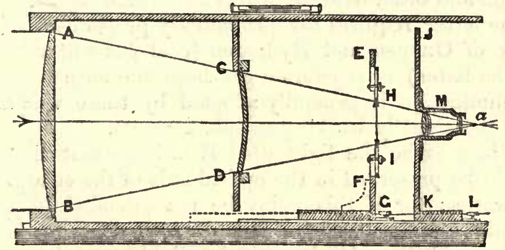
The objective, or lens L, may be an ordinary portrait combination; but care must be taken, in this case, that the lens which faces the ground glass. as in ordinary work, now faces the Negative to be reproduced, J.

The Negative should be moveable in the direction of the axis of the optical system by means of rack and pinion, so as to admit of any amount of enlargement that may be required.

An adjustible mirror, AB, is so placed and regulated as to throw the sun's rays through the condenser, I, and the enlarging lens, L.

The management of the apparatus is very simple. It is sufficient to place the part EHBA of the solar camera in an opening in a darkened window, to communicate by means of the adjusting screws, B and D, the movements necessary for keeping the solar rays always reflected in the same direction, I*f*; to properly adjust the negative, J, so that its enlarged image is sharply formed on a screen, placed at a distance and perpendicular to the optical axis of the apparatus, and, lastly, to substitute for the screen a sheet of sensitive paper or other Photographic surface.

Considerable improvements have been made in the Solar camera of Woodward, notably those by Dr. Monckhoven, who, to cure the evils arising from the aberrations of sphericity, whereby the various transmitted rays do not arrive at the same focal point, constructed his condenser on what is called the *dialytic principle.* This principle consists in intercepting the cone of rays from a single crown-glass condensing lens, by a concave lens by which the aberrations both of sphericity and colour may be, the former considerably and the latter altogether, remedied. The accompanying sectional diagram of this camera will serve to show its construction.



The large condenser, A B, is what is called a *crossed lens,* one side being more convex than the other. The more convex side is placed towards the source of light. The refracted rays are intercepted in their passage through the camera by the *correcting* lens, C D, which is concavo-convex, the concave side facing the condenser. This lens simply corrects for spherical and chromatic aberrations. The wooden frame, E F, which holds the Negative to be enlarged is moveable by means of a milled-head screw, G, nearer or farther away from the lens, M, when required.

The front of the camera to which the objective or enlarging lens is fixed, is also moveable towards or from the frame, E F, by means of the screw, L.

In other respects Dr. Monckhoven's solar apparatus is similar to Woodward's, and the mode of using them identically the same. At the same time, although both of them are called "Solar cameras," they can be used for enlargements by artificial light. But in this latter case the enlarged image will have to be *developed* instead of being *directly* impressed, on account of the feeble actinism of artificial, compared with solar light.

There are several kinds of artificial light which may be employed with good effect, namely, the Electric, the Magnesium, or the Lime light. The first is considered to be the most actinic, but the expense of producing it in sufficient power precludes its commercial adoption. Magnesium wire or ribbon when ignited is also highly actinic and often used, so also is the "lime" light; but as the latter requires the preliminary preparation of a stock of Oxygen and Hydrogen (coal gas will answer for the latter) in separarate gas bags, the former mode of illumination is generally adopted by those who are only occasionally working at enlargements.

Whatever be the light used it is important that it should be preserved in the optical axis of the enlarging apparatus; for if this point be not attended to, the magnified image will be less distinct than it otherwise would be. With artificial light no mirror is required to throw the light on the condenser, because the point or centre of illumination can be adjusted at discretion.

By this method of enlargement small portraits, &c., can be magnified to life size, and even larger—to monstrous giants if one wished that style of delineation. But, as a rule, Photographic enlargements are merely meant as a basis upon which the Painter or Crayon-draughtsman can work and fill in details of expression and shading which the Camera must fail to give under such circumstances.

Other Methods of Enlargement.—The above described plan has been for a long time in use, and is still practised to some extent; but the most recently adopted method of producing enlargement is by making a large Negative, and printing from it in the pressure frame. At the time this book goes to press, it may be said that this plan has, except for very large sizes, supplanted all the others.

There are two modes by which enlarged Negatives may be produced; the first is by making a Positive transparency of the same size as the Negative on Collodionized glass (see p. 152), placing that in a suitable frame in an aperture of a window, and then directing towards it a long-bodied Camera fitted with what is called a quarter plate, or "*carte de visite*" lens, the *front*, or plano-convex side of which must be turned towards the ground glass, or focussing screen of the Camera. It is important that a sheet of ground glass be placed outside of the transparency so as to equalize the light, unless the light is seen to be truly uniform, and that is easily detected by an examination of the image on the focussing screen. But if the apparatus is pointed towards the blue or grey sky, as the case may be, there is no necessity for blocking off a great deal of Actinic light by any intercepting medium, such as ground glass.

A Negative taken in this way can be printed from in the usual manner.

Another method of obtaining a large Negative is to take a *Positive* transparency of the full size that the Negative is intended to be; this transparency being taken on wet Collodion in the manner above indicated. The enlarged transparency after having its defects eliminated by a retouching artist, is used for the production of a carbon or paper Negative by the usual processes. Of course a Collodionized plate can also be employed instead of these other methods.

The optical principles involved in the production of enlargements are simple. In the Solar and similarly constructed Cameras, we have first of all the Condenser, the function of which is to collect a large volume of light, and condense it in such a manner that it shall all fall evenly on the transparency whether that be a Negative or a Positive. The Lens or objective behind refracts the image on to the sensitive medium placed in proper position. The degree of amplification is determined by the distance at which the screen is placed for the reception of the enlargement. All those conditions which are requisite in a portrait combination for producing a first-class Negative, are also necessary in the objective of an enlarging apparatus, whether that be the Solar Camera or of any other kind.

SECTION II.—*Enlargement by the Microscope, or Photomicrography.*

The method of making enlarged images of minute objects by the combined use of the Microscope and Photography has been successfully practised by many, and has now reached a high degree of perfection. In this country, Dr. Maddox; in America, Dr. J. J. Woodward; and in France, M. Jules Girard, also Dr. Moitessier have long earnestly endeavoured to advance the progress of this most interesting and instructive branch of applied science.

In the following remarks, the writer does not enter into the minor yet not unimportant details for the production of first-class work. These will be found in the books devoted to this speciality, some of which will be enumerated at the end of the section.

Two plans will be particularized,—one where the ordinary microscope and a long-ranged box or bellows camera are conjointly employed out of doors or at an open window, the other where the entire operations are performed in the dark room, the necessary light being admitted through a special aperture. If preference be given to the first method, select a window facing south or south-west, throw it open, place a *firm* *table* near to it, fix the microscope at one end of a 4 or 5 feet stout deal clamped board resting on the table, and so arrange the instrument that when turned horizontally, the sun's image may be thrown by the mirror or prism, set at a right angle to the path of the rays, through the axis of the instrument, the objective and eye-piece being removed. Select the camera to be used, and so place it on the board that the eye-piece end of the microscope may be passed through the centre of a stout cardboard cap, or brass tube lined with cloth, made to take the place of the ordinary brass cap of the camera combination, the cells carrying the lenses having been unscrewed. Receive the image of the sun on the ground glass screen, observing that the spot of light occupies its centre, firstly throwing the ordinary focussing cloth over the end of the camera and microscope, so as to totally exclude any light admitted into the camera by the side of the tube of the microscope. Now attach a low-power objective to the microscope, and note if the sun's image remains central on the focussing screen, if not, adjust the mirror, camera, and microscope until this be determined, then mark the position of the camera and microscope on the deal board, and clamp them there. Select the object to be photographed, place it on the stage, as usual (it is better generally to narrow the central aperture of the stage to nearly the size of the object by a pierced card blackened or black paper gummed to the under side of the slide), shut up the camera so that with the hand on the coarse rack adjustment it may be focussed at the same time as the head is inclined towards the focussing glass, so that with the focussing cloth thrown over it, the eye may note the definition, size of the image, and equality of the illumination; test both the concave and plane surfaces of the mirror, or employ as illuminator and condenser Abraham's achromatic condensing prism. Make two or three diaphragms from some stout card, cut a central round aperture of about 3 inches diameter in one, and of 3½ inches and 4 inches or more as desired in the others; turn up sharply the top and bottom edges of the card to form flanges, and cut the sides so as to fit tightly into the sliding part of the body of the camera, or at any rate, so as to be somewhat near to the ground glass; blacken the card by black varnish, indian ink, or any other simple plan, and insert the one with the smallest aperture into the camera; the image will now appear sharper, the diffused reflected light from the inside of the camera being greatly diminished. If the body of the microscope be long and narrow, the dimensions of the image are often interfered with, and a wider and shorter tube may be needed, or the mirror, stage, and objective may be attached to the camera front, as suggested by Mr. Highley. Should it be determined to use the full range of the camera, some arrangement for working the rack movement will be necessary, such as a rod attached at its opposite end by a lever or grooved wheel, connected by a band to the milled head of the coarse or fine rackwork. Suppose the sensitive plate prepared and ready to be dropped with its carrier into the camera, note that the illumination is perfect, then shut off the light by any simple plan, as a velvet lined card placed against the stage, or if the objective be of very long focus in front of it; insert the carrier, draw up the shutter, and lift away the card, apportioning the period of exposure to the colour of the object, the distance of the screen, the brightness of the light, and condition of the chemicals or sensitiveness of the plate; this may range from one to several seconds. The Negative, when developed and cleared, may show a very imperfect or ill-defined image from the want of coincidence of the visual and actinic foci of the objective, which for that distance may be ascertained by tentative trials, withdrawing the objective from the object by a turn or part of a turn of the fine adjustible milled head, or what is perhaps preferable, by having a suitable thin convex, long focus, spectacle lens, ground down and fitted into a cell which screws into the place of the back stop of the objective. The focus of the lens required may be from 8 to 12 or 14 inches; or a large cell with parallel glass slides, containing a deeply-coloured solution of ammonio-sulphate of copper may be placed between the mirror and the stage, to shut off the non-actinic rays. Some of the low powers are found to have their chemical and visual foci so nearly coincident that they require no extra adaptation. The actual position of the objective for a given distance once found, a mark may be made on the board at which the sensitive plate was placed, to save further trouble.

With medium powers more care is required, and the adjustment collar for the thickness of the cover must be attended to; what is needed in the objective being rather under correction for colour though correct for spherical aberration, which latter alters with the distance between the object and image. Generally some form of condenser is necessary to concentrate the light from the plane mirror or prism. These are of various kinds, and are used as in the ordinary conditions of the microscope, but it has been found best to employ lenses of some size, of course taking care that the focus is so arranged as not to scorch the object. In some cases there is a difficulty in getting rid of the diffraction lines at the edges of objects, and then a cap containing a piece of ground glass in a cell, slipped over the top combination of the achromatic condenser, and so placed as to become a bright radiant of softened sunlight wherewith to illuminate the object, is found to have great advantages, though the time of exposure is increased.

With high powers, the visual and actinic foci so nearly approximate that they are often used as if really coincident; but even here it will be found a better plan to insert the ammonio-sulphate of copper cell, or else to use a prism of some considerable dispersive power, and illuminate the object by the violet end of the spectrum. At the same time as the powers increase, it becomes very important to employ an examining glass, as a Ramsden's positive eye-piece, for the best point of the image as regards definition on the focussing screen, or even to substitute for the ground glass a polished piece of plate glass, Dr. Woodward's method, always remembering that the more enlarged the image, the less sharp will it appear; moreover, it is objectionable to strain the lens to work beyond its suitability, or to use the eye-piece with it without especial care.

If a heliostat be employed for this form of apparatus, it may be placed on the window sill, having taken the necessary precautions for its position as regards the sun and its correct level; or, as adopted by Mr. Higgins, it may be fixed to the side of the top of the front part of the camera. Much good work can be done without it if the chemicals be in good working order. With high power immersion lenses the time of exposure is lessened, and they have other advantages; but whatever means may be taken to illuminate the object, it is absolutely necessary the whole *apparatus remains free of vibration.* Indeed, after lifting the shutter of the camera, it is as well to pause before removing the card from the stage or objective.

All that has been said respecting this first plan or method as regards the mode of manipulation, will apply to the second method, which, however, needs a few additional remarks. Here the table and base-board are removed into the dark room, the window of which, facing south or south-west, is closed by a stiff shutter, in which an aperture has been made for the passage of the mirror stem of the microscope, which will require lengthening; the mirror, placed on the stem now outside the shutter, is worked from the inside by two thin rods attached to it, passing through light-tight apertures in the shutter: Dr. Woodward's method. The ammoniacal solution of sulphate of copper cell should be fixed vertically outside the shutter opposite a hole lined by a brass tube made for the passage of the rays of light from the mirror; a thick black velvet curtain or hood attached to the inside of the shutter is allowed to fall over all the parts of the microscope, where diffused light can escape into the dark room. The bellows part of the camera can now be retained or dispensed with; and if the latter, the image can be received upon a finely-polished white card, fixed at a right angle to a heavy foot that can be slid along the base-board, being kept central by guides, and be clamped at any position; Mr. Wenham's plan, and adopted by Dr. Maddox and others.

A narrow square box, black inside, with a front flap shutter, made to hold a series of two or three different pierced card diaphragms, and at the back of the box provided with two sliding clamp bars to retain *in situ* the ordinary different-sized plates of glass, will be found very serviceable. Curtains of black cloth or velvet should fall from the top of the box behind the sensitive plate when exposed, to check the diffused light, which may have passed through the plate. A slip of card laid against the eye-piece end of the microscope stops the light impinging on the plate before all is ready, and this is suddenly and carefully snatched away to be replaced when the exposure is terminated.

It is as well to divide the base-board on the central line into half inches for the sake of reference and measurements. Also, in this plan the body of the microscope may be removed if found inconveniently long, and the objective attached to the arm carrying the body. Whether retained or not, it is as well to set one or more diaphragms in the path of the rays from the object to the image on the card, and one especially just in front of the sensitive plate, which must be placed in the exact position the card-screen occupied when the image was focussed.

Instead of the mirror stem of the microscope being passed through the shutter, if this be small, and not liable to vibration of any kind, a solar microscope mirror, with its wheel and pinion for rotation or altering its plane, can be fixed into an aperture in the shutter, centrally with the axis of the microscope;

a very convenient method—the light being passed through the tubular part or body of the solar microscope, either with or without its condensing lenses, and which abuts closely against, or fits into or over the tube carrying the achromatic condenser; but which parts must be made light-tight by a velvet collar or curtain. With this form of apparatus, as also with the other, a very useful adjunct will be found in Mr. Wenham's triple condenser of three plano-convex lenses, by which a large amount of light, with considerable angular aperture for high powers, can be obtained and the exposure greatly shortened. If a heliostat be used with this method, it must be set outside, so as to throw a constant beam of light on the plane mirror of the ordinary or solar microscope, the proper position of which is effected from within, or by the hand passed through a loose sleeve fitted expressly into the shutter. In focussing in the dark room, it is as well to draw a dark curtain over the usual window glazed with deep red glass, and retain it covered during the exposure. The base-board should be well blackened to prevent reflection from its surface, and if preferred, can be supported either at the window or in the dark room on stout legs attached to it; it should be properly levelled, and all the parts of the apparatus it supports kept strictly central with the source of light. If the stage of the microscope and screen be set so far distant from each other as to prevent easy manipulation of the focus and simultaneous examination of the image, some method must be employed to bring the focussing arrangement under control whilst examining the image on the card, as a focussing rod supported at the side or beneath the base-board.

For taking objects stereoscopically, for the use of polarized light, and for the employment of the electric, oxyhydric, or magnesium light, with abundant details of various methods of manipulation, as well as reference to the chief literature of the subject, we must refer the reader to Dr. Beale's "How to Work with the Microscope," which has a special chapter on the subject; to Mr. Hogg's "Treatise on the Microscope;" to Dr. Moitessier's "La Photographie appliquée aux recherches Micrographiques," 1866; to Reichardt and Stürenburg's "Lehrbuch der Mikroskopischen Photographie," 1868; to M. Jules Girard's "Photomicrographie Pratique," 2^e ed., 1870, and various excellent papers on the employment of artificial illumination used with high powers by Dr. J. J. Woodward, U.S.A., copied into the microscopical journals, as well as to sundry articles in the British Journal of Photography. The short space allotted for this subject has obliged us to curtail many points of interest; yet we believe this succinct statement will suffice for guidance of the inexperienced, for whom it is mainly intended.

CHAPTER XV.

MICROPHOTOGRAPHY, OR REDUCED PHOTOGRAPHS.

By the usual mode of copying, which has already been described, reduced photographs can be taken; but not altogether microscopic. For instance, a whole page of the *Times* newspaper can be reduced to the size of about four square inches or less, and still be perfectly legible by the aid of a magnifying glass. But this is not the kind of reduction of image that we have now to deal with, the outlines, &c. of which can only be properly discerned by an instrument similar to that by which these minute photographs were taken.

M. Wulff of Paris has described in a little book the whole *modus operandi* by which they are produced on an extensive scale; but on a small scale an instrument can be extemporized very easily by any Photographer who is not even conversant with the microscope. A rigid board, about three and a half feet long and six inches wide is taken. At one end there are two uprights, between which a small Camera (which need not be larger than an inch square) fitted with a one-inch microscopic objective, can be raised or lowered so as to place the lens opposite the centre of the Negative, whatever may be the size of the latter. The object glass is screwed into a brass tube projecting from the Camera towards the Negative to be reproduced, the tube being fitted with stops of different sizes. A micrometer head, for fine adjustments, is also necessary, because microscopic objectives are only corrected for visual rays. When focussing, the best glass to use is one coated with collodion, sensitized and washed. On this the sharpest visual image must be found with a powerful magnifying glass, and the *chemical* or *actinic* focus determined by repeated trials. When once found this focus will remain constant for the same adjustment of apparatus. The Negative to be reduced is placed in a sliding frame at any required distance from the objective, and must be perpendicular to the axis of the latter.

The illumination may either be by natural or artificial light; but in either case it must pass *through* the negative. When using natural light, the whole system, except the side of the negative farthest away from the lens, must be enclosed in a dark box, and that side exposed to the sky. Artificial light is much less troublesome, and all the operations may be conducted in any room, or at night without the usual Photographic messes; but the operator must take care not to bring his sensitive plate too near the source of illumination until the image has been developed. A paraffin lamp behind the Negative, with a condenser intervening, gives very nearly parallel rays, which will impress the sensitive plate in from five to forty seconds, according to the strength of the illumination, the density of the Negative, and the sensitiveness of the chemicals.

It is not deemed necessary to enter into minute details of procedure, because they who hope to succeed in this process, must already be conversant with ordinary Photographic manipulations. A few hints will be sufficient.

The Collodion should be old and structureless, of the ordinary kind, but simply Iodized. It must be thin, and is all the better if it has liberated a great deal of Iodine by decomposition; for this high colour, although impairing sensitiveness, is conducive to clearness of image. For a similar reason, Pyrogallic acid and not Protosulphate of iron should be used as a developer, because the former gives a much finer silver deposit than the latter.

The Photographic dishes may consist of three tall wineglasses, a slop basin, and a pail of clean water; one glass contains the nitrate bath, which requires no dipper, because the upper part of the microscopic glass-slip which is used projects above the solution; the second glass contains the developer, which will decompose rapidly. Instead of this glass it would be better to pour a small portion of the developer on and off the plate as usual. The third glass contains the fixing solution either of Hyposulphite of Soda or Cyanide of Potassium. The object of the other dishes is evident.

The little proofs are often made on the thinnest of glass and attached to a Stanhope lens by means of Canada balsam. The lens is first warmed, and its flat side smeared with the balsam; the picture-side of the glass is pressed in close contact; after a few minutes the thin glass will be perfectly adherent and free from air bubbles intervening; if not, warm the lens again and apply stronger pressure. All that is now necessary is to round off the corners on a stone in such a manner that it takes the form and dimension of the *Stanhope*, which may be mounted as a piece of jewelry.

This application of Photography is exceedingly simple; and although its practical value is little, yet it may serve as a source of amusement and instruction in the long winter evenings.

Other Applications of Photography.—These are numerous, and in many cases of great practical value. In Astronomy, for instance, the surface of the moon has been delineated with a fidelity of representation that was never known before; the physical appearances presented by an eclipse of the sun have been portrayed, and been the means of conveying much valuable information to the Astronomer, &c. In Meteorology automatic registrations are made by Photography, and these are of immense value. The bottom of the sea has been Photographed by sinking a water-tight apparatus, and unclosing the lens by a string at the proper moment; and, before long, an attempt will be made by the scientific expedition sent out in H.M.S. Challenger, to determine by means of Photography, a long disputed question—viz., the depth to which light penetrates in the clear and open ocean.

As all these applications require special apparatus, and do not fall within the range of the ordinary Photographer, a description of the *modus operandi* in each case is deemed unnecessary.

VOCABULARY OF PHOTOGRAPHIC CHEMICALS.

ACETIC ACID.

Acetic Acid is a product of the oxidation of Alcohol. It is also prepared on a large scale by subjecting wood to a red heat in an iron retort, to which is attached a condenser. By a tedious process the vinegar, or Acetic Acid, is separated from the other constituents of the condensed matter and purified by distillation.

The strength of Acetic Acid is very variable, and cannot be determined by its Specific Gravity. The most constant is what is called the "glacial," which below 40° (Fahr.) becomes solid. But even this is no reliable indication of its strength, which can only be estimated by analysis.

The commercial *Glacial* Acetic Acid, so termed, is usually diluted with water, and sometimes a trace of Sulphurous Acid is introduced, to confer the property of solidifying in cold weather, and thus to give an appearance of strength. It is, however, probably due in most cases to the decomposition of the Sulphuric Acid used to obtain it. Sulphurous and Hydrochloric Acids are both injurious in Photographic Processes, from their property of precipitating Nitrate of Silver. To detect them proceed as follows:—Dissolve a small crystal of Nitrate of Silver in a few drops of water, and add to it about half a drachm of the Glacial Acid; the mixture should remain quite clear even when exposed to light. Hydrochloric and Sulphurous Acid produce a white deposit of Chloride or Sulphite of Silver, distinguishable by Nitric Acid, which dissolves the Sulphite, but leaves the Chloride unchanged; and if *Aldehyde* or volatile tarry matter be present in the Acetic Acid, the mixture with Nitrate of Silver, although clear at first, becomes discoloured by the action of light.

Glacial Acetic Acid sometimes has a smell of garlic. In this case it probably contains an organic Sulphur Acid, and is unfit for use.

Many employ a cheaper form of Acetic Acid, sold by druggists as "Beaufoy's" acid. It contains less acid, but is perfectly suited for Photographic purposes, only more bulk of it will have to be used. This form of acid is more constant in its properties than the "Glacial Acid" so called.

ALBUMEN.

Albumen is an organic principle found both in the animal and vegetable kingdom. Its properties are best studied in the *white of egg*, which is a very pure form of Albumen.

Albumen is capable of existing in two states; in one of which it is soluble, in the other insoluble in water. The aqueous solution of the soluble variety gives a slightly alkaline reaction to test-paper; it is somewhat thick and glutinous, but becomes more fluid on the addition of a small quantity of an alkali, such as Potash or Ammonia.

Soluble Albumen may be converted into the *insoluble* form in the following ways:—

1. *By the Application of Heat.*—A moderately strong solution of Albumen becomes opalescent and coagulates on being heated to about 150° Fahrenheit, but a temperature of 212° is required if the liquid is very dilute. A layer of *dried* Albumen is not rendered insoluble by *dry* heat of 212°.

2. *By Addition of Strong Acids.*—Nitric Acid coagulates Albumen perfectly without the aid of heat. Acetic Acid, however, acts differently, appearing to enter into combination with the Albumen, and forming a compound soluble in warm water acidified by Acetic Acid.

3. *By the Action of Metallic Salts.*—Many of the salts of the metals coagulate Albumen completely. Nitrate of Silver does so; also the Bichloride of Mercury. Ammonio-nitrate of Silver, however, does not coagulate Albumen.

The white precipitate formed on mixing Albumen with Nitrate of Silver is a chemical compound of the animal matter with Oxide of Silver, and has been termed Albuminate of Silver. Its Chemical constitution has not been ascertained, but its properties render it valuable to the Photographer. There is only one drawback to its use, and that consists in the difficulty of afterwards entirely removing from it by any fixing agent the silver salts which have not been used up in impressing the picture. Hence such prints are very liable to fade, even if all other causes of fading were removed.

ALCOHOL.

Alcohol is obtained by the careful distillation of any spirituous or fermented liquor. If wine or beer be placed in a retort, and heat applied, the Alcohol, being more volatile than water, rises first, and may be condensed in an appropriate receiver; a portion of the vapour of water, however, passes over with the Alcohol, and dilutes it to a certain extent, forming what is termed "Spirits of Wine." Much of this water may be removed by redistillation from Carbonate of Potash; but in order to render the Alcohol thoroughly *anhydrous*, it is necessary to employ *quicklime*, which possesses a still greater attraction for water. For this purpose strong Alcohol of 823 should be left in contact with powdered quicklime for three or four days, or until the latter has ceased to swell from absorption of water, after which it is separated by distillation, the retort being placed in a water-bath.

Properties of Alcohol.—Pure anhydrous or absolute Alcohol is a limpid liquid, of an agreeable odour and pungent taste; sp. gr. at 60°, 794. It absorbs vapour of water, and becomes diluted by exposure to damp air; boils at 173° Fahr. It has never been frozen.

Alcohol distilled from Carbonate of Potash has a specific gravity of 815 to 823, and contains 90 to 93 per cent. of real spirit.

The specific gravity of ordinary rectified Spirits of Wine is about 836, and it contains 80 to 83 per cent, of absolute Alcohol.

Different Commercial Qualities of Alcohol.—What is termed *absolute* Alcohol is not necessary in *Photography*. A spirit with less than four per cent. of water (sp. gr. 805) may be obtained by agitating commercial Spirits of Wine first with Carbonate of Potash in the manner presently to be advised, and then with a common quality of dry Chloride of Calcium. Put in about three-quarters of a pound of the Chloride of Calcium to half a gallon of Spirit of 815; the greater part dissolves with perceptible rise of temperature. Draw over as much as possible in a steam bath; and, to prevent the residue in the retort from setting into a hard mass, it is well to add a little water to it, after the distillation is completed. In this way the commercial absolute Alcohol is usually prepared.

The next quality of Spirit is the strong Alcohol of 815 to 823. This may be obtained by agitating Spirits of Wine, 836, with an excess of dry Carbonate of Potash. The salt termed Carbonate of Potash is a *deliquescent* salt, having a great attraction for water; consequently when Spirit of Wine is shaken with Carbonate of Potash, a portion of water is removed, the salt dissolving in it and forming a dense liquid, which refuses to mix with the Alcohol, and sinks to the bottom. At the expiration of two or three days, if the bottle has been shaken frequently, the action is complete, and the lower stratum of fluid may be drawn off with a syphon and rejected.

The cheaper and more dilute alcohols answer very well for mixing with the developer, and for various other purposes where strength is not requisite.

ALCOHOL, METHYLATED.

This is a mixture of ten parts of purified wood spirit with ninety parts of *vinous* Alcohol. The mixture was supposed not to be potable, and therefore escaped the high Excise duties levied on vinous Alcohol. There are now considerable restrictions on its sale.

This form of Alcohol should not be used for making Collodion, as it is certain to contaminate the Nitrate of Silver bath with organic impurities. At the same time being very cheap it may advantageously be used for mixing with the Developer, and for various other Photographic purposes, such as making of varnishes, &c.

ALCOHOL, METHYLIC.

This substance, called also "Wood Alcohol," or "Pyroxylic Spirit," is analogous in constitution to vinous or Ethylic Alcohol.

This substance is a powerful solvent of resins, &c.; hence the writer knows no better method of removing old varnished Collodion films from glass than by treating them with this Alcohol (see p. 54). The smell is certainly an objectionable adjunct to its utility.

ALUM.

There are many varieties of *Alums*, which may be briefly described as combinations of Sulphate of Alumina with the Sulphates of Ammonia, Potash, Soda, &c.

Solutions of Alum possess the property of rendering

Gelatine insoluble in warm water; hence the value of this salt in *fixing* Photographic proofs in pigmented Gelatine.

AMMONIA.

The liquid known under this name is an aqueous solution of the volatile gas Ammonia. Water will take up about seven hundred times its bulk of this gas, forming a solution which goes under the name of "*Liquor Ammoniæ Fortissimus*," or, when the water is less highly charged, "*Liquor Ammoniæ*." But the real strength of the liquid does not depend on these arbitrary distinctions. It can only be properly estimated by ascertaining how much acid of a definite strength it will neutralize. The Specific Gravity test is not reliable.

Ammonia is used in several Photographic operations, but for these neither its strength nor its purity are of much importance.

AMMONIA, BICHROMATE OF.

This salt is obtained by dividing a solution of Chromic Acid into two parts, neutralizing one with Ammonia, then adding the other part and evaporating. The resulting crystals are permanent and soluble in water.

Bichromate of Ammonia is used in many Photographic processes, notably Willis's Aniline printing method, and in all other processes dependent on the peculiar property of this salt in rendering certain organic bodies, such as Albumen, Gelatine, &c., insoluble in their usual menstrua, after exposure to light.

The rationale of the various processes seems to be this. The Bichromate, in contact with the Gelatine or other organic body and exposed to Light, gives up part of its Oxygen to the organic body, which is thus rendered insoluble in warm water in exact proportion to the extent of the Actinic action.

AMMONIA, CARBONATE OF.

There are several Carbonates of Ammonia; but the one which is of any use to the Photographer generally goes under the name of the *Sesquicarbonate*, and is easily recognised by its giving off Ammoniacal fumes when exposed to the air. For this reason it is important that the lumps or solution of them should be kept in closely stoppered bottles, else the excess of Ammoniacal vapour would escape, and the product be useless for its intended purpose—viz., *Alkaline development.*

AMMONIA, HYDROSULPHATE OF.

This solution is formed by passing Sulphuretted Hydrogen through Ammonia. It is used in Photography for precipitating silver solutions, and for intensifying Negatives. The latter object it accomplishes by changing the deposit on the developed image into a dense black colour which obstructs the Actinic rays.

The solution should be kept in a well stoppered bottle, and at a distance from the dark room, because the fumes given off are exceedingly prejudicial to other operations which have to be performed there.

AMMONIUM, BROMIDE OF.

This is a crystallized salt, which is usually prepared by precipitating Bromide of Calcium with Carbonate of Ammonia. It is more soluble in Alcohol and Ether than the corresponding Potassium salt, and is very useful as a Bromide in the ordinary wet Collodion process; but for the *simply* Bromized processes it is not sufficiently soluble to give a dense creamy film with Nitrate of Silver, unless the Alcohol and Ether contain more water than is conducive to an even layer of Collodion on the Photographic plate.

AMMONIUM, CHLORIDE OF.

This salt is much used in preparing paper for Positive printing, as it is supposed to be better adapted for that purpose than any other soluble Chloride; the reason assigned being that the print assumes a more pleasing tone. This, however, is a mere matter of opinion, because much depends on other modifying causes.

AMMONIUM, IODIDE OF,

is a salt very valuable in Collodion, because it has the property of conferring limpidity, sensitiveness, and adherency to the glass, which other Iodides do not always possess. It is, however, an unstable substance, prone to liberate Iodine and to decompose the Collodion in which it is dissolved, unless this bad effect is neutralized by Iodide of Cadmium, which has an opposite tendency.

To decolorize Iodide of Ammonium which has been decomposed by keeping, shake it up with a little strong Ether; the Iodine will be dissolved out, and, unless Alcohol be present, no great loss from solution will result.

AMMONIUM, SULPHOCYANIDE OF. (*See* SULPHOCYANIDES.)

ANILINE.

This powerful base is derived from Indigo, Nitrobenzol, Coal-tar, &c.

When pure, Aniline is a thin, colourless, and highly refracting oil, of a burning taste and aromatic flavour. With acids it forms a remarkable series of salts, which crystallize with great beauty and facility.

With Chromic Acid it gives a deep green or bluish black colour, which has been taken advantage of by

Mr. Willis in his very ingenious Photographic process for copying drawings, &c.

ANIMAL CHARCOAL.

This product of the carbonization of bones, blood, muscle, &c., is sometimes used in Photography to remove colour and organic impurities from solutions of Nitrate of Silver. It is itself, however, often very impure, containing soluble Phosphates, &c., which react injuriously on Silver solutions.

AQUA REGIA. (*See* NITRO-HYDROCHLORIC ACID.)

BARIUM, CHLORIDE OF.

Barium is a metallic element very closely allied to Calcium, the elementary basis of *Lime*. The Chloride of Barium is commonly employed as a test for Sulphuric Acid, with which it forms an insoluble precipitate of Sulphate of Baryta. It also slightly alters the colour of the Photographic image when used in preparing Positive paper, which may be due in some measure to a chemical combination of Baryta with Albumen; but it must be remembered that this Chloride, from its high atomic weight, contains *less Chlorine* than the alkaline Chlorides.

Properties of Chloride of Barium.—Chloride of Barium occurs in the form of white crystals, soluble in about two parts of water at common temperatures. These crystals contain two atoms of water of crystallization, which are expelled at 212°, leaving the anhydrous Chloride.

BENZOL.

A limpid liquid, obtained commercially by distilling off the most volatile constituent of the substance known as "Coal Naphtha." It does not mix with water, but is dissolved in any quantity by Alcohol or Ether.

Benzol is used in dissolving resins for varnishes, and in a few Photographic processes which have now fallen into desuetude. It also dissolves Caoutchouc and Gutta Percha, forming solutions often used as a substratum for the Collodion film in the dry processes.

BITUMEN OF JUDÆA, OR ASPHALTUM,

is an indurated pitch found in the Dead Sea, in Trinidad, and many other places.

It is the basis of most black varnishes, being soluble in Naphtha and some other substances.

Being sensitive to light, it has also been used in some Photographic processes, first by M. Nicephore Niépce in his Photo-engraving process; by Mr. Macpherson for Photo-lithography; and by Mr. Pouncy for printing on paper.

BROMIDES, TEST FOR PURITY.

The most common impurity in Bromides is an Iodide. This impurity is of little or no consequence in the wet Collodion process, or when sensitizing Bromized Collodion in a Nitrate bath; but it is prejudicial in all the *emulsion* processes, because the particles of Iodide of Silver thus formed are much coarser than the Bromide, falling to the bottom of the Collodion very speedily and carrying with them a proportion of Bromide.

Dissolve four or five grains of the suspected Bromide in an ounce or two of distilled water in a test tube. In another similar test tube have distilled water only. Now dip the end of a clean glass rod into a solution of Chloride of Palladium, and with it stir up the Bromide solution. With another rod do the same with the distilled water. If Iodide is absent both tubes when held up to the light will be equally transparent; but if the least trace of Iodide be mixed with the Bromide a brownish-red colour will instantly be struck.

This is a most delicate test for an Iodide, and should never be omitted when one wishes to have his Bromized emulsion of Silver in the finest possible state.

BROMINE.

This elementary substance is obtained from the uncrystallizable residuum of sea-water, termed *bittern.* It exists in the water in very minute proportions, combined with Magnesium in the form of a soluble Bromide of Magnesium.

Properties.—Bromine is a deep reddish-brown liquid of a disagreeable odour, which gives off ruddy vapours at common temperatures; sparingly soluble in water (1 part in 23, Löwig), but more abundantly so in Alcohol, and especially in Ether. It is very heavy, having a specific gravity of 3·0.

In the Daguerreotype process it is used to confer a higher sensitiveness to the Iodized plate than it would otherwise possess.

CADMIUM, BROMIDE OF.

This salt is much used in Photography, on account of its great stability and its solubility in Collodion.

It is prepared by heating an excess of filings of the metal Cadmium with Hydro-bromic Acid and water. By evaporation acicular crystals are formed, which constitute the Bromide of commerce and contain four equivalents of water of crystallization. This water is expelled by heating the Bromide in a porcelain evaporating dish on a sand-bath placed over a Bunsen's gas-burner. After a time the Bromide melts into a pasty mass in its own water of crystallization, and at last solidifies into a solid cake. It is better, however, when the Bromide is in the pasty state to keep stirring it occasionally with a glass rod to promote the complete expulsion of the water. The product is now pounded up and kept in a stock bottle.

If the heat is raised too high a risk is run of the Bromide decomposing, the symptom of which is the liberation of Bromine, most easily detected by the sense of smell. In such case remove the flame or the dish for a short time until the temperature has been brought lower.

CADMIUM, IODIDE OF.

This salt is formed by heating filings of metallic Cadmium with Iodine, or by mixing the two with addition of water.

Iodide of Cadmium is very soluble, both in Alcohol and Water; the solution yielding on evaporation large six-sided tables of a pearly lustre, which are permanent in the air. The commercial Iodide is sometimes contaminated with Iodide of Zinc, the crystals being imperfectly formed and slowly liberating Iodine when dissolved in Ether and Alcohol. Pure Iodide of Cadmium remains nearly or quite colourless in Collodion, if the fluid be kept in a cool and dark place.

Iodide of Cadmium impairs the fluidity of Collodion and is therefore, generally conjoined with an alkaline Iodide which has the opposite tendency.

CALCIUM, BROMIDE OF.

This salt may be obtained in various ways. The simplest and perhaps the best plan is by saturating Hydro-bromic Acid with Carbonate of Lime.

Its aqueous solution, when evaporated, yields silky hydrated crystals. It is not much used in Photography.

CALCIUM, IODIDE OF.

This salt, useful for the preparation of some other Iodides, may be obtained either by saturating Hydriodic

Acid with Carbonate of Lime, or by digesting Iodine with metallic Iron and Water until the liquid is purely green, then adding excess of Lime and filtering off the solution from the precipitate and evaporating.

It is very soluble in Alcohol; but, on account of its instability, is very seldom used for Iodizing Collodion.

CAMPHOR.

This substance is obtained by distillation from the *camphor laurel* of China and Japan. When a small piece is added to solutions of Gelatine, Albumen, Tannin, &c., it tends to prevent them from decomposition and mould.

CANADA BALSAM.

Is a kind of inspissated turpentine obtained from a species of fir tree. In Photography it is used for cementing the components of Actinic lenses, and when dissolved in Benzol for rendering paper highly translucent.

CAOUTCHOUC.

This compound, known also by the name of "India Rubber" is the inspissated milky juice of certain trees growing in America and the East Indies.

Chloroform is the most perfect solvent for Caoutchouc, and leaves it unchanged on evaporation. Benzol also acts upon it. Mineral Naphtha takes it up on applying heat, but the residue after evaporation is sticky.

By combination with Sulphur, Caoutchouc undergoes a change of properties, familiar to us in the article sold as *vulcanized India-rubber*.

Thin solution of Caoutchouc in Benzol is often used as a substratum to Collodion in some of the dry processes; but in this respect it is inferior to dilute Albumen. It is also used to render the black varnishes, when dry, less brittle than they would otherwise be.

CARBOLIC ACID.

Like Creasote, this substance is derived from wood or coal tar. It is a powerful antiseptic—or preventive of putrefaction, more so than Creasote. For this purpose a very minute quantity added to Albumen, &c., will prevent decay or mould.

CASTOR OIL.

This oil is extracted from the seeds of *Ricinus communis*, or Palma Christi, both of which are cultivated in warm climates.

In Photography it is used in a small quantity to confer toughness on Collodion for transferring from the glass, and also to give the same property to Photographic varnishes.

CHARCOAL, ANIMAL.

Animal Charcoal is obtained by heating animal substances, such as bones, dried blood, horns, &c., to redness, in close vessels, until all volatile empyreumatic matters have been driven off, and a residue of Carbon remains. When prepared from bones, it contains a large quantity of inorganic matter in the shape of Carbonate and Phosphate of Lime. Animal Charcoal is freed from these earthy salts by repeated digestion in Hydrochloric Acid; but unless very carefully washed it is apt to retain an acid reaction, and so to liberate free Nitric Acid when added to solution of Nitrate of Silver.

Properties.—Animal Charcoal, when pure, consists solely of Carbon, and burns away in the air without leaving any residue: it is remarkable for its property of decolorizing solutions; the organic colouring substance being separated, but not actually *destroyed*, as it is by Chlorine employed as a bleaching agent. This power of absorbing colouring matter is not possessed in an equal degree by all varieties of Charcoal, but is in great measure peculiar to those derived from the animal kingdom.

CHLOROFORM.

This volatile liquid is obtained by the action of Chloride of Lime upon dilute Alcohol. It does not mix with water, but is very soluble in Spirit.

Chloroform is the best solvent known for Caoutchouc, and it also dissolves Gutta-percha readily. Amber and many other resins are more or less soluble in Chloroform; and this solvent is well suited for the preparation of Photographic Varnishes, from its volatility, and from its having no solvent power on any of the varieties of Collodion films, some of which would be dissolved by an Alcohol Varnish.

CITRIC ACID.

This acid is derived from the juice of lemons and other fruits. It is made to undergo a short fermentation in order that impurities may subside. It is then neutralized with chalk, by which Citrate of Calcium, an insoluble compound, is formed. After washing, this Citrate is decomposed with dilute Sulphuric Acid; the solution is evaporated and left to crystallize. The product may be purified by another process; but for Photographic work this is not necessary.

Citric Acid is a powerful retardent to the action of the developer, much more so than Acetic Acid. Hence, in hot weather it is much used; and, for the same reason, it is also very useful when intensifying a Negative, as it tends to keep the shadows clear.

A small proportion of Citric Acid may be added with great advantage to the Nitrate solution for sensitizing Positive paper, when there is too much tendency exhibited by the paper to print of a pale slaty tone.

CREASOTE, OR KREASOTE,

is manufactured from wood tar, and is sometimes used, in minute quantity, for keeping dilute solutions of Albumen, Tannin, and other organic solutions from mould or putrefaction. In this respect, however, it is much inferior to dilute Carbolic Acid.

ETHER, SULPHURIC.

It will be altogether unnecessary to describe the manufacture of this compound, because it can only be prepared properly by those thoroughly conversant with the process on a large scale. Sufficient be it to point out the means of ascertaining when one has got this most important Photographic material in a state fit for his purpose.

The first test is that of smell. If the Ether smells of Methyl or Wood Spirit, reject it without going farther; but if it does not, proceed to test it farther with Tincture of Iodine. Put one drop of the latter into, say, an ounce of the Ether. If the resulting colour is discharged after a few hours, that Ether is not to be trusted to, as it certainly contains too much Methyl. The other test is for Specific Gravity, which should range from 720 to not more than 730.

When pure Ether is exposed to light it *ozonizes* or becomes acid and is liable to decompose the Iodides &c., with which it has afterwards to come in contact. Hence it should always be kept in a dark and, for another reason, in a cool place.

ETHER, METHYLATED.

This preparation is largely, indeed almost universally, used in the manufacture of the Collodions of the present day. When properly rectified and purified it answers very well, and, being so much cheaper than the Ethylic Ether, has almost superseded that produced from pure Alcohol. Its only bad tendencies are to disarrange the Nitrate bath, and by its acrid fumes to affect the eyes of the operator when coating his glasses with Collodion.

GALLIC ACID.

Gallic Acid is obtained from the Tannic Acid by a species of fermentation. The powdered galls mixed with water, or their infusion, is left for some weeks, during which it becomes mouldy, Oxygen is absorbed and Carbonic Acid is given off, and Gallic Acid is deposited in abundance. The mouldy paste is squeezed to get rid of foreign matters, and then boiled in water, which on cooling deposits the Gallic Acid. By digestion with Animal Charcoal and recrystallization it is obtained pure.

Gallic Acid, like Tannic Acid, gives an intensely blue-black colour with salts of Peroxide of Iron, but it differs from the latter in giving no precipitate with Gelatine.

GELATINE.

This is a nitrogenized organic substance somewhat analogous to Albumen, but differing from it in properties. It is obtained by subjecting bones, hoofs, horns, calves' feet, etc., to the action of boiling water. The jelly formed on cooling is termed *size*, or, when dried and cut into slices, *glue*. Gelatine, as it is sold in the shops, is a pure form of Glue. *Isinglass* is gelatine prepared chiefly in Russia, from the air-bladders of certain species of sturgeon.

Properties of Gelatine.—Gelatine softens and swells up in cold water, but does not *dissolve* until heated; the hot solution, on cooling, forms a tremulous jelly. One ounce of cold water will retain about three grains of Isinglass without gelatinizing; but much depends upon the temperature, a few degrees greatly affecting the result. The solution forms an insoluble precipitate with Tannic Acid, which has the composition of leather.

When long boiled in water, and especially in presence of an acid such as the Sulphuric, Gelatine undergoes a peculiar modification, and the solution loses either partially or entirely its property of solidifying to a jelly.

GLYCERINE.

Fatty bodies are resolved by treatment with an alkali into an acid, which combines with the alkali, forming a *soap*, and Glycerine, which remains in solution.

Pure Glycerine, as obtained by Price's patent process of distillation, is a sweet viscid liquid of sp. gr. about 1·23; miscible in all proportions with Water and Alcohol. It is neutral to test-paper. It has little or no action upon Nitrate of Silver in the dark, and reduces it very slowly even when exposed to light.

Glycerine has been used as a preservative for keeping wet Collodion films from drying during long exposures.

GOLD, CHLORIDE OF.

There are two Chlorides of Gold—viz., the Protochloride and the Terchloride. The latter is the one used in Photography. It is prepared by dissolving gold in *aqua regia* or Nitro-hydrochloric Acid.

Absolutely pure Chloride of Gold can only be made from the pure metal, but as purity is not an essential for Photographic purposes, the following method of making it from standard gold coin, which also applies to the pure metal, will be found convenient. The Australian gold coins, in which the alloy is silver, are preferable to those of the English mint, inasmuch as the silver is left in the shape of undissolved Chloride, which can be afterwards filtered out, whereas copper is much more difficult to get rid of. The mode of procedure is as follows:—

Mix in a rather tall and thin German beaker two fluid drachms of Nitric with one ounce of Hydrochloric Acid. Unless the acids are very strong the addition of water will be unnecessary. Place in the mixture, say an Australian sovereign, and apply a gentle heat, which should be continued till solution is complete. A water bath or a warm hob will give sufficient heat to commence and continue the action. In most cases the above proportion of acids will be sufficient to dissolve the sovereign if the gentle heat is continued; but if not, add a little more mixed acid. A great excess of acid should be avoided, because it renders their neutralization or their subsequent elimination more difficult.

When solution of the gold is complete there will remain a precipitate of Chloride of Silver arising from the alloy. Dilute down, say with six ounces of distilled water, neutralize the excess of acids with powdered chalk, and filter into a stock bottle. But in order to avoid the least trace of waste rinse out the beaker with two ounces more of distilled water, which pass through the filter into the stock bottle. Repeat the rinsing, &c. Thus we have the whole or nearly the whole of the gold in a sovereign converted into Chloride of Gold fit for Photographic purposes. It is advisable to keep this neutral solution of Chloride in the dark, because light has the effect of causing a partial reduction of the metallic element.

As a sovereign contains 113 grains of pure gold it is easy to calculate that, if waste is avoided, it will yield 174 grains of Chloride.

Supposing then the Chloride of Gold thus made from a sovereign is diluted, say with ten ounces of distilled water, each fluid ounce will contain seventeen grains of the Chloride, leaving four grains to be laid to the account of waste or a light sovereign.

GOLD, HYPOSULPHITE OF.

This salt, which is produced by the reaction of Chloride of Gold on Hyposulphite of Soda, is now rarely employed in Photography. In former times it was much used for toning Daguerreotype images, and went under the name of "Sel d'Or."

Being a very unstable substance it is totally unfitted for toning Photographic paper prints, for which purpose it has been sometimes recommended.

GUMS.

These may be shortly described as exudations from various kinds of trees. They are all more or less soluble in water, and this distinguishes them from "resins," which are insoluble in that menstruum.

In Photography some of them are used as pastes for mounting Photographs, and in dilute solution as preservatives or organifiers in the dry Collodion processes. The only drawback to their employment for the latter purpose is their tendency, when conjoined with Collodion, to cause blistering of the film during or after development.

Gum Arabic may be considered the best type of that class of substances called "*gums.*"

HYDROCHLORIC ACID,

also known as Muriatic Acid, is a volatile gas, which may be liberated from most of the Chlorides by the action of Sulphuric Acid. Water absorbs it greedily, and this solution constitutes the Hydrochloric Acid of commerce.

The most concentrated solution of Hydrochloric Acid has a sp. gr. of 1·26, and contains about forty per cent. of gas.

Pure Hydrochloric Acid is colourless, and fumes in the air. The yellow colour of the commercial acid depends on Chloride of Iron, or organic matter, free Bromine, &c.

HYDROGEN, PEROXIDE OF.

This curious compound was discovered by Thénard in the year 1818. It is a powerful oxidizing agent, and is also a reducing agent. In virtue of its former property, it has been recommended as a very convenient solution for converting the last traces of injurious Hyposulphites in Photographic prints into innocuous Sulphates. This it does by oxidizing the Hyposulphites. But, unfortunately, it acts in two ways; first it oxidizes, and then reduces them.

HYDROSULPHURIC ACID.

This gas, also known under the name of Sulphuretted Hydrogen, is usually prepared by the action of dilute Sulphuric acid on Sulphide of iron. Cold water takes up about three times its volume of this gas, and the solution is slightly acid to litmus paper. In Photography it is chiefly used for reducing Silver from solutions of the salts of that metal. This it effects by throwing down Sulphide of Silver, which is again converted into the metal by fusion.

It is most important that this substance should not be used in the dark room, as the fumes arising from it would destroy all chance of good Photographic work with the salts of Silver.

IODINE.

Iodine is chiefly prepared at Glasgow, from *kelp*, which is the fused ash obtained on burning seaweeds. The waters of the ocean contain minute quantities of the Iodides of Sodium and Magnesium, which are separated and stored up by the growing tissues of the marine plant.

In the preparation, the mother-liquor of kelp (which is the liquid that remains after most of the salts, which contain no Iodine, have been separated by crystallization) is distilled at a gentle heat with a certain proportion of Sulphuric acid and black oxide of Manganese. The Iodine passes over as a violet-coloured vapour, which condenses in dark-coloured plates having a metallic lustre.

Iodine is sparingly soluble in water, but dissolves readily in Ether and Alcohol, forming dark brown solutions. It also dissolves readily in solutions of the alkaline Iodides, such as those of Ammonium, Potassium, &c.

Besides its valuable Photographic properties, a dilute solution of Iodine is an excellent test for the presence of a soluble Hyposulphite even in extremely minute quantity. If a Hyposulphite be present, the colour of the Iodine is instantly discharged.

IRON, AMMONIO-SULPHATE OF.

This is a double salt of iron prepared by mixing equal equivalents of Protosulphate of Iron and Sulphate of Ammonia. Take 139 parts of Protosulphate of Iron and 75 of Sulphate of Ammonia, dissolve them in a minimum of water, and set aside in an evaporating dish till the double salt crystallizes. It has been recommended to use this salt as a developer instead of the plain Protosulphate, chiefly on account of its greater stability. It possesses no other advantages.

IRON, IODIDE OF.

Iodide of Iron is prepared by digesting an excess of Iron filings with pulverized Iodine and water. It is very soluble in water and in Alcohol, but the solution rapidly absorbs Oxygen, and deposits Peroxide of

Iron; hence the importance of preserving it in contact with metallic Iron, with which the separated Iodine may recombine. By very careful evaporation, hydrated crystals of Proto-iodide may be obtained, but the composition of the solid salt usually sold under that name cannot be depended on.

At one time this Iodide was much vaunted as conferring great sensitiveness on Collodion. But this opinion seems to be erroneous.

IRON, PROTACETATE OF.

There are two Acetates of Iron, a Protacetate, which is nearly colourless, and a Peracetate, which is red; the former only is useful in Photography.

A solution of the Protacetate containing a slight excess of the Sulphate, but sufficiently pure for Photographic purposes, may be made by dissolving 12 grains of Protosulphate of Iron, and 12 grains of crystallized Acetate of Lead, each in half an ounce of water, mixing, and filtering from the white deposit, which is Sulphate of Lead. The solution is very unstable, and soon deposits a reddish Sub-salt, or if free Acetic Acid be present, it assumes a red colour.

A mixture of Acetate of Soda with Protosulphate of Iron, six grains of the former and twelve grains of the latter to an ounce of water, acts in Photography very much in the same manner as the pure solution of the Acetate.

A developer made from this salt soon oxidizes. It should therefore only be made as wanted.

IRON, PROTOSULPHATE OF.

This salt, sometimes called copperas or green vitriol, is obtained by acting on iron wire or filings with dilute Sulphuric Acid, evaporating and crystallizing. When pure, the crystals are of a fine bluish green colour, free from red stains, and in the form of oblique rhombic prisms. In dry air they effloresce, but in moist air they become partially oxidized into a per-salt and assume a red colour.

Protosulphate of Iron forms double salts with the Sulphates of Ammonia and Potash. Its aqueous solution absorbs Binoxide of Nitrogen from the air and becomes of a deep brown colour. As Binoxide of Nitrogen is itself a reducing agent, it has been erroneously supposed by some, that this changed solution is a more energetic developer than the plain Protosulphate.

KAOLIN, OR CHINA CLAY.

This is prepared, by careful levigation, from mouldering granite and other disintegrated felspathic rocks. It is a *Silicate of Alumina*, containing Silicic Acid or *Flint*, united with the base Alumina. Kaolin is perfectly insoluble in water and in acids, and produces no decomposition in solution of Nitrate of Silver. It is employed by Photographers to decolorize solutions of Nitrate of Silver which have become brown from the action of Albumen or other organic matters.

Commercial Kaolin may contain chalk, in which state it produces alkalinity in solution of Nitrate of Silver when Salts of Ammonia are present. The impurity, detected by its effervescence with acids, is removed by washing the Kaolin in diluted vinegar and subsequently in water.

LEAD, ACETATE OF.

The neutral Acetate of Lead is a very abundant substance in commerce, and is known as *Sugar of Lead*. It is prepared by digesting Oxide of Lead in Pyroligneous or Acetic Acid, and crystallizes in acicular masses.

Acetate of Lead is easily soluble in cold water, but the solution is usually milky, either from the presence of a little Carbonate mixed with the Acetate, or from

Carbonic Acid or Carbonate of Lime in the water used.

When a little of this salt is added to the Gallic Acid *developer* for paper Negatives or Positives, it exercises a marked effect in forwarding the development. The rationale is not known, but the fact remains.

LIME, CHLORIDE OF.

The exact chemical composition of this substance is a subject of dispute among chemists. It emits the peculiar odour of Hypochlorous Acid when exposed to the air, and at the same time absorbs Carbonic Acid.

In Photography it is sometimes used in the Gold toning bath to neutralize the acidity of the solution; but it must be so used with great discretion, otherwise the Chlorine which escapes attacks the silver image and greatly weakens it.

On account of its powerful oxidizing properties, a solution of this salt has been recommended for eliminating the last traces of soluble Hyposulphite from washed Photographic prints. This it effects in the same way as Peroxide of Hydrogen, by oxidizing the Hyposulphite into an innocuous Sulphate. It is doubtful, however, whether the advantage gained will counterbalance the disadvantage of an enfeebled print.

The so-called Chloride of Lime is an excellent substance for removing silver stains from the hands, linen, &c. Make up a little of the dry Chloride into a paste, with water acidulated with any acid, and apply to the stains by hard rubbing. They will quickly disappear. Afterwards wash with Hyposulphite of Soda solution, which absorbs the disagreeable Chlorine fumes.

LITMUS.

Litmus is a vegetable substance prepared from various *lichens*, which are principally collected on rocks adjoining the sea. The blue colouring-matter is extracted by a peculiar process, and is afterwards made up into a paste with chalk, plaster of Paris, &c.

Litmus occurs in commerce in the form of small cubes of a fine violet colour. In using it for the preparation of test-papers, it is digested in hot water, the solution concentrated at a gentle heat, and sheets of porous paper soaked in the blue liquid so formed. The red papers are prepared at first in the same manner, but are afterwards placed in water which has been rendered faintly acid with Sulphuric or Hydrochloric Acid. Papers are prepared also of a *purplish* tint, which becomes full blue with alkalies, and bright red with acids.

MAGNESIUM.

This is a silver-white metal of crystalline structure and somewhat brittle. It is obtained from the Chloride by several methods which need not be described here.

If kept in dry air this metal is not altered, but, in damp air, it soon becomes covered with a film of Hydrate of Magnesium.

Its only use in Photography is for the purpose of illumination, as it emits a most dazzling light when burnt in air or Oxygen. For this purpose it is sold in the form of wire or ribbon. The light emitted is supposed to be more *actinic* than any other form of artificial illumination.

An ingenious lamp with a reflector has been devised, which facilitates the production of a regular and constant flame from the burning metal. The product of the combustion is Magnesia.

The Bromide and Iodide of Magnesium are objectionable in Photography by reason of their great affinity for water and their liability to decomposition.

MERCURY, CHLORIDE OF

(Formerly BICHLORIDE).

This salt, also called Corrosive Sublimate, and often *Bichloride of Mercury* (the atomic weight of Mercury being doubled), may be formed by heating Mercury in excess of Chlorine, or, more economically, by subliming a mixture of Sulphate of Mercury and Chloride of Sodium.

Properties.—A very corrosive and poisonous salt, usually sold in semitransparent, crystalline masses, or in the state of powder. Soluble in 16 parts of cold, and in 3 of hot water; more abundantly so in Alcohol, and also in Ether. The solubility in water may be increased by the addition of free Hydrochloric Acid, or of Chloride of Ammonium.

This salt is sometimes used as an intensifier for Negatives. A saturated aqueous solution is poured over the image until the latter becomes of a whitish grey colour. The film is then washed, and treated with a one-grain solution of Iodide of Potassium until the image assumes a green tone, which is very non-actinic. Negatives so treated, after repeated exposures to light become too dense.

NITRIC ACID.

Nitric acid or *aqua-fortis* is manufactured on a large scale by mixing equal weights of Nitrate of Potash and Sulphuric Acid and distilling the mixture in a retort by means of heat. The Nitric Acid passes over and is condensed, while Sulphate of Potash remains behind. It is purified and strengthened by redistillation with an equal weight of Sulphuric Acid.

The strength of commercial Nitric Acid varies much; but, except for the purpose of making Pyroxyline, exactitude in strength is of little importance to the Photographer. For acidulating the Nitrate bath, for making Chloride of Gold, Nitrate of Silver, &c., *purity* is of some consequence, but not great strength.

To detect the most common impurities, dilute a portion of the acid with distilled water, and add a drop or two of solution of Nitrate of Silver. If a white cloudiness appears, Chlorine is present. To detect

Sulphates or Sulphuric Acid, dilute another portion and add a few drops of solution of Chloride of Barium in distilled water. If no cloudiness appears, Sulphates are absent.

NITRO-HYDROCHLORIC ACID.

This is a mixture of Nitric and Hydrochloric Acids, sometimes called *aqua regia* or Nitro-muriatic acid. In Photography it is used for dissolving Gold (*see* Gold, Chloride of).

PHOSPHORIC ACID.

This acid in a diluted form is used in Willis's Aniline process. It may be prepared by pouring four fluid ounces of Nitric Acid and eight ounces of distilled water on six drachms of Phosphorus in a retort, and applying the heat of a sandbath. The distillation should proceed till the residue in the retort is of a syrupy consistence. The syrup is then poured into a platinum vessel, and heated to a dull red. On cooling, it concretes into a transparent mass, often assuming the crystalline form. This constitutes what is called Glacial Phosphoric Acid, which may be diluted to any extent.

POTASH.

Potash, the Oxide of Potassium, is obtained from Carbonate of Potash by separating the Carbonic Acid by means of Caustic Lime. Lime is a more feeble base than Potash, but the Carbonate of Lime, being *insoluble* in water, is at once formed on adding Milk of Lime to a solution of Carbonate of Potash in not less than twelve parts of water.

Properties.—Usually met with in the form of solid lumps, or in cylindrical sticks, which are formed by melting the Potash and running it into a mould. It always contains one atom of water, which cannot be driven off by the application of heat.

Potash is soluble almost to any extent in water, much heat being evolved. The solution is powerfully alkaline, and acts rapidly upon the skin; it dissolves fatty and resinous bodies, converting them into soaps. Solution of Potash absorbs Carbonic Acid quickly from the air, and should therefore be preserved in stoppered bottles; the glass stoppers must be wiped occasionally, in order to prevent them from becoming immovably fixed by the solvent action of the Potash upon the Silica of the glass.

Solution of Potash is a powerful detergent, and is sometimes used in Photography for removing grease from glass, &c. This object it effects by converting the oil or grease into a soluble soap.

POTASH, BICHROMATE OF.

This salt is analogous in its properties to the corresponding salt of Ammonia, and is used for the same purposes.

It is obtained by acting on Chromate of Potash with Nitric or other Acid. The acid abstracts half the Potash, and deep orange or red crystals are deposited, which constitute the Bichromate.

POTASH, NITRATE OF.

This salt, also termed *Nitre*, or *Saltpetre*, is an abundant natural product, found efflorescent upon the soil in certain parts of the East Indies. It is also produced artificially in what are called Nitre-beds.

There are different qualities of Nitre sold in commerce, some of which contain much Chloride of Potassium, detected on dissolving the Nitre in distilled water, and adding a drop or two of solution of Nitrate of Silver. This impurity is injurious when the Nitre is employed for Photographic use: in the manufacture of Pyroxyline it decomposes the Nitric Acid; and in the case of positive developing solutions, the presence of Chloride in the Nitre seems to produce a white cloudiness on the film.

A quality of Nitre which answers very well for making Pyroxyline can be obtained at the operative chemists' at a very cheap rate; it is often sold as pure Nitre, but usually contains sufficient Chloride to produce an opalescence with Nitrate of Silver; if the impurity is in larger quantity, and produces a decided precipitate with Nitrate of Silver, the sample must be rejected.

POTASH, PERMANGANATE OF,

is a salt which has been recommended for destroying organic matter in the Nitrate of Silver bath. It acts as an oxidizing agent, but it is very doubtful whether the advantage gained is not counterbalanced by other obvious disadvantages.

POTASSIUM, BROMIDE OF.

Bromide of Potassium is prepared by adding Bromine to Caustic Potash, and heating the product, which is a mixture of Bromide of Potassium and Bromate of Potash, to redness, in order to drive off the Oxygen from the latter salt. It crystallizes in anhydrous cubes, like the Chloride and Iodide of Potassium; it is easily soluble in water, but very sparingly so in Alcohol; it yields red fumes of Bromine when acted upon by hot and strong Sulphuric Acid.

Bromide of Potassium was extensively used in the paper—especially the waxed paper—negative processes. It is also occasionally used in Collodion, but from its sparing solubility in Alcohol and Ether, it is inferior to some other Bromides.

POTASSIUM, CYANIDE OF.

This salt is obtained by mixing eight parts of thoroughly dried Ferrocyanide of Potassium with three parts of dry Carbonate of Potash, and fusing the mixture in a covered earthen crucible. When effervescence has ceased, and iron which separates, has settled down, the clear liquid is poured off, and on cooling, solidifies into the white mass known as Cyanide of Potassium. Thus obtained it is not pure, but pure enough for the Photographic purposes to which it is applied, viz. fixing the image and removing silver stains from the hands, &c.

Cyanide of Potassium, being highly poisonous, must be used with great caution. If there exist abrasions or cuts on the hands, it is not safe to use, because, by absorption of the poison, serious results might ensue. Care also should be taken not to allow acid to get mixed with the solution; for, in that case, fumes of Hydrocyanic or Prussic acid would be given off. These fumes, incautiously inhaled, might cause fainting, or even death. The first symptom after inhaling the fumes, is a feeling of constriction in the throat and giddiness.

POTASSIUM, IODIDE OF.

This salt may be prepared by dissolving Iodide in a solution of Potash until it assumes a brown colour. Iodide of Potassium, and Iodide of Potash are thus formed, but by evaporation and heating to redness, the latter salt parts with its Oxygen, and is converted into Iodide of Potassium. The salt is then redissolved, filtered, and allowed to crystallize.

Iodide of Potassium may contain several *incidental* impurities from carelessness in the manufacture. If Carbonate, Iodate, or Sulphate be present, solution of Chloride of Barium will detect them. In the two former instances the precipitate dissolves on the addition of a single drop of *pure* dilute Nitric Acid, but in the latter case it is insoluble.

A simple test for Carbonate of Potash, which is the most objectionable impurity, is to dissolve the Iodide in about three times its weight of Lime water; a turbidity will indicate the presence of Carbonate.

The mere fact of reddened Litmus-paper becoming blue in solution of Iodide of Potassium is no proof of impurity, since the finest crystals which can be obtained have an alkaline reaction. But if an Alcoholic solution of the Iodide remains quite colourless when exposed for several days to a strong light, it is almost certain that an excess of alkali is present: the chemically pure Iodide of Potassium is generally decomposed by light, and assumes a faint straw-yellow tint, returning however to its colourless condition on putting the bottle again in a dark place.

Iodide of Potassium may, when required, be purified by recrystallizing it from Spirit, or by dissolving it in Alcohol of 805, in which Carbonate, Sulphate, and Iodate are insoluble.

POTASSIUM, SULPHIDE OF.

There are many Sulphides of Potassium, but the one commonly employed by Photographers, and sold in commerce as "Liver of Sulphur," is an impure Tersulphide. It is prepared by heating Sulphur with Carbonate of Potash, the result of which is that a portion of the Sulphur is oxidized into Sulphuric Acid, and combines with Potash, forming Sulphate of Potash, whilst another portion enters into combination with Potassium, producing a Sulphide of Potassium containing three atoms of Sulphur to one of Potassium.

"Liver of Sulphur" is used for reducing the Silver which has been taken up by Hyposulphite of Soda from Negatives or Positives.

POTASSIUM, SULPHOCYANIDE OF.

(*See* SULPHOCYANIDES.)

PYROGALLIC ACID.

This substance is obtained by the action of heat of 420° (Fah.) on Gallic Acid. The acid sublimes and is collected in the form of white shiny scales.

Pyrogallic acid can hardly be called a *real* acid, as it does not redden blue litmus-paper. It is very soluble in water, Alcohol, and Ether. Its aqueous solution soon decomposes by oxidation; but an Alcoholic or Ethereal solution will remain unchanged for a very long time.

It is a powerful deoxidizer, and reduces the Oxides of all the noble metals, hence its value as a developer in Photography.

SALICIN.

This substance is an extract from the bark of the willow, poplar, and some other trees.

It is obtained by exhausting the bark with boiling water, concentrating the solution, and digesting with Protoxide of Lead. The Lead is got rid of by precipitation with Sulphuretted Hydrogen. On evaporation, Salicin crystallizes out, and is purified by treatment with animal charcoal and again crystallizing.

It forms white silky needles, of an intensely bitter taste, and has an alkaline reaction. It is soluble in from five to six parts of water.

A solution of this substance forms an excellent preservative for dry plates.

SEL D'OR.

(*See* GOLD, HYPOSULPHITE OF.)

SILVER.

This metal, the *Luna* or *Diana* of the Alchemists, is found native in Peru and Mexico; but its principal ore is the Sulphide.

When pure it has a sp. gr. of 10·5, and is very malleable and ductile; melts at a bright red heat. Silver does not oxidize in the air, but when exposed to an impure atmosphere containing traces of Sulphuretted

Hydrogen, it is slowly tarnished, from formation of Sulphide of Silver. It dissolves in strong boiling Sulphuric Acid, but the best solvent for it is Nitric Acid.

The standard coin of the realm is an alloy of Silver and Copper, containing 92·5 per cent. of Silver.

To prepare pure Nitrate of Silver from it, dissolve in Nitric Acid by aid of heat, and evaporate until crystals are obtained. Then wash the crystals with a little dilute Nitric Acid, redissolve them in water, and crystallize by evaporation a second time.

The process is also occasionally conducted by boiling down the impure acid solution of the Silver to dryness, without any crystallization, and fusing the product pretty *strongly*, until a portion taken out, dissolved in water, and filtered from Oxide of Copper, ceases to give a blue colour with Ammonia, showing that the Nitrate of Copper is quite decomposed; afterwards recrystallize as before. Perhaps the easiest method is, to dissolve the alloy in Nitric Acid, immerse a piece of metallic Copper until the Silver is wholly precipitated, remove the Copper, wash the Silver well with water, then with a little Nitrate of Silver to remove any adhering Copper, and lastly dissolve in Nitric Acid and crystallize; or else take the Silver as precipitated by Copper, wash it, and dissolve in Nitric Acid, *avoiding all excess* (or if excess has been added, evaporate carefully to dryness to expel it); and to neutralize and remove traces of Copper, add Oxide of Silver to the boiling solution until on filtering and testing a portion with Ammonia, no blue colour is perceived, then filter the whole. This solution, if of the right strength (*see* Appendix), might be used at once for Photographic purposes.

SILVER, ALBUMINATE OF.

This name has been given to the insoluble white substance precipitated on adding Nitrate of Silver to a solution of Albumen, and which analysis shows to contain Oxide of Silver combined with the animal matter. It is reducible to a red subcompound, both by white light and by Hydrogen Gas.

SILVER, AMMONIO-NITRATE OF.

Crystallized Nitrate of Silver absorbs Ammoniacal gas rapidly, with production of heat sufficient to fuse the resulting compound, which is white, and contains 22·5 per cent. of Ammonia with 77·5 per cent. of Nitrate of Silver. The solution however which Photographers employ, is prepared by adding to the solution of Nitrate of Silver, *quite neutral*, a pure solution of Ammonia until the precipitate which first forms is *nearly* redissolved, and then filtering.

Ammonio-nitrate of Silver is often used for sensitizing *plain*-salted paper for Positive printing; but it is not suited for Albuminized paper, as the Ammonia dissolves off the Albumen.

SILVER, BROMIDE OF.

This salt is now much used in Photography, especially in the dry processes.

It may be produced, either by direct union of its elements, as in the Daguerreotype process, or by double decomposition between Nitrate of Silver and a soluble Bromide, as in the wet and *emulsion* processes of Photography.

Bromide of Silver is insoluble in water : soluble in alkaline Hyposulphites, Cyanides, Sulphocyanides, and Ammonia. By exposure to light it darkens to a tawny grey colour; yet, like the corresponding Iodide, it is capable of yielding, by development, a visible from an invisible image in the Camera.

SILVER, CARBONATE OF.

This is a white or yellowish powder deposited on adding any soluble Carbonate to solution of Nitrate of

Silver. It is only slightly soluble in water, or in solution of Nitrate of Silver, but yet sufficiently so to produce an alkaline reaction to Litmus. More soluble in water containing Nitrate of Ammonia, and freely so in Ammonia itself. Also dissolved by dilute Nitric or Acetic Acid, forming a Nitrate or Acetate.

SILVER, CHLORIDE OF.

Chloride of Silver may be obtained by the direct union of Silver and Chlorine, or, as in the preparation of papers for Positive printing, by double decomposition of Nitrate of Silver and a soluble Chloride.

SILVER, IODIDE OF.

In the Daguerreotype process, Iodide of Silver is produced by a direct union of the elements, but, in the Collodion and other Photographic processes, by the double decomposition of a soluble Iodide and Nitrate of Silver.

This compound differs from the corresponding Bromide and Chloride in being insoluble in Ammonia; but it resembles them in being readily dissolved by Hyposulphites, Cyanides, and Sulphocyanides. It is also soluble to some extent in concentrated solutions of the Alkaline Chlorides, Bromides, and Iodides.

SILVER, NITRATE OF.

Preparation and Properties. — The preparation of Nitrate of Silver has been sufficiently described under the head of Silver, to which the reader is referred. There are, however, some points of practical importance yet to be considered.

Pure Nitrate of Silver may be made from alloys of Silver and Copper, as described (art. SILVER); but since the heat which is necessary to decompose the Nitrate of Copper often produces Nitrite of Silver, it is advised that Silver nearly free from Copper should be chosen in preference. The consumption of Nitrate of Silver in Photography has now become very large, and it fortunately happens that the crystallized salt can be obtained in almost any quantity at a moderate price, being a bye-product in the operations of parting Gold and Silver, which are carried on in the refineries. The assay processes also yield a portion of the Nitrate sold in commerce, but not by any means the greater part.

This facility of obtaining commercial crystallized Nitrate of Silver at a price which is very little above that of the metal it contains, has however acted injuriously as regards the purity of the article; since it necessarily leaves its manufacture in the hands of a few individuals, who are not able to pay that attention to it which is needed. The crystals are usually sent out simply dried off from the Nitric Acid, as a refuse product on which no profit can be expected. Intentional adulteration, however, is not practised by the large producers of Nitrate of Silver, so far as the writer is aware.

The purity of Nitrate of Silver may easily be ascertained by dissolving a portion in distilled water, and precipitating the solution entirely with pure Hydrochloric Acid; the liquid filtered from the precipitate should leave no residue on evaporation to dryness.

Nitrate of Potash and Nitrate of Copper have been spoken of as occasional impurities in commercial Nitrate of Silver, but the presence of these salts in small quantity would have little effect except in reducing the strength of the Baths. The peculiar Photographic action of bad Nitrate of Silver is probably to be referred to a different cause—viz., to the presence of oxidized organic matter. In the assay processes fragments of charcoal are introduced to prevent the acid from *bumping* as it dissolves the Silver; we have good reason for believing that during this process, the Nitric Acid oxidizes the charcoal into a substance which has an affinity for the Silver salt; and the writer has found that Nitrate of Silver so produced is altogether unfit for Collodion Photography.

When old Nitrate Baths are precipitated by Zinc, organic matter is carried down by the reduced Silver, and the product, if converted into Nitrate of Silver without previous fusion, is useless for Photographic purposes.

The writer has also detected impurity of a similar kind, but in less quantity, in cases where no charcoal had been employed. Pieces of straw, &c. may perhaps fall into the acid; but, however this may be, the fact is certain that Nitrate of Silver prepared by dissolving Silver in Nitric Acid, and evaporating to dryness without any crystallization, cannot be depended on for Photography.

It has been suggested that the Nitrate of Silver for the Bath should be made purposely by dissolving pure Silver in pure Nitric Acid. Probably, however, no manufacturer would care to compete with the refiners, who are in a better position to supply the article at a reasonable price. *Recrystallization* seems therefore to be the proper remedy. The first crop of crystals may be dried off from the acid, and then crystallized a second time from distilled water; after which the product will be in a pure state if charcoal and substances of that kind have been excluded. This second crystallization ought not, according to a competent authority, to add more than fourpence, or at most sixpence, to the price per ounce.

A saturated solution of the purified crystals slowly restores the blue colour of reddened litmus-paper, if the Nitric Acid be expelled by heating to 240° previous to the second crystallization. This proceeding, however, is not actually necessary, inasmuch as a trace of adhering Nitric Acid can always be removed by Carbonate of Soda when making the Bath; and it is well known that the presence of a little acid facilitates the crystallization of Nitrate of Silver.

SILVER, OXIDE OF.

Oxide of silver may be obtained by adding a solution of Potash (pure or nearly free from Chloride) to one of Nitrate of Silver; a brown-black precipitate of Oxide of Silver falls, which may be collected on a filter and washed, or it may be allowed to settle down, the clear liquid poured off, fresh water added, and the Oxide again allowed to settle; this being repeated until the Nitrate of Potash and Potash have been removed, which may be ascertained either by evaporating a little on a slip of glass, or, if excess of Potash was added in the first place, by testing with red litmus-paper. It may be kept in a bottle in a moist state, its use being to neutralize Nitrate of Silver Baths, and to separate Oxide of Copper from Nitrate of Silver; the bottle should be kept in the dark.

SILVER, SULPHIDE OF.

This compound, sometimes termed Sulphuret of Silver, is formed by the action of Sulphur upon metallic Silver, or of Sulphuretted Hydrogen or Hydrosulphate of Ammonia upon the Silver salts: the decomposition of Hyposulphite of Silver also furnishes the black Sulphide.

Sulphide of Silver is insoluble in water, and in those substances which dissolve the Chloride, Bromide, and Iodide, such as Ammonia, Hyposulphites, Cyanides, &c.; but it dissolves in Nitric Acid, being converted into soluble Sulphate and Nitrate of Silver.

The colour of precipitated Sulphide of Silver varies with the quantity present; it is black when in mass, but yellowish-brown in a state of fine division.

SODA, ACETATE OF.

This salt is obtained by recrystallizing the crude Acetate formed during the first stages of the manufacture of Acetic acid.

Acetate of Soda is often used along with Chloride of Gold in the toning bath for positive prints.

SODA, CARBONATE OF.

There are two Carbonates of Soda. The one (Carbonate) is the common washing Soda. The other is the Bicarbonate, which is used in Photography sometimes for neutralizing a too acid Silver bath, and very often in the Chloride of Gold toning bath.

SODA, HYPOSULPHITE OF,

is a salt largely used in Photography for fixing images. This it effects by virtue of the power which it possesses of dissolving the Haloid salts of Silver. This property was discovered many years ago by Sir John Herschel.

Hyposulphite of Soda is made on an extensive scale, mainly for the purposes of the paper manufacturers, who employ it as an *antichlor*, or absorbent of the Chlorine used in bleaching the pulp of linen and cotton rags. Some of the inferior qualities have a yellowish colour, arising probably from Sulphide or free Sulphur. This kind should not be used for a fixing solution, as it is sure to impregnate the print with that deadly enemy to silver photographs—Sulphur. Acids, even in minute quantity, decompose it, liberating Sulphur. Hence the importance of keeping Hyposulphite solutions in a slightly alkaline, or at least neutral, state.

SODIUM, CHLORIDE OF.

Common Salt exists abundantly in nature, both in the form of solid rock-salt, and dissolved in the waters of the ocean.

Properties.—Fusible without decomposition at low redness, but sublimes at higher temperatures; the melted salt concretes into a hard white mass on cooling.

Nearly insoluble in absolute Alcohol, but dissolves in minute quantity in rectified spirit. Soluble in three parts of water, both hot and cold. Crystallizes in cubes, which are anhydrous.

Impurities of Common Salt.—Table Salt usually contains some Chloride of Magnesium, which, being deliquescent, produces a dampness by absorption of atmospheric moisture: Sulphate of Soda is also commonly present. The salt may be purified by repeated recrystallization, but it is more simple to prepare the pure compound *directly*, by neutralizing Hydrochloric Acid with Carbonate of Soda.

SULPHOCYANIDES.

Solutions of the Sulphocyanides of Ammonium or Potassium have been recommended for fixing positive photographs, instead of Hyposulphite of Soda. But it is doubtful whether any advantage is gained.

SULPHURETTED HYDROGEN.

(*See* HYDROSULPHURIC ACID.)

SULPHURIC ACID.

Sulphuric acid is the highest Oxide of Sulphur, prepared by an ingenious but roundabout process, involving many complicated reactions.

In Photography the principal use of Sulphuric acid is confined to its employment along with Nitric acid or Nitrate of Potash in the manufacture of Pyroxyline. It is also occasionally used in a dilute form for cleaning glass plates.

The impurities contained in commercial Sulphuric acid are generally not of such a nature as to interfere with its properties either in the manufacture of Pyroxyline or in cleaning refractory glass plates. An excess of water is the most dreaded impurity in making Pyroxyline; but this can be detected very readily by taking the Specific Gravity, which should range from 1836 to 1845.

TANNIN.

Various organic substances, possessing an astringent action, have been termed "Tannin;" such, for instance, as the extractive matters from bark, used in tanning hides, the astringent principles of Tea and Coffee, &c. The most important however is the Tannin of the Gall Nut, known as "Tannic Acid" or "Gallo-Tannic Acid."

Gall Nuts contain as much as two-thirds of their weight of Tannic Acid, which is extracted by reducing the nuts to powder, and digesting them with washed Ether: the decanted liquid separates on standing into two portions, the lower being an aqueous solution of Tannic Acid, the watery constituent of which is derived from the *washed* Ether. On evaporating the aqueous solution to dryness, a porous buff-coloured residue of amorphous Tannic Acid is obtained.

Tannic Acid is freely soluble in water, but it rarely yields a clear solution, on account of traces of remaining resinous matter. The reaction to test-paper is slightly acid, and on adding an alkali a "Tannate" is formed, but the alkaline Tannates are very unstable, and tend to absorb Oxygen and become brown. Tannic Acid gives with the Per-salts of Iron a violet-black precipitate, which is the basis of common Writing Ink. Solutions of Gelatine are precipitated by Tannic Acid in the form of Tanno-Gelatine, the material of Leather: Albumen is also precipitated by Tannin. When Tannic Acid is heated to about 600° Fahr., it is decomposed, and yields Pyrogallic Acid. Nitrate of Silver is not immediately precipitated by Tannic Acid, but suffers a slow reduction to the state of Metallic Silver.

URANIUM, NITRATE OF.

This salt is obtained by dissolving one of the higher oxides of Uranium in Nitric Acid, and evaporating over a water bath.

The remarkable Photographic properties of some of the Uranium salts were first discovered by Mr. Burnett, of Edinburgh. Since then the Nitrate of Uranium has been used conjoined with Silver or Gold in several processes.

The rationale seems to be this. The Uranium *per-salt* is reduced by light to a *proto-salt*, which, when the exposed paper or film is brought in contact with Gold or Silver solutions, reduces them by again absorbing Oxygen and passing into a per-salt.

WATER.

Distilled water is water which has been vaporized and again condensed. By this process it is freed from earthy and saline impurities, which, not being volatile, are left in the body of the *still*. When pure, distilled water leaves no residue on evaporation, and it remains perfectly clear on the addition of Nitrate of Silver, even when exposed to the light. It should also be neutral to test-paper.

The condensed water of steam-boilers, often sold for distilled water, is apt to be contaminated with oily and empyreumatic matters, which are very injurious to the Nitrate of Silver bath. Newly made stills, also, fail at first in giving a pure product, from the presence of grease and dust in the soldered joints. Professor Tomlinson has shown that a very minute amount of grease may be detected by camphor. A small fragment thrown on water free from grease spins round, but if these impurities are present this motion is prevented.

Rain water, having undergone a natural process of distillation, is free from inorganic salts, but it usually contains a minute portion of *Ammonia*, which gives it an alkaline reaction to test-paper. It is very good for Photographic purposes if collected in clean vessels, but when taken from a common rain-water tank should always be examined, and if much organic matter be present, tinging it of a brown colour, and gradually reducing Nitrate of Silver in presence of light, it must be rejected.

Spring or *River* water, commonly known as "hard water," usually contains Sulphate of Lime, and Carbonate of Lime dissolved in Carbonic Acid; also Chloride of Sodium in greater or less quantity. On boiling the water for twenty minutes or half an hour, the Carbonic Acid gas is evolved, and the greater part of the Carbonate of Lime (if any be present) deposits, forming an incrustation which dissolves in Acetic Acid with effervescence. Spring-water is less likely to contain brown organic matter than rain-water.

In testing water for Carbonates, Sulphates, and Chlorides, divide it into two parts, and add to the first a dilute solution of Chloride of Barium, and to the second, Nitrate of Silver,*—a milkiness indicates the presence of either Carbonate or Sulphate in the first case, or of Carbonate or Chloride in the second. Next, acidify the two liquids with a few drops of Glacial Acetic Acid: if the opalescence disappears and the fluid becomes clear, Carbonates are present; but if, as is more frequently the case, the cloudiness is only partially removed by the Acetic Acid, then the Carbonate is mixed with Sulphate or Chloride as the case may be.

Water for the Nitrate Bath.—Common hard water can often be used for making a Nitrate Bath when nothing better is at hand. The Chlorides it contains

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* The *Photographic Nitrate Bath* cannot be used as a test, since the Iodide of Silver it contains is precipitated on dilution, giving a milkiness which might be mistaken for Chloride of Silver.

are precipitated by the Nitrate of Silver, leaving small quantities of soluble *Nitrates* in solution which are not injurious. Carbonate of Lime, if present, neutralizes acid, and may render the bath alkaline if Salts of Ammonia are present. Sulphate of Lime causes no precipitation, and ought not theoretically to produce any injurious effect. Organic matter will almost certainly be injurious to the Bath, and therefore, unless the purity of the rain-water can be guaranteed, spring-water will be preferable.

Ordinary spring or river-water answers very well for the developers, excepting for solutions of Pyrogallic Acid, which rapidly decomposes if *hard* water is used in dissolving it.

The comparatively small amount of Chlorides usually found in common water does not decompose much of the free Nitrate in the exposed film ; hence failure in the development from that source does not arise, except to a very limited extent.

APPENDIX.

TO FIND THE EQUIVALENT FOCUS OF A LENS, AND THE ANGLE OF VIEW INCLUDED.

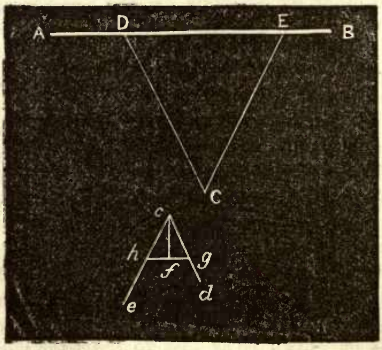
It is often of importance, and always of interest to the Photographer to be able to ascertain the angle of picture included on a plate of a given size, and also to determine the "equivalent" or correct focal length of his lens. Mr. Shadbolt has published a very simple and correct method of determining both these points, which, with his permission, we here reproduce.

"If we place a theodolite upon the spot whence we are about to take a photograph, and having ascertained by inspection what portion of the view will be included upon our plate, we turn the instrument first to one extremity of the subject and then to the other, we ascertain by the number of degrees marked on the scale that have been passed over by the telescope what 'angle of picture' we are to have. If we move nearer to or further from the subject, we shall of course include less or more of it respectively upon our plate or ground-glass. But for all that we do not alter the *angle* of picture included; for if we perform the same operations as before with the theodolite, at the nearer and more distant stations respectively, we find just the same number of degrees on the scale of the instrument passed over in each case as before.

"If we imagine a line to be drawn from between the eyes of the spectator directly towards the centre of our subject, the 'angle of picture' means the distance to the right and left of the central spot to which other imaginary lines from the observer might be drawn, so as just to limit the view to that which our lens would include from the same spot.

"Mr. Grubb has already pointed out that the camera itself may be made to do duty as a theodolite, by placing it upon a level table on a sheet of paper fastened down upon the latter; then, having ascertained by inspection the limits of the subject delineated upon the focussing-screen, turn the camera round until the object at one extreme occupies the centre of the ground-glass, and accurately coincides with a pencil line made thereon. Now with a pencil draw a line on the paper beneath the camera, parallel with one side of the latter; turn the camera round until the object at the other extremity of the subject coincides with the pencil line on the focussing-screen, and draw another line on the paper as before. The angle formed by the two lines thus drawn will show the 'angle of picture' included. But this is not all; for if we draw a line *opposite to the angle* thus found, at such a distance therefrom as shall allow the third line, bounded by the two previous ones, to be of the same length as the focussing-screen, a perpendicular let fall from the angle upon the third line will give the *equivalent* focal length of the lens employed. This equivalent focal distance may or may not agree with the distance of the screen from the lens—most probably *not*, especially if it be a double or triple combination.

"To simplify this matter, we append the following diagram:—



"Let A B represent a moderately distant view, and C the place of the camera. On focussing, we find the portion included on the ground-glass to be from D to E only; this is the 'angle of picture.' If we now turn the camera towards D, so as to make its image fall on a line in the centre of the focussing-screen, and draw a line parallel with the side of the camera, we shall have a line parallel to C D—viz. *c d*. On turning the camera towards E, and making its image fall on the same mark on the screen, another line drawn parallel with the same side of the camera will also be parallel with C E—viz. *c e*, and these two lines are inclined to one another exactly in the same ratio as are C D and C E.

"By measurement upon the ground-glass, we find the distance between the images of the objects D and E to be equal to *g h*; and if we now place this line exactly opposite the angle *c*, so as to be bounded by the lines *c d*, *c e*, and let fall the perpendicular *c f*, the distance *c f* is the *equivalent* focus of the lens, and this holds good whether the marginal rays suffer deviation by the lens or not; only in the latter case the equivalent focus of the lens may vary to a very trifling extent as the rays of light fall upon it perpendicularly or obliquely. This is not of any great importance in practice, and we merely name it for the sake of accuracy. Any one possessing a lens and camera need therefore be under no uncertainty about the *equivalent focus* of the former; and this once ascertained, he can always calculate the angle of any view he may take with it, no matter upon what sized plate he may operate."

QUANTITATIVE TESTING OF SOLUTIONS OF NITRATE OF SILVER.

The amount of Nitrate of Silver contained in solutions of that salt may be estimated with sufficient delicacy for ordinary Photographic operations by the following simple process:—

Take the *pure* crystallized Chloride of Sodium,—which operative chemists make purposely for analysis by dissolving the best Carbonate of Soda in pure Hydrochloric Acid,—and either dry it strongly or fuse it at a moderate heat, in order to drive off any water which may be retained between the interstices of the crystals; then dissolve in distilled water, in the proportion of 8½ grains to 6 fluid ounces.

In this way, a standard solution of salt is formed, each drachm of which (containing slightly more than one-sixth of a grain of salt) will precipitate half a grain of Nitrate of Silver.

To use it, measure out accurately one drachm of the Bath in a minim measure, and place it in a two-ounce stoppered phial, taking care to rinse out the measure with a drachm of distilled water, and to add the rinsings to the fluid drachm of Bath; then pour in the salt solution, in the proportion of a drachm for every 4 grains of Nitrate *known to have been present* in an ounce of the Bath which is to be tested; shake the contents of the bottle briskly, until the white curds have perfectly separated, and the supernatant liquid is clear and colourless; then add fresh portions of the standard solution of salt by 30 minims at a time, with constant shaking. When the last addition causes no *milkiness*, read off the total number of drachms employed (the last half-drachm being subtracted), and multiply that number by 4 for the weight in grains of the Nitrate of Silver present in an ounce of the Bath.

In this manner the strength of the Bath will be indicated within two grains to the ounce, or even to a single grain if the last additions of standard salt-solution be made in portions of 15 instead of 30 minims.

Supposing the Bath to be tested is thought to contain about 28 grains of Nitrate to the ounce, it will be convenient to begin by adding to the measured drachm 6 *drachms* of the standard solution; afterwards, as the milkiness and precipitation become less marked, the process must be carried on more cautiously, and the bottle shaken violently for several minutes, in order to obtain a clear solution. A few drops of Nitric Acid added to the Nitrate of Silver facilitate the deposition of the Chloride; but care must be taken that the sample of Nitric Acid employed is pure and free from Chlorine, the presence of which would cause an error. The delicacy of this mode of testing may be increased by adding to the Silver solution a little Bichromate of Potash, omitting the Nitric Acid; a deep red precipitate of Chromate of Silver is thus formed, which tinges the Chloride of Silver, formed on adding the standard solution, until the last, when all the Silver having been precipitated, the Chloride of Sodium finally decomposes the red Chromate of Silver into the white Chloride, and the completion of the operation is evident from the change of colour in the precipitate.

The Photographer may perhaps require to perform these operations when pure Chloride of Sodium is not immediately obtainable. In that case the ordinary commercial Chloride of Ammonium may be substituted, 7¾ grains being dissolved in 6 fluid ounces of water. It is advisable however, when using a Chloride of doubtful purity, to take the precaution of trying the strength of the standard saline solution, by testing it upon 30 grains of pure dried Nitrate of Silver dissolved in an ounce of water.

Ordinary fluid measures are seldom graduated with perfect accuracy, and hence one of the various forms of "argentometer" which have been devised purposely for bath-testing is preferable: by its employment the necessity for calculations will be avoided, since the number of measures are made to indicate grains per ounce. Another very correct method of ascertaining the strength of *pure* solutions of Nitrate of Silver is by the annexed Table of Specific Gravities, which, if the correction be made for temperature, will indicate the number of grains in each ounce of solution to within a small fraction of a grain. If the solution to be tested has been used for some time in sensitizing Positive paper, Nitrate of Potash or Ammonia will have accumulated to a slight degree, and two on an average must, therefore, be deducted from the tabulated number of grains. To test an old Nitrate of Silver Collodion Bath, 2 grains will require to be added, on account of the Ether and Alcohol which have become mixed up therewith, and which reduce the specific gravity more than the Nitrate of Potash, Ammonia, &c., increase it.

Table for ascertaining from the Specific Gravity the amount of Nitrate of Silver contained in one fluid ounce of any pure Solution, at Sixty degrees Fahrenheit.

Grs. per fl. oz.	Sp. Gr.	Grs. per fl. oz.	Sp. Gr.	Grs. per fl. oz.	Sp. Gr.	Grs. per fl. oz.	Sp. Gr.
10	1·021	43	1·084	76	1·146	109	1·207
11	1·023	44	1·086	77	1·148	110	1·209
12	1·025	45	1·088	78	1·150	111	1·211
13	1·027	46	1·089	79	1·152	112	1·213
14	1·029	47	1·091	80	1·153	113	1·215
15	1·031	48	1·093	81	1·155	114	1·216
16	1·032	49	1·095	82	1·157	115	1·218
17	1·034	50	1·097	83	1·159	116	1·220
18	1·036	51	1·099	84	1·161	117	1·222
19	1·038	52	1·101	85	1·163	118	1·224
20	1·040	53	1·103	86	1·165	119	1·226
21	1·042	54	1·105	87	1·167	120	1·227
22	1·044	55	1·106	88	1·168	121	1·229
23	1·046	56	1·108	89	1·170	122	1·231
24	1·048	57	1·110	90	1·172	123	1·233
25	1·050	58	1·112	91	1·174	124	1·235
26	1·051	59	1·114	92	1·176	125	1·236
27	1·053	60	1·116	93	1·178	126	1·238
28	1·055	61	1·118	94	1·180	127	1·240
29	1·057	62	1·120	95	1·181	128	1·242
30	1·059	63	1·122	96	1·183	129	1·244
31	1·061	64	1·123	97	1·185	130	1·245
32	1·063	65	1·125	98	1·187	131	1·247
33	1·065	66	1·127	99	1·189	132	1·249
34	1·067	67	1·129	100	1·191	133	1·251
35	1·069	68	1·131	101	1·193	134	1·252
36	1·070	69	1·133	102	1·194	135	1·254
37	1·072	70	1·135	103	1·196	136	1·256
38	1·074	71	1·137	104	1·198	137	1·258
39	1·076	72	1·138	105	1·200	138	1·259
40	1·078	73	1·140	106	1·202	139	1·261
41	1·080	74	1·142	107	1·204	140	1·263
42	1·082	75	1·144	108	1·205		

CORRECTION FOR TEMPERATURE, ETC.—For every 10° below 60° *deduct* one grain from the number quoted by the Table, and for every 10° above 60 *add* one grain to the number tabulated. In testing old Printing Solutions *deduct* two, and for old Collodion Baths *add* two grains to the number quoted.

SAVING OF SILVER AND GOLD FROM WASTE SOLUTIONS AND RESIDUES.

The judicious collection of wastes from solutions of the noble metals is one of the best economies that a photographer can practise. Seeing that these substances are most expensive items which must be largely used, and also bearing in mind the fact that very little of them is really used up in forming the Photographic image, it stands to reason that the rest can be recovered.

1st. A large glazed earthenware or porcelain jar is provided; or an ordinary cask, tarred and dried inside, will answer. It should be fitted with a tap near the middle, to draw off superfluous water when required. Into this jar are thrown all the drippings of Nitrate of Silver from sensitized paper, the first washing water of vessels which have contained the Nitrate, the first washing water of Photographic prints *before* toning, and in short all *waste* silver salts that can be made insoluble by a Chloride or other Haloid.

The jar should be well supplied with Chloride of Sodium (common salt) to reduce the Silver to Chloride. But sometimes it happens that the latter insoluble compound is in a state of such fine division that it does not readily subside so as to enable one to draw off, without waste, part of the superfluous liquid when necessary. In that case, acidulate with a little Hydrochloric or Sulphuric acid, and stir the whole well up. In a short time the supernatant liquid will be quite clear and free from silver.

2nd. Another saving of Silver arises from the filters, the clippings of prints, and the bits of blotting-paper used for absorbing waste drops either in the Negative or Positive processes. These should all be dried and placed in a bag until they accumulate in sufficient quantity for reduction. To effect this the papers or other absorbents of Nitrate of Silver are burnt and the ashes carefully preserved. The burning may be done in an ordinary grate. First clear out all the ashes from the fireplace, fill the grate with the clippings, filters, &c., and *set fire to them from the top.* If ignition takes place from the bottom, the chances are that the draught will be immoderately strong, and waft up the chimney some of the silver. Throw on all the papers, little by little, till they are reduced to a fine ash, carefully sweep up the ashes, and either add them to the contents of the "waste jar," or reserve them to mix with the precipitated Chloride after it has been dried.

It should have been mentioned with respect to the "waste jar" that it should not be too highly charged with common salt; because Chloride of Silver is, to some extent, soluble in concentrated solutions of Chloride of Sodium, and therefore a little waste might be incurred when drawing off the superfluous liquid. Care also should be taken to notice that all the Silver has been precipitated before drawing off the water. This is easily ascertained by adding a drop of solution of Chloride of Sodium to the liquid. If all the precious metal has not been precipitated a decided cloudiness will be apparent.

3rd. Another saving of Silver arises from the fixing solutions of Hyposulphite of Soda. This economy is seldom practised, for the reasons that the operation is a very disagreeable one, and as it is the custom now-a-days to use fresh solutions for every batch of prints fixed, the resulting proceeds are scarcely worth the trouble of recovering them.

Silver is reduced from these used solutions by means of Liver of Sulphur (Sulphide of Potassium). The form in which the Silver is precipitated is that of an impure Sulphide containing a great excess of Sulphur. But this operation must be conducted at a distance from the dark room, else the sulphurous fumes which are given off would be very prejudicial both to health and more particularly to clean and clear Photographic manipulation.

4th. *Recovery of Gold.*—When the toning bath has apparently become exhausted and refuses to tone any more prints, it still contains a considerable quantity of Gold which has become *inert.* To precipitate this throw in a little of a solution of Protosulphate of Iron. The black deposit which is immediately formed consists mainly of Carbonate and Oxide of Iron mixed with metallic Gold in an extremely fine state of division. Filter. The precipitate remains in the filter, which should be dried and burnt along with the silver filters. It is not worth while to keep these wastes separate, as the refiner allows for the Gold when reducing the whole, and can estimate the value very accurately.

When the time has come to clear the "waste jar" of its Chloride or other insoluble salt of Silver, all the clear water is drawn off with a syphon, the moist precipitate is spooned out into a large evaporating basin, or into one of those *enamelled* iron pots or pans which can now be purchased at most of the ironmongers' shops, and the water driven off by heat.

All these "wastes," *when dry*, may be reduced together, and by any one who has competent metallurgical knowledge, and who is in possession of a furnace specially fitted for the work; but from the writer's experience, by far the best plan is to send the wastes to the professional refiner, who after recouping himself for his trouble, will show more of the precious metal than one who only works occasionally can possibly do.

MODE OF TAKING THE SPECIFIC GRAVITY OF LIQUIDS.

Instruments are sold, termed "Hydrometers," which indicate specific gravity by the extent to which a glass bulb containing air, and properly balanced, rises or sinks in the liquid; but a more exact process is by the use of the specific-gravity bottle.

The bottles are made to contain exactly 1000 grains of distilled water, and with each is sold *a brass weight*, which counterbalances it when filled with pure water.

In taking the specific gravity of a liquid, fill the bottle quite full and insert the stopper, which being pierced through by a fine capillary tube allows the excess to escape. Then, having wiped the bottle quite dry, place it in the scale-pan, and ascertain the number of grains required to produce equilibrium; this number added to, or subtracted from, *unity* (the assumed specific gravity of water), will give the density of the liquid.

Thus, supposing the bottle filled with *rectified Ether* to require 250 grains to enable it to counterbalance the brass weight,—then 1· *minus* ·250, or ·750, is the specific gravity; but in the case of *Oil of Vitriol* the bottle, when full, will be *heavier* than the counterpoise by perhaps 836 grains; therefore 1· *plus* ·836, *id est*, 1·836, is the density of the sample examined.

Sometimes the bottle is made to hold only 500 grains of distilled water in place of 1000: in this case the number of grains to be added or subtracted must be multiplied by 2.

The form of Specific Gravity bottle, now most commonly used, has a brass weight which counterpoises the empty bottle only. This is an advantage, because the weight indicated by the liquid, when the bottle is filled, at once indicates the Specific Gravity; or in the case of a bottle holding 500 grains of distilled water, the weight multiplied by 2 will indicate the sp. gr. The temperature should register 60° Fah.

REMOVAL OF SILVER STAINS FROM THE HANDS, LINEN, ETC.

The black stains upon the hands caused by Nitrate of Silver may readily be removed by rubbing them with a moistened lump of Cyanide of Potassium, leaving it on the hands for a little time, and then washing well with water. A solution of Iodide of Potassium allowed to dry on the hands will also after a time change the black stains into yellow Iodide of Silver, which may then be removed by Hyposulphite of Soda.

Stains upon white linen may be easily removed by brushing them with a solution of Iodine in Iodide of Potassium, and afterwards washing with water and soaking in Hyposulphite of Soda, or Cyanide of Potassium, until the yellow Iodide of Silver dissolves out; the Bichloride of Mercury (neutral solution) also answers well in many cases, changing the dark spot to white).

The following liquid, when other means fail, is an energetic remover of Silver stains:—Cyanide of Potassium, 100 grains; Iodine, 10 grains; Water, 1 ounce: the solution should be colourless.

REMOVAL OF STOPPERS AND CLEANSING OF BOTTLES.

Substances which exert a solvent action on Silica are likely to fix the stoppers of bottles; such, for instance, as Caustic Potash and Carbonate of Potash; also iodizing solutions containing Iodide of Potassium, etc. To remove the stopper, begin by inverting the bottle for about half an hour, that the liquid may gravitate into the neck, then tap it gently, pressing the side of the stopper, opposite to the part tapped, pretty strongly with the thumb, when it will probably be found to yield; if not, continue the tapping with the wooden handle of a spatula, on each side successively, so as to keep up a constant vibration. Next fix a string to the table, and having twisted it round the neck, hold the other end of the string in the hand, and move the bottle rapidly backwards and forwards, until a considerable amount of heat has been generated, after which the gentle tapping may be resumed. Lastly, heat the neck with a spirit-lamp applied gradually and with constant movement, and when sufficient expansion has been produced, tap as before, or tie a cloth round the stopper, and twist it out by aid of a key.

In cleansing dirty bottles, consider first the nature of the impurity to be removed. If it be soluble in water, a careful rinsing two or three times repeated will be sufficient, but in other cases the proper solvent must be used, or mechanical friction resorted to. Greasy bottles are always troublesome, and are likely to soil both the bottle-brushes and the washing water. Liquor Potassæ or a strong solution of washing Soda will generally remove the grease; if not, try a little strong Sulphuric Acid, turning the bottle round so as to bring it into contact with every part, and it will generally be found that on washing it out the bottle will be left perfectly clean. Red stains of Peroxide of Iron are removed by a few drops of Hydrochloric Acid; crusts of Carbonate of Lime by the same. Brown stains of Sulphide of Silver dissolve in Nitric Acid. Varnish bottles are often most effectually cleansed by Spirit of Wine, followed by shot and water; Collodion bottles, by shot assisted by a pointed wire, to scrape away the precipitated Pyroxyline.

In using shot for cleansing, avoid those bottles which contain grease or resinous matter likely to adhere to the shot; bottle-brushes would also be soiled by using them for cleaning away any organic substance insoluble in water. When a considerable number of bottles require cleansing, begin by marking each of the stoppers, or by tying them securely to the necks in order to avoid confusion.

REMOVAL OF VARNISH FROM GLASS PLATES.

The black varnish may often be removed from Collodion positives by means of Chloroform or Benzol, neither of which dissolves the Pyroxyline constituting the film.

Glass plates varnished with Negative varnish, may sometimes be cleaned with Chloroform or Benzol; but when the preservation of the picture is not an object, the plates may be left soaking in a solution of washing "Soda" for several hours, after which the film will be removable by friction. A few drachms of waste Nitro-Sulphuric Acid poured over the plate, will oxidize the varnish and loosen the film in the course of half an hour.

VARNISH FOR BLACKING BRASS-WORK.

Take the ordinary spirit-lacquer of the shops, and rub it up with Lampblack into a thin cream, afterwards filtering through muslin. The brass-work must be heated before the black is applied, or it will give a shining instead of a lustreless surface.

DEGREES CENTIGRADE, COMPARED WITH THE SCALE OF FAHRENHEIT.

The Thermometric Scale in common use in France is the Centigrade. The following Table will serve for its conversion into degrees of Fahrenheit, from the freezing to the boiling point of water.

°Cent.	°Fahr.	°Cent.	°Fahr.	°Cent.	°Fahr.	°Cent.	°Fahr.
0	32·0	26	78·8	51	123·8	76	168·8
1	33·8	27	80·6	52	125·6	77	170·6
2	35·6	28	82·4	53	127·4	78	172·4
3	37·4	29	84·2	54	129·2	79	174·2
4	39·2	30	86·0	55	131·0	80	176·0
5	41·0	31	87·8	56	132·8	81	177·8
6	42·8	32	89·6	57	134·6	82	179·6
7	44·6	33	91·4	58	136·4	83	181·4
8	46·4	34	93·2	59	138·2	84	183·2
9	48·2	35	95·0	60	140·0	85	185·0
10	50·0	36	96·8	61	141·8	86	186·8
11	51·8	37	98·6	62	143·6	87	188·6
12	53·6	38	100·4	63	145·4	88	190·4
13	55·4	39	102·2	64	147·2	89	192·2
14	57·2	40	104·0	65	149·0	90	194·0
15	59·0	41	105·8	66	150·8	91	195·8
16	60·8	42	107·6	67	152·6	92	197·6
17	62·6	43	109·4	68	154·4	33	199·4
18	64·4	44	111·2	69	156·2	94	201·2
19	66·2	45	113·0	70	158·0	95	203·0
20	68·0	46	114·8	71	159·8	96	204·8
21	69·8	47	116·6	72	161·6	97	206·6
22	71·6	48	118·4	73	163·4	98	208·4
23	73·4	49	120·2	74	165·2	99	210·2
24	75·2	50	122·0	75	167·0	100	212·0
25	77·0						

[Réaumur's Scale is occasionally employed in Germany, Russia, etc. : in this the freezing point of water is termed 0°, and the boiling point 80°. Each degree of Fahrenheit's scale is equal to four-ninths of a degree on Réaumur's : if therefore the number of degrees of Réaumur be multipied by 9 and divided by 4, the quotient *plus* 32 will be the corresponding degree of Fahrenheit. Thus 80° (Réaumur) × 9 = 720 ÷ 4 = 180 + 32 = 212° (Fahrenheit).]

WEIGHTS AND MEASURES.

Troy or Apothecaries' Weight.

1 Pound = 12 Ounces. 1 Ounce = 8 Drachms. 1 Drachm = 3 Scruples. 1 Scruple = 20 Grains. (1 Ounce Troy = 480 Grains, or = 1 Ounce Avoirdupois *plus* 42·5 grains.)

Avoirdupois Weight.

1 Pound = 16 Ounces. 1 Ounce = 16 Drachms. 1 Drachm = 27·343 grains. (1 Ounce Avoirdupois = 437·5 grains.) (1 Pound Avoirdupois = 7000 Grains, or = 1 Pound Troy *plus* 2½ Troy Ounces *plus* 40 grains.)

Imperial Measure.

1 Gallon = 8 Pints. 1 Pint = 20 Ounces. 1 Ounce = 8 Drachms. 1 Drachm = 60 Minims. (A Wine Pint of water measures 16 Ounces, and weighs a Pound.)

An Imperial Gallon of water *weighs* 10 Pounds Avoirdupois, or 70,000 Grains. An Imperial Pint of water *weighs* 1¼ Pound Avoirdupois. A fluid Ounce of water *weighs* 1 Ounce Avoirdupois, or 437·5 Grains. A fluid Drachm of water *weighs* 54·7 Grains. A Minim *weighs* 0·91 Grains.

French Measures of Weight.

1 Kilogramme = 1000 Grammes = something less than 2¼ Pounds Avoirdupois.

1 Gramme = 10 Décigrammes = 100 Centigrammes = 1000 Milligrammes = 15·433 English Grains.

A Gramme of water *measures* 1 Cubic Centimètre, or 17 English Minims, nearly. 1000 Grammes of water *measure* 35½ English fluid Ounces.

French Measures of Volume.

1 Litre = 10 Décilitres = 100 Centilitres = 1000 Millilitres = 35¼ English fluid Ounces.

1 Litre = Cubic Décimètre = 1000 Cubic Centimètres.

1 Cubic Centimètre = 17 English Minims.

A Litre of water *weighs* a Kilogramme, or something less than 2¼ Pounds Avoirdupois. A Cubic Centimètre of water *weighs* a Gramme.

French Measures of Length.

1 Mètre = 10 Décimètres = 100 Centimètres = 1000 Millimètres = 39·37079 English inches.

A metre is equivalent to the ten-millionth part of the arc of the meridian, extending from the Equator to the Pole.

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_ *The List of Photographic Chemicals is placed in alphabetical order in the Vocabulary.*

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