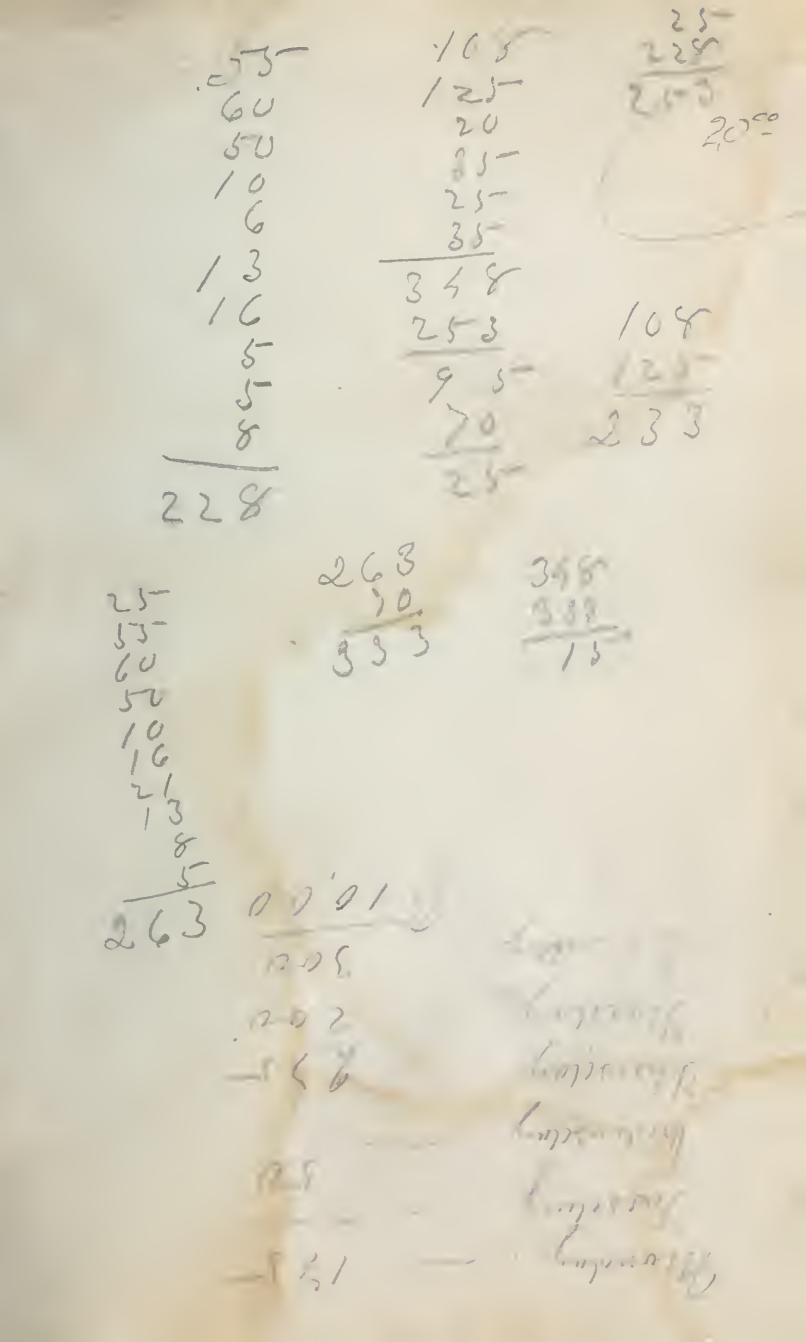

THE SILVER SUNBEAM:

A Practical and Theoretical Text-Book

ON

SUN DRAWING AND PHOTOGRAPHIC PRINTING:

COMPREHENDING ALL THE

WET AND DRY PROCESSES

AT PRESENT KNOWN, WITH

Collodion, Albumen, Gelatine, Wax, Resin, and Silver;

AS ALSO

Heliographic Engraving, Photolithography, Photozincography, Celestial Photography, Photography in Natural Colors, Tinting and Coloring of Photographs, Printing in Various Colors; the Carbon Process, the Card-Picture, the Vignette, and Stereography.

BY

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"And God said, Let there be light: and there was light."

SECOND THOUSAND.

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PHOTOGRAPHY.

CHAPTER I.

HISTORY OF PHOTOGRAPHY.

Every step, whether thoughtlessly or discreetly taken, is the commencement of a new era in a man's life. As in a game of chance—where either red or black must occur at the cessation of motion in the finger of the dial-plate—the probability that red will prevail over the black the next time, because black has occurred for twenty times in succession, is not valid; it is equally probable that black will be the successful color; so, in the game of life, each successive move is a new beginning; and, as a single twirl of the roulette may be the bane or the boon of the career of an individual, so the slightest event, the most insignificant indeed, may turn out to be the center of incalculable results. New developments in the science of nature are not limited to their own immediate sphere; they act and react upon the past and the future, by illustrating phenomena that before were dark and not understood, or by eliciting truths which hitherto were utterly unknown. Thus it is that the invention of a machine, the improvement of a part of a machine, or the discovery of some new chemical ingredient, may be the date of the commencement of a new history. The verification of this idea is pertinently made manifest in the change from the simple double convex lens to the achromatic combination by Dolland;* in the change from the signal telegraph on the mountains to the electric telegraph in the closet; in the improved application of steam by Watt; in the development of a picture on the iodized plates of silver by the vapor of mercury; and in the discovery of the hypo-

* Dolland, J., was born in London, in the year 1706, and died in 1762.

sulphite of soda, cyanide of potassium, pyrogallic acid, and the protosalts of iron. For from the moment that chromatic and spherical aberration could be reduced, the telescope and the microscope became altogether new instruments in the hands of the natural philosopher, by which many crude notions were quickly laid aside as false, and many new truths as quickly denuded of their cloudy habiliments. Astronomy, one of the oldest of sciences—one whose history can be traced back to the time of the Chaldeans—entered, at the time of the introduction of the achromatic refracting telescope, upon an epoch as distinct in its history as the transition from the system of Hipparchus to that of Copernicus. At the same time, too, Physiology received a new impetus, by the deductions drawn with the aid of the compound achromatic microscope, so that Biology, since then, is gradually becoming more and more of a science. By means of the former improved instrument, our eyes are permitted to revel amid the enchanting scenes of the starry firmament, by the latter to scrutinize the realms of minute organisms of the earth, and by both to become acquainted with the secrets of creation. For the investigator of nature in the great and the minute, this is a new era in the history of the world as it exists and acts. In like manner the age of steam and the telegraph commenced a new history in the social existence and actions of men. The mild tenets of the Gospel, which would seem to have no connection whatever with the subject, have been more powerfully, more efficaciously implanted in foreign soils, by the accessory instrumentality of these agents, than by any preceding direct operations of the missionary organization; the superiority of the race of men that have invented and that wield such mighty instruments for weal and for woe, is so distinctly marked, that admiration and awe have engendered, in the minds of the ignorant and less enlightened, respect for the creeds of religion and morality of their superiors. Coexistent with the steam-engine and the electric telegraph, and equally important as these in its influence on the ways and means of life, is the art of sun-drawing. It is one of the great wonders of the phenomena of created matter, so far eclipsing the seven vaunted wonders of the world, that these recede into dark nooks, like the wired dolls of an automatic puppet-show. This art, and the science that explains the different effects produced in its manipulations, form the subject of the present volume. The art and the science are of modern origin and of recent date.

Sun-drawing, Heliography, and Photography are synonymous expressions for the same phenomenon, although etymologically the two latter are somewhat different—heliography signifying *sun-writing*, whilst the word photography signifies *light-writing*. Not one of these expressions is strictly correct, because actinic impressions can be obtained from rays emanating from the moon, from artificial light, or the electric spark. Actinic drawing would probably be the best name, although as regards the representation of facts by words, it is immaterial for the masses of mankind whether these words have an intrinsic or root-meaning or not. The phenomena comprehended under any one of the above synonymous expressions, depend immediately upon what is termed *light* as the force or cause, and upon the property, which only certain substances apparently possess, of being affected according to the intensity of the light employed. The principal of these substances are the *salts of silver*, the *salts of iron*, *bichromate of potassa*, and certain resins, as the *oil of lavender* and *asphaltum*. That light acts upon organized substances is a phenomenon which must have been observed by the first occupants of earth; they could not fail to remark the brilliant hues on the side of an apple that received the direct rays of the sun, and to contrast these resplendent mixtures of red, crimson, green, purple, yellow, orange, and other colors, on the one side, with the white, or greenish white, on the side exposed simply to the diffused light of day. The variegated foliage of a tropical clime, as contrasted with the continual merging into green, according to the increase in latitude, gives evidence of the influence of actinic action; and this change of green into white in the leaves and stalks of similar plants, when supplied with heat and air, and not with light, is a still stronger proof of heliographic influence. But this species of influence is not limited to the vegetable part of the earth; it is perceived, in all its beauties, in the blooming cheeks of a maiden from Kaiserstuhl in the Black Forest, or from the pasturing declivities of the Tyrolese Alps; and its deficiency is quite as apparent in the pale, white, and lifeless facial integuments of the unfortunate denizens of crowded cities, as in the blanched stalks of celery in a dunghill, or the sickly white filiform shoots of potatoes in a dark cellar. These phenomena are full of wonder, no less so than any of the operations of sun-drawing on paper or collodion, and quite as inexplicable; but they have long failed to excite astonishment, from the frequency and commonness of their occurrence.

The first remark in reference to the cause of the change of color in silver salts is due to the distinguished Swedish chemist, Scheele.* He regarded the blackening effect of chloride of silver, when exposed to the rays of the sun, as caused by a species of reduction of the salt to the metallic state and the accompanying formation of hydrochloric acid. He undertook a course of experiments, to ascertain whether all the colors of the spectrum had an equal influence in coloring or blackening this salt, and arrived at the conclusion that the maximum chemical or decomposing action of the spectrum was in the neighborhood of the *violet* part, and that it gradually diminished toward the red, where it was scarcely perceptible. The researches of Scheele in this track terminated here; and no application of the property of blackening of the chloride of silver to photogenic purposes was made until after the lapse of several years.

In 1801 Ritter† not only corroborated the experiments of Scheele, but demonstrated that chloride of silver was blackened to some distance external to the spectrum, on the violet side. The scientific investigators of the time repeated the experiments without any further developments.

Dr. Wollaston‡ published a report of experiments which he made with gum-guaicum, when acted upon by the different colored rays of the spectrum. The violet rays turned paper, stained yellow by a solution of this gum in alcohol, to green, which was soon changed back to yellow by the red rays; he discovered afterward, however, that the heat of the red rays was sufficient of itself to reproduce the yellow color of the tincture of the gum.

The same results were obtained by Bérard. He experimented with half the spectrum at a time, which was condensed by a lens to a focus, and made to impinge at this point upon chloride of silver. The half next the violet, or more refrangible rays, were very efficacious in discoloring this salt of silver; whilst the other half, or red side, and least refrangible rays, although far more luminous, produced no blackening effect. The experiments of Seebeck seem to show that light transmitted through colored glass pro-

* Scheele, Charles William, was born on the nineteenth of December, 1742, at Stralsund, Sweden. He died on the twenty-first of May, 1786, at Koeping, on Lake Moeler.

† Ritter, John William, was born at Samitz, in Silesia, in 1776, and died in 1810.

‡ Wollaston, William Hyde, M.D., was born on the sixth of August, 1766, at East-Dereham, and died December twenty-second, 1828, in London.

duced the same general effect as the different colored rays of the spectrum. He furthermore ascertained that a piece of paper dipped in a rather concentrated and neutral solution of chloride of gold, in the dark, was not reduced, as long as it was kept in the dark; whereas if it had previously been exposed to the direct rays of the sun, it gradually turned purple in the dark chamber. Sir Humphry Davy observed that the oxide of lead, in a moist condition, is acted upon very differently by the red and the violet rays of the spectrum; by the latter, the puce-colored oxide is turned black—by the former, red. He ascertained, too, that hydrogen and chlorine, when exposed to the rays of the sun, frequently enter into combination so vividly as to produce an explosion in the formation of hydrochloric acid; but the two gases may be kept in contact, in the dark, without undergoing much change. A solution of chlorine in water remains unchanged, as long as it is kept out of the light; but is soon converted into hydrochloric acid, by decomposing the water, when exposed to the sun. A similar case of decomposition is effected by light, when carbonic oxide and chlorine are exposed to light; they then enter into combination chemically, condensing into a substance denominated *phosgene gas.*

The preceding remarks comprehend the sum and substance of the knowledge of the chemical effects of light previous to its application to the taking of impressions of pictures by the salts of silver or otherwise. It is true that a certain Hoffmeister published some vague remarks about the sun being an engraver, several years previous to Daguerre's publication; but they were the mere remarks of one who probably thought the thing possible without possessing the most distant idea of the mode of its effectuation. And in the report which Arago made to the Chamber of Deputies in reference to Daguerre's discovery, this distinguished philosopher mentions the name of Charles as having been in possession of a process for communicating pictures, by the aid of the sun, to prepared surfaces. No publication has been discovered to corroborate this assertion, and the details of the operation have never been disclosed.

The first recorded attempts by Wedgwood* and Davy,† to take pictures by the rays of the sun on a prepared silver

* Wedgwood, Josiah, was born at Newcastle-under-Lyne, in 1730, and died in the year 1795.

† Sir Humphry Davy was born at Penzance, in 1778, and died at Geneva, in 1828.

surface, were published in the year 1802. The receptacle of the picture was either paper or leather, or some other convenient material, stretched upon a frame, and sponged over with a solution of nitrate of silver; over this prepared surface a painting on glass was placed in direct contact and exposed to the rays of the sun. It is evident that the picture thus obtained would be inverted as to light and shade. The difficulty, which at this time could not be overcome, was the fixing of the picture; and the process was abandoned on this account. No chemical substance was known whose peculiar properties were of such a nature as to dissolve the unaltered salt of silver and leave the portions on which the image was projected untouched or uninjured. These experiments of Wedgwood were actually made several years previous to the publication in 1802; because at that date he had been dead for seven years. The surface prepared with nitrate of silver was not sensitive enough to receive an impression in the camera obscura, although Sir Humphry Davy succeeded in getting a very faint image in the solar microscope, where the picture was very much condensed in size or situated very near the focus of parallel rays. From that date to the year 1814 not only no other publication appeared, but there are no accounts of any one having prosecuted the study of sun-drawing. At this time a new laborer entered the field of investigation and directed all his mental energies to the discovery of means of making sun-pictures. From the work of Daguerre, which was published several years later, it appears that Niepce* was the *first* who obtained a permanent sun-picture; to him we are indebted for the *first idea* of a fixing material; it was he who *first employed* silver and the vapor of iodine. The process of Niepce had been so far perfected as to admit the use of the camera, which, by reason of the want of sensitiveness in the materials used, had remained a useless optical arrangement. Niepce, in his experiments, discarded the use of the silver salts, and substituted in their place a resinous substance denominated the "Bitumen of Judæa." He named his process "Heliography," or "Sun-drawing." His pictures were produced by coating a metal plate with the resinous substance above alluded to, and then exposing this plate, under a picture on glass, or in the camera, for several hours in front of the object to be copied. By this exposure to light the parts of

* Niepce, Joseph-Nicéphore, was born at Chalon-sur-Saône, and died in 1833.

the bitumen which had been acted upon by the rays underwent a change according to the actinic intensity, whereby they became *insoluble* in certain essential oils. By treatment afterward with these essences, as, for instance, the oil of lavender, the picture was developed, the *shadows* being formed by the brilliant surface of the metal exposed, by the solvent action of the essential oil in those parts of the resin on which the rays of light had not impinged; whilst the *lights* were represented by the thin film of bitumen which had become altered and insoluble in the oleaginous substance employed in fixing. Some of the specimens produced by this method at this period exist still in the British Museum; some of them are in the form of etchings, having been acted upon probably by the galvanic current. It is evident that Niepce was acquainted with a method of fixing his sun-drawings; but his successes were limited to productions which now would be regarded very trivial and unsatisfactory. After ten years' labor in the prosecution of his favorite investigation, by some accidental disclosure, Niepce became acquainted with Daguerre,* who had been experimenting independently in the same path. Daguerre's experiments with chemical processes and the camera date from the year 1824; and in 1829 these two great originators of sun-drawings entered into partnership for mutually investigating this enchanting art. In 1827 Niepce had presented an article to the Royal Society of London on this subject; but as yet Daguerre had not arrived at any successful results, nor had he published any thing in reference to them. The process of Daguerre aimed to perform the same operation by the same method, that is, by light; the materials for the sensitive surface, for developing and fixing alone, being different. In this process are found the use of the camera, iodide of silver on a metal plate, mercury as a developer, and hyposulphite of soda as a fixing agent; in that of Niepce, bitumen on a metal plate, iodine as a developer, and oil of lavender in place of the hyposulphite of soda. The use of the latter substance was probably suggested to Daguerre by the publication of a paper, by Sir John Herschel, on the solubility in this menstruum of the insoluble salts of silver. The image formed on the iodized surface was quite *latent* until brought out by the vapor of mercury. It seems wonderful how Daguerre should hit upon the idea of using this vapor, or that a latent

* Daguerre, L. J. M., was born at Cormeilles, in 1787, and died in 1851

image was on the surface. Knowing the latter and the possibility of such a development, the chemist has only to persevere in a systematic exploration among the infinite number of chemical substances, in order finally to meet with success; but Daguerre could not *à priori* be furnished with such positive knowledge; hence our admiration at his success, at the hardihood and perseverance of his character in search of this success, can not be otherwise than boundless. Niepce, too, is entitled to an equal share of honor; for without Niepce, in all probability, sun-drawing would still be a latent property of nature; as also, without Daguerre, the discoveries of Niepce would not stand out in that bold relief in which they are now exhibited.

The plates which Daguerre used for the reception of the heliographic image were of silver, or of copper plated with silver. The silver surface, highly polished, was subjected to the vapor of iodine in the dark-chamber; the iodide of silver thus formed being very sensitive to the actinic influence, the plate was ready for the reception of the latent image. This mode of sensitizing the surface had reduced the time of exposure from hours to minutes; and an increase of sensitiveness was attained at the suggestion of Fizeau, who recommended the use of bromine-water; and about the same time the chloride of iodine was recommended as an accelerator by Claudet; and the bromide of iodine by Gaudin. By means of these accelerators the time was again reduced from minutes to seconds. In this state of perfection we will now leave the art of heliography, or of the Daguerreotype as it is more frequently denominated, and observe only, in conclusion, that this discovery of Daguerre was reported to the world in January, 1839; but the process was not communicated until after a bill had been passed by the French government, which secured to Daguerre a pension of six thousand francs a year, and to Isidore Niepce, the son of Daguerre's partner, an annual pension for life of four thousand francs, one half of which was to revert to their widows.

That Mr. Fox Talbot was acquainted with the experiments of Niepce and Daguerre is very doubtful, because the result of these experiments was kept secret until the pensions had been granted; but Mr. Talbot states, in the communication which he made to the Royal Society on the thirty-first of January, 1839, six months before the publication of Daguerre's process, that he had been applying the property of discoloration of the silver salts by light to use-

ful purposes. This application consisted in preparing a sensitive paper for the copying of drawings or paintings, by direct contact. The paper was dipped, in the first place, in a solution of chloride of sodium, and afterward in one of nitrate of silver, whereby a film of *chloride of silver* was formed — a substance much more sensitive to light than the nitrate of silver, which had heretofore been employed for photographic purposes. The object to be copied, which had to be transparent, or partly so, was applied in direct contact with the sensitive paper, and exposed to the rays of the sun. By this means, a copy of the object was obtained, in which the lights and shades were inverted. This was the *negative*, which, when fixed, was superimposed on another piece of the sensitive paper, and exposed in its turn to the rays of light, whereby a *positive* print was obtained of the object, in which the lights and shades were exhibited in their natural position.

The communication of Talbot is the first, which laid the foundation of multiplying copies of a picture by the combined action of light and chemical material; it gave the *first idea* of photographic printing.

In the year 1841 another method was devised and patented, called *Talbotype* or *Calotype*. The process consisted in preparing paper with the *iodide of silver*, which, when exposed to light, became the recipient of a latent image, which afterward was made to appear by the application of a developer, and was fixed with hyposulphite of soda. This method is the essential point in the present collodion process; it is, in fact, the very foundation of photography. Talbot, therefore, merits an equal position in history with Niepce and Daguerre. These three—this much to be honored trio—are the undisputed originators of that branch of natural science which hereafter will occupy a prominent part of human intelligence.

The paper, in the Calotype process, was immersed in a solution of iodide of potassium, or floated on its surface; as soon as dry, it was floated on a solution of nitrate of silver for a certain time. By this operation, a film of iodide of silver was formed by the double decomposition of the two salts in contact. The excess of iodide of potassium, or of nitrate of silver and the nitrate of potassa were afterward removed by washing in several waters. These operations had to be performed in the dark chamber, by the aid of a small candle or lamp. When the paper was required to be used, it was brushed over with a solution of one part of

nitrate of silver, containing fifty grains to the ounce, two parts of glacial acetic acid, and three of a saturated solution of gallic acid; or the paper was floated on the surface of this *gallo-nitrate* of silver, as it is called, for a few seconds, and the excess of fluid removed by blotting-paper. By this mode of treatment, the paper was rendered very sensitive, sufficiently so to receive an impression of a living person, by means of the camera obscura. An exposure of one second, or of a fraction of a second, was found effective in producing an impression on the Calotype paper. This impression might be totally invisible, partly visible, or distinctly visible, according to the circumstances of time, intensity of the light, and sensitiveness of the prepared paper. The latent image, or partially visible image, was then developed to any degree of depth of shades, by washing the surface of the paper with one part of a solution of nitrate of silver, of the same strength as before, and four parts of the saturated solution of gallic acid. The image gradually becomes developed by this treatment, and in a few minutes reaches its maximum degree of intensity. The fixing solutions were bromide of potassium and hyposulphite of soda. The first impression, thus obtained, was in this process, as well as in that with chloride of silver, a *negative*, which, by continuing the process and using this negative as an original object, either in the camera or by direct application, produced a *positive*, with the lights and shades in their appropriate positions.

The difficulty in this process is the want of homogeneity, and of a sufficient transparency, in the structure of paper. The want of transparency probably was regarded the greatest drawback in the production of negatives; whilst the irregularities in the fiber of the paper could never yield a surface to compete with the brilliant and even surface of a polished piece of silver for the reception of positive pictures. To obviate these disadvantages, Sir John Herschel proposed the use of glass plates, and was the first to employ them.

In the year 1847 Niepce de St. Victor, the nephew of Daguerre's partner, to whom we are indebted for many interesting publications on the Chromotype, managed to fix a film of albumen on the glass plates. This film is intimately mixed with the iodides or bromides, and flowed upon the surface of the glass. Such albumen plates are employed by many very distinguished artists at the present day, who exhibit specimens of fine and sharp definition and softness of tone in their stereographs, that have not been surpassed by

any other process; as, for instance, regard those beautiful productions of Ferrier.

The next important improvement in photography was effected in 1851; it is the foundation-stone of a new era. Legray originally suggested that collodion might be used as the receptacle of the sensitive material, in place of albumen; but we are indebted to Archer for the practical application of the solution of gun-cotton, and of the mode of employment, pretty much as it now stands. Archer substituted *pyrogallic* acid for the gallic acid that had been previously used in the development of the latent image. Pyrogallic acid, although still used as a developer, has been since pushed aside, in a great measure, by another substitute, the *sulphate of the protoxide of iron*, at the suggestion of Talbot. It is now limited principally to the operation of intensifying.

Collodion is a solution of a substance very much resembling gun-cotton in ether and alcohol. A decided improvement, in many respects, has been made in this solution, at the suggestion of Sutton, the editor of the *Photographic Notes*, who recommends an excess of alcohol. When this solution is poured upon a piece of clean glass, it forms a very thin, even, and transparent film, which quickly dries, and can scarcely be distinguished from the surface of the glass beneath it. It contains the materials for sensitization. The discovery and application of this substance have given rise to what is denominated the *collodion process*. It is impossible to calculate the impetus given to photography by this discovery, or its value to society, in the promotion of comfort and happiness; much less can an idea be conceived of the resources to which it may give rise by its future developments.

In the year 1838 or 1839, Mr. Mungo Ponton pointed out a very important discovery in reference to bichromate of potassa, when acted upon by light, whereby this salt, the chromic acid, or (as Mr. Talbot advances) the organic matter with which the salt is in combination, becomes insoluble. The paper for experimenting on this point is uniformly coated with a mixture of bichromate of potassa, gelatine, and lampblack in cold distilled water, and allowed to dry in the dark room. When dry, it is ready to be placed beneath a negative. The time varies from four or five minutes to a quarter of an hour or upward. The impression obtained in this way is quite latent, and is made to appear by dissolving off, with hot water, those parts that have been entirely or partially excluded from the actinic influence of the light. The

picture resulting from this treatment is a positive print, in black and white, of which the shades are produced by the carbon of the lampblack. This discovery gave rise to carbon-printing.

In the year 1852 a patent was taken out in England by Talbot, reserving to himself the sole use of bichromate of potassa and gelatine in the production of photo-engravings on steel. Three years after this date, that is, in 1855, Poitévin patented a process for making carbon prints by means of the same materials combined with coloring matter, as well as for obtaining a photographic image on a lithographic stone, capable of being printed from by the ordinary lithographic press. In Talbot's process the steel plates were covered with a coating of bichromate of potash and gelatine, the operation taking place in the dark chamber. A transparent positive is then placed on its surface, and the plate is then exposed to the light. The latent image is developed as before alluded to. Afterward the edges of the plate are raised with wax, or some resinous preparation, so as to form a sort of dish, into which is poured the acid or etching-fluid, which etches away the parts exposed by the removal of the soluble gelatine. The etching-fluid used by Talbot was the bichloride of platinum. Poitévin's process is in principle the same. The disadvantage in the latter process arises from the want of durability in the image, which, being formed out of organic matter lying, as it must do, between the ink and the stone, is liable to be soon abraded after a few pictures have been printed from it. These attempts have created a number of improvements, by which matrixes can now be furnished, by the aid of photography, for the engraver's press, the lithographic press, and the typographic press.

Messrs. Cutting and Bradford took a patent out, in this country, for a process in which the image is formed directly of greasy ink used in lithography.

The next important step in photo-lithography is that in which the picture is first formed by bichromate of potash and gelatine on lithographic *transfer*-paper, that is, paper coated with a layer of albumen. A negative is placed in direct contact with paper so prepared, from which an image is obtained, that is, after certain other operations, transferred directly, in lithographic ink, to the stone. This process was patented in 1859, at Melbourne, in Australia, by Mr. Osborne, for which he was awarded by the government of the colony of Victoria the sum of one thousand pounds. This process

promises to be the basis of the most successful operations in photo-lithography.

Asser, of Amsterdam, invented or used the transfer process at the same time that Osborne was using it in Australia.

Colonel Sir Henry James makes use of zinc, upon which he transfers the image formed in ink; the image having been produced on engraver's tracing-paper by the means adopted by Talbot, Poitévin, and Osborne.

In the year 1859 another process for photo-lithographic purposes was patented in Vienna, in Austria, in which asphaltum is again brought into the field. The developer is oil of turpentine and water. The latent image is produced in a film consisting of a solution of asphaltum in chloroform, by means of a collodion negative exposed for a number of hours. As soon as the soluble asphaltum has been removed, the remaining insoluble parts which form the shades of the image are coated with a layer of ink by the printer; the image is then gummed in, and slightly etched; after which it is ready for the press.

Poitévin has just published a new method of direct carbon-printing on paper. It depends upon the insolubility communicated to certain organic matters, such as gum, albumen, gelatine, etc., by the per-salts of iron, and on a new fact observed by him, namely, that this matter, coagulated and rendered insoluble in cold and even in hot water, becomes soluble under the influence of light, and in contact with tartaric acid, which, by the reduction of the iron salt, restores to the organic matter its natural solubility. The paper for carbon-printing is floated in a bath of gelatine dissolved in water and colored with a sufficient quantity of lampblack, or other coloring matter, and maintained at a lukewarm temperature. The paper becomes thus uniformly covered with the colored gelatine.

The sensitizing part is performed in the dark room by plunging each sheet into a solution of sesquichloride of iron and tartaric acid in water. By this immersion the gelatine becomes quite insoluble even in boiling water. The sheets are taken out and dried. The prints are obtained by placing transparent positives in direct contact with the paper in the printing-frame. Two or three minutes' exposure to the rays of the sun will be found sufficient to render those parts through which the light has passed soluble in boiling water, which is the developer and fixing agent at the same time. A little acid water is used toward the end of the washing, in order to remove all traces of the ferruginous compound.

Poitévin has other methods of producing direct carbon-prints, which, together with this and others preceding, will be fully discussed in their proper place.

Niepce de St. Victor has long been experimenting in his favorite study of the chromotype. He has succeeded in producing photogenic impressions endowed with certain colors of the original. Yellow is found very difficult to transfer to the heliochromic plate at the same time with other colors. Red, green, and blue, it appears, could be formerly reproduced satisfactorily. In the fifth memoir of Niepce on this subject, the author states that he can now reproduce yellow along with other colors in a definite manner. The trouble with these heliochromic specimens is still their want of permanence. At the very most, the colors can not be preserved longer than two or three days. The problem to be settled is the means and mode of fixation.

CHAPTER II.

PRELIMINARY OBSERVATIONS.

The art of Photography comprehends all the operations of taking a picture on a sensitive surface by means of light and chemical reagents. These operations are as varied as the different substances on which they are taken, or by which they are taken. In all cases, whatever may be the process, the conditions required in the operation of producing a photographic image are, firstly, a suitable groundwork or receptacle, such as paper, metal, glass, or stone; secondly, a coating of substances called sensitizers, which are very sensitively affected by light and altered according to its intensity; thirdly, chemical ingredients, denominated developers, that act differently upon the parts that have been changed by light from what it does upon the parts upon which light has not acted at all or feebly; fourthly, fixing agents or chemical solvents of the sensitizing agents that have not been changed by light. Other important conditions are comprehended in the light, requiring it to be of a certain intensity, in a certain direction, and in a certain quantity.

The various sorts of matter for the reception of the photographic image have given rise to a variety of processes, whose appellations refer rather to the material employed than to any difference in the actinic principle; thus, on paper, exist a number of so-called processes, as, for instance, printing by direct contact, and printing by development; the plain-paper process, the wax-paper process, the resin process, and the albumen process. On glass are found the negative process, the positive or ambrotype process, and the transfer process. On metal the melainotype and daguerreotype processes and photo-engraving; and on stone, photolithography. In addition to these may be mentioned the card-picture process and that of the stereograph. In reference to the materials used in the sensitized photographic film, or rather to contain the sensitizing ingredients, stand

out most prominently; the Collodion processes, wet and dry, the Tannin process, and the Albumen process.

The sensitizing substances most generally used are the salts of silver in combination with organic matter. In the carbon process, as also in photo-lithography, photo-engraving, photo-zincography, and photo-glyphography, the sensitive materials are gelatinous or resinous substances in combination with certain chemical reagents that render them insoluble, and in which the solubility, in certain menstrua, is again restored by the agency of light. The salts that have hitherto been used are the bichromate of potassa and the sesqui-salts of iron; the receptacles, asphaltum and gelatine; and the solvents, hot water, oil of turpentine, and oil of lavender. The fixing agents or solvents of the undecomposed iodides, bromides, and chlorides of silver in the collodion, albumen, or surface-sensitized film, on which the rays of light have not acted, or but partially acted, are hyposulphite of soda, cyanide of potassium and sulphocyanide of ammonium. The chemical reagents that either develop the latent image or perfect that which light has already commenced, are the proto-salts of iron, ammonia, gallic and pyrogallic acid, formic acid, and, in the daguerreotype-plate, mercury. Other materials are used in addition to intensify the image already formed by the ordinary developers. The principle involved in the strengthening of negatives is, first, probably by certain electrical decompositions, to produce a deposit on the shadows formed by means of silver, mercury, lead, or iodine; and secondly, to blacken this deposit by sulphurizing or reducing agents, or by the alkalies.

The great divisions into which photographic operations may be divided are those which treat of *negatives* and *positives*. A negative is an actinic impression on glass or waxed paper, in which the lights and shadows are inverted, as also the figures and the different items that form the picture; that is, right becomes left, and left right. The negative is the matrix from which photographic prints are obtained either on paper or other material; these prints are produced either by direct contact of the paper or glass with the negative, or the negative is placed in one focus of a camera, and the paper or glass in its conjugate focus. Such prints or impressions, whether by reflected or transmitted rays, are *positives*, in which the lights and shades, as well as all the delineations, are in their true and natural position. There is another class of positives in which the shading is natural, but the delineations are inverted; these are exemplified in

the daguerreotype, ambrotype, and melainotype, which are exhibited only by reflected light.

As the present work is intended for practical men, it will be necessary at the very outset to give a list of all the articles and arrangements required in the successful pursuit of the photographic art.

LIST OF A PHOTOGRAPHIC OUTFIT.

1. Glass-house, or room in the garret furnished with a sky-light.
2. Dark room, for sensitizing plates or papers.
3. Operating room, for collodionizing plates, mounting prints, etc.
4. Screens (white, gray, blue, and artistic) for the glass-house.
5. Lenses, ($\frac{1}{4}$, $\frac{1}{3}$, $\frac{4}{4}$, etc., stereoscopic and orthoscopic.)
6. Cameras, (for portraits, views, stereographs, and for copying.)
7. Ornamental carpets, chairs, stands, curtains, pillars, balustrades, etc.
8. Head-rests, etc., camera-stands, mirrors, brushes, combs, pins, needle, and thread.
9. Washhand-stand, pitcher and basin, soap and towels, clothes-brush and nail-brush.
10. Stove, tongs, shovel, poker, coal or wood-box.
11. Antechamber, suitably furnished with lounges, etc.
12. Show-cases for artistic productions, and cases for chemicals, etc.
13. Collodion, (negative and positive,) acetic acid, nitric acid, citric acid, tartaric acid, protosulphate of iron, gallic acid, pyrogallic acid, formic acid, carbonate of soda, carbonate of lime, (chalk,) chlorinetted lime, nitrate of silver, citrate of soda, phosphate of soda, blue litmus-paper, red litmus-paper, sulphide of potassium, sulphocyanide of ammonium, ammonia, oxide of silver, iodide of potassium, iodide of ammonium, iodide of cadmium, iodine, tincture of iodine, bromide of potassium, bromide of ammonium, bromide of cadmium, bromine, nitrate of uranium, bichloride of mercury, gum-arabic, starch, gelatine, glue, shellac, chloride of gold, acetate of soda, alcohol, ether, distilled water, loaf-sugar, cyanide of potassium, hyposulphite of soda, pyroxyline, sulphuric acid, rotten-stone, tannin, sesquichloride of iron, oxalic acid, varnish, hydrochloric acid, acetate of lead, caustic potassa, salts of tartar, chloride of sodium, chloride of ammonium, bichromate of potassa, as-

phaltum, copal, chloroform, cotton, nitroglucose, mastic, resin, thus, benzoin, benzine, wax.

14. Funnels, filtering-stands, collodion-glasses, developing and fixing-glasses, porcelain or photographic-ware baths and dishes, filtering-paper, plain paper, plain-salted paper, albumen paper, arrowroot paper, tinted paper, resinized paper, wax paper, blotting paper, plate-cleaners, plate-holders, Canton flannel, cotton cloths, silk cloths, brushes, colors, pencils, scale and compasses, magnifying-glass, cases, mats, preservers, glass plates of various sizes, (transparent and ground,) melainotype-plates, black leather, black velvet, black varnish, black paper, scissors, pliers, pens, ink, paper, post-stamps, envelopes, pocket-knife, black lead-pencils, gutta-percha dishes, pails, towels, pitcher, ice-cooler, soft water, focussing-cloths, brooms, hand-brush, diamond, cutting-board for glass, shelves for negatives, drawers for mounts, papers, etc., beaker-glasses, wash-tubs, scales, weights and graduated measures, dropping-tubes, test-tubes and rack, evaporating-dishes, crucibles and furnace, tongs, coal or wood, door-mats, hat-stand, artificial paraphernalia, as stuffed birds, beasts, etc., skeletons, vases, printing-boxes, fuming-boxes, forms for cutting out stereographs, card-pictures, etc., card-board, mounts of various sizes, spatula, pestle and mortar, India-rubber, lamps, candles, frames for photographs, solar camera and its appendages, solar microscope and accessories, glue-pot, tea-kettle, changing-box for dry plates.

15. For out-door work will be required extra: a small hand-cart and tent, or dry collodion or tannin-plates, wax-paper, graduated tape, saw, hatchet, hammer and nails, negative-holder.

CHAPTER III.

SPECIALTIES IN REFERENCE TO THE ARTICLES IN THE PRECEDING CHAPTER—THE GLASS-HOUSE, ETC.

The first thing which claims the attention of the photographer, is to secure to himself suitable rooms. In many instances the artist has the privilege of superintending the construction of his glass-house or operating-rooms; in this case he must not only know what is required in such a construction, but he must know what arrangements are the most appropriate. The success of many an artist depends upon the fortuitous advantages of his glass-house; but these fortuitous advantages depend upon fixed laws and principles which the photographer must learn, if he is still ignorant of them. To be brief, contrast between light and shade is agreeable to the eye, whether tutored or untutored; whereas uniformity of light or of shade is very displeasing. It is not known why this is so any more than why harmonious combinations of notes are delightful to the ear, or why non-coincident vibrations produce discord. By means of a *happily arranged* contrast of light and shade, a stereographic roundness is communicated to pictures which, where this contrast is deficient or quite wanting, are flat and in no way satisfactory; and where the contrast is exaggerated—where the lights are very bright and the shades very deep—where the transition from one to the other is direct, and the line of demarcation between them is almost visible—the roundness becomes a complete distortion of solidity. This distortion, arising from a vulgar contrast, is sometimes so great as to cause the sitter to disclaim his own picture. The qualifications of an artist are very distinct from those of a mere operator; the former, by reason of his qualifications, can associate with gentlemen and the intelligent; the latter can aspire to no higher companionship than with the ignorant and vulgar. But the qualifications in question are attributable, in a great measure, to a thorough knowledge of

light in reference to his art, whereby *nature becomes natural.*

If an object be placed so that the light in one direction, whether brilliant or dull, falls perpendicularly upon its surface, the picture will be flat and disagreeable, because there is no contrast; if the light falls obliquely, the contrast will be displeasing according to its intensity, because the shadows will be elongated and distinctly marked from the lights. A single light, therefore, can scarcely be said to produce an artistic satisfaction.

Two *equally bright* lights, in opposite directions, or rather in directions at right angles to each other, are very objectionable, because either produces a bright circle of light in the eyes, which is repugnant to an artist's feelings, from the fact that the picture is severely flat for want of contrast.

If lights proceed from two directions, at right angles to each other, or somewhere in the neighborhood of this angle, *of which one is more brilliant than the other*, then it is possible so to arrange the sitter or model as to satisfy a cultivated taste.

The greater the brilliancy of the light, the more unmanageable it becomes in the production of that soft merging of light into shade which in photography is so much required. It is, therefore, quite objectionable to use the direct rays of the sun in taking portraits. But during the day these rays proceed from three directions of the compass—in the morning from the east, at noon from the south, and in the evening from the west; from the north alone, in the northern hemisphere, the rays never emerge. But the northern sky or space is illumined by the direct light from the sun, which, by reflection and diffusion, has parted with much of its offensive brilliancy, and is rendered soft and manageable. The direct light into the glass-house, therefore, must *enter from the north;* this is the light which performs, or is to perform, the principal part in the production of a negative. Now this single light, which enters from the northern part of the hemisphere, or a portion of it at least, may be softened down by reflection from side-screens, and so directed by them upon the sitter as to make any degree of agreeable contrast. With these principles in view, the glass-house must be constructed. If the operating-room is situated in the highest story of a house, this house ought to be at least as high as the adjoining or contiguous buildings; and the glass window on the roof must be quite unobstructed by chimneys or trees in a direction perpendicular to its surface.

Supposing the ends of the building in which it is required to construct a photographic establishment face east and west, the following arrangement is one which I would recommend: Let the southern side-wall be raised until it is as high as the ridge of the roof; in like manner fill up to the same height the triangular space in the end-wall between the chimney and the southern wall now raised, either on the eastern or western end, as it may happen to be; at a distance of fifteen feet from the end-wall raise another, equally high, and parallel with it, from the southern side to the ridge of the roof. Next construct a water-tight flat roof, beginning at the side and running toward the north about ten feet. Where this terminates, introduce the wooden frame, the southern portion inclining to the horizon toward the north at an angle of forty-five degrees, to contain the sky-light, which may be fifteen feet wide by twelve feet deep, and inclined at an angle of forty-five degrees with the horizon and facing the north; the southern part of the frame and the window, therefore, comprehend a right angle. Where it is practicable, it is well to have a window in either of the end-walls, furnished with sets of tight shutters about four feet wide, and proceeding (in direct contact, at the commencement, with the part of the sky-light nearest the north) downward to within two feet from the floor. Such side-lights can frequently be used instead of screens; and by the adjustment of the shutters, light can be admitted as required, either as regards quantity or direction, that is, from the west in the morning, and from the east in the evening. From the lowest part of the skylight downward, and right across the room, the space is boarded up about four feet deep, and then the remaining part overhead is a flat ceiling as far as the northern side of the building. The length of this room must be about thirty feet. The dark-chamber and the ordinary work-room may be constructed on the northern side, the window of one being glazed with an orange-yellow colored glass, in order to absorb the actinic rays, and the other with common crown-glass. On the outside of the side-windows, small platforms are formed for the reception of the printing-frames, where no other room can be had separately and especially for the direct-printing department. The sky-light and the side-lights have to be furnished with curtains, in order to soften or modify the light, which has access according to the circumstances of the case or the taste of the artist. The backgrounds are placed in the space beneath the flat roof, on the southern side, and so far back as to cut off, as much as pos-

sible, the direct rays upon the head of the sitter. The northern end must be papered with a grayish-colored paper —the more uniform the better—so as to keep this part as feebly lighted as possible. It is even advisable to have the part where the camera is situated entirely curtained off from the remaining space; by such an arrangement, the operator requires no focussing-cloth, and the curtains being of some material such as wool, and of a deadened color, the sitter's eyes are never strained by looking in this direction.

It happens, however, very frequently, that photographers can not direct the construction of their rooms, and that the sky-light is inserted directly into the slanting side of the roof. In this case, if the light comes from the north, the room will have a direction from east to west, the sitter being placed at either end, according to circumstances. Here only one side-light can be used; to compensate the want of a southern side-light, a screen, movable on an axis, is placed in its stead, which, receiving light either from above or the opposite side, can be made to reflect the same in the direction required.

Where the ridge of the roof of a building is directly north and south, and a sky-light has to be constructed on the slanting roof, there seems to be no alternative but to make two sky-lights, one on either side, furnished with thick curtains within, and on the outside with a tall partition between them, as also one on the southern side, to exclude the direct rays of the sun; or to construct a suite of rooms, by raising one of the side-walls of the building as nearly in accordance with the plan first proposed, with those exceptions only which the nature of the building would demand. For instance, if the building were somewhat wide, there would be only one side-window, and the facilities for printing would not be so great, unless some room could be fixed up with a southern aspect. The illumination of the background by the light from the sky-light, just described, is uniform, because the construction of the frame admits an equal quantity at the top as well as at the bottom. The ordinary mode of erecting the southern part of the frame, which supports the sky-light in a position perpendicular to the horizon, excludes much of the light, and forms a shadow on the upper part of the background, unless a contrivance of reflection overhead causes the illumination to be equally and uniformly distributed.

The screens or backgrounds for placing behind the model

are various. If the background is to be quite white, the screen must be white; if intermediate between black and white, the screen may be gray, grayish-blue, blue, and violet. A red, orange-red, yellow, and black screen will produce a dark-colored background, from the fact that light, impinging upon such surfaces, reflects scarcely any but three colors, and absorbs almost all the rest; but these colors are known by experience to be possessed of little or no actinic influence. Screens with graduated tints, shading off from one color into another, or gradually shading off from a deep to a light color, are to be highly recommended to an artistic operator. Other screens again represent landscapes, castles, shipping, city scenery, etc., in dark-colored outlines and shading, on a gray or bluish-gray foundation. Such representations are very pleasing to the uneducated taste; the true artist sometimes seems to regard them as finical. If such backgrounds are in true perspective, are correct representations of natural objects and scenery, and can be well focussed on the ground-glass, I would not hesitate to pronounce them legitimately artistic, and as such they must enhance the value of a card-picture or other photograph. On the contrary, if the productions are rude, faulty, and carelessly shaded, their images on the collodion-film will be equally so, and even more so, by distortion from the lenses, and will tend to communicate to the photograph a vulgar appearance.

On the subject of light, a few words more will suffice in this section. Place the model in a very easy and graceful manner, either standing or sitting, leaning on a pillar, balustrade, or small stand, in such a manner that every part is nearly equally in focus, but especially the hands, face, and feet, (if the latter are to be visible.) Avoid as much as possible that silly clinging to uniformity in the position of the sitter, which some operators fall into, as of laying the hands folded together on the lap, or of fixing the thumb in the armhole of the vest. Such sameness becomes a characteristic of the gallery, and renders the specimens that proceed from it ridiculous. Old and young, handsome and ugly, the grieved and the joyous, have all been invested in the same exuviæ, have all been grouped or posed amid the same accoutrements. Above all things, endeavor at least to produce a variety of position and paraphernalia in the respective members of one and the same family; otherwise, your photographs will be no better than the painting of Dr.

Goldsmith's family in the *Vicar of Wakefield*, in which is beheld an orange in the hand of each figure. As soon as the figure or group is fixed in a pleasing, an easy, and artistic position, the next and a very important business presents itself, which consists in illuminating this figure or group in such a way as to obtain a clear and distinct image on the ground-glass of the camera. If the light falls too much on the head, prevent this by means of the curtain on the sky-light; if the shadows are too strong, and apparent beneath the eyebrows, nose, or chin, correct this defect by means of the side-light or the movable screen, recollecting the first law of reflection of light, which teaches that the angle of incidence is equal to the angle of reflection, so that, if the screen be inclined to the horizon at an angle of forty-five degrees, rays that fall upon it through the sky-light will pass off from it in a direction parallel with the horizon, and in a good condition for destroying those horrid black specks of shadow wherever there exist prominences or cavities. The great art in photography is to simplify the light to the very utmost, to use if possible light from two directions alone, and only that sort of light which is endowed with actinic influence on the sensitized plates. It will frequently happen that, with the most brilliant illumination, no other but a hazy image of the model can be obtained on the ground-glass; and where this image is thus indistinct and fuzzy on the ground-glass, it is utterly impossible to obtain any better result on the film of collodion. The haziness in question is caused by a multiplicity of reflections of light, by which rays interfere, cross each other, and are jumbled together in a very irregular and heterogeneous manner, and also by the impure and unequally dense layers of air and vapor set in motion in the room, which produce an atmosphere in front of and around the sitter similar to those dazzling ascending columns of air visible at the sides and on the top of a stove. To avoid the first cause, it is recommended to glaze the sky-light with glass containing cobalt, which communicates to it a blue or violet tinge. Such glass excludes all superfluous light, allows only actinic rays to penetrate, and subdues the illumination to such a degree as to render the image on the ground-glass quite distinct and agreeable to the eye. Although the room, by such glazing, is considerably darkened, the operations in photography are incomparably superior in result, and the time of exposure is not lengthened. The second cause is obviated by preserving a uniform tempera-

ture in the room, and by having the currents of ventilation proceeding to their exit at some distance from the sitter. Let me finally impress upon every photographer the absolute necessity he is placed in of learning to *manage the light*, before he can ever hope to be successful in the subsequent operations with chemical materials. An imperfectly lighted picture can never be metamorphosed afterward into a respectable production.

CHAPTER IV.

SPECIALTIES CONTINUED.—THE CAMERA AND LENS.

The second most essential thing after a good light, and a successful illumination of the object, is a compound lens, so far corrected for spherical and chromatic aberration as to reproduce on the ground-glass an image in which straight lines are exhibited straight, and all the parts, both in the central and peripheral portions, are clearly defined and free from spectral colors. No single lens can be practically ground and polished so as to be free from spherical aberration; which means that no lens can be constructed so that, with the whole opening, the rays both through the center and all the way to the edges shall be refracted to one point. The focus of those rays which are transmitted through the lens near the periphery, is nearer to the lens than of those which pass through the center. Hence exist a multiplicity of foci, thus converting that which ought to be a point into a circular space; and that which ought to be a line, into a rectangular or curvilinear space; hence the origin of indistinctness and haziness in the photograph—the picture is devoid of sharpness and fine definition. If the optician were able to grind lenses with ellipsoidal surfaces, then a single lens might be constructed so as to be totally free from this sort of error or aberration. This, however, is manifestly a practical impossibility. The form of lens which distorts the least, that is, which has the least spherical aberration, is the one which is well known as the *crossed lens*, whose radii of curvature are in the proportion of one to six. Spherical aberration may be corrected partly by a combination of lenses and partly by the use of diaphragms, the latter of which exclude all but the central rays, or all but the peripheral rays.

Chromatic aberration arises from the difference in the refrangibilities of the colored rays in the spectrum, and the decomposition of white light into the colored or spectral light, whenever it is transmitted through a homogeneous

transparent medium whose two surfaces are not parallel. But the two surfaces of a lens are never parallel; therefore every simple and homogeneous lens must decompose light into the spectral colors of which the violet on one side is much more refrangible than the red on the other. On this account the focus of the red light will be more remote from the lens than that of the violet light. This sort of aberration, therefore, has the same tendency as spherical aberration to convert points and lines into circular, rectangular, or curvilinear spaces, with an additional inconvenience arising from the different colors, which it is well known are possessed of very different degrees of actinism. Now, when both these causes of distortion and indistinctness exist in a lens or in a combination of lenses, it is not in the power or skill of the photographer to obtain a well-defined, sharp, and actinically well-developed picture. Some sorts of glass refract light more than others; again, some decompose light into the spectral colors differently, so that the angle between the extreme rays, the red and the violet, where the refracting angle of the prism or lens is the same, but the material different, is not a fixed quantity. Combining these angular differences, the differences in the refracting powers of transparent media and the varying radii of curvature, mathematicians are now able to devise a variety of combinations of lenses which are practically free from the aberrations in question. Generally crown-glass and flint-glass are combined in accordance with the principles just alluded to. Such a combination corrects partially; it is a decided improvement over any single lens as regards fine definition; but what it gains in definition it loses in magnifying power. A triplet, or a combination of three lenses, properly constructed, is an improvement upon the doublet; and a pair of doublets whose radii and distances are mathematically and optically calculated, can be made to produce more correction than it is possible to obtain from a triplet. Three pairs, too, will effect more than two; but, unfortunately, whatever is now gained in focal sharpness is diminished in value by the absorbing power of the different lenses; so that when the combinations increase in number, the light which finally emerges, however much corrected, becomes more and more actinically weak. For photographical purposes, a pair of compound lenses can be constructed and adjusted so as to be practically perfect. We are indebted to Dolland for the first achromatic combination. Doublets and triplets are decidedly the best arrangements for land-

scape photography; whereas two pairs of doublets, adjusted at a given distance apart, or at a variable distance apart, are preferred for portraiture. The nearer the pairs of combinations approach each other, the greater the magnifying power; the maximum power existing when they are in juxtaposition. When a tube is fitted up so that one of the combinations admits of motion by a rack and pinion, its focal length can be thus changed, and is practically good within certain limits. With such tubes, too, it becomes an easy matter to adjust a pair of them for stereoscopic purposes.

The following rules and information will be found useful for ascertaining the comparative value of the different tubes in the market.

To find the Principal Focus of a Lens.—Fix the lens in a tube or aperture in the camera; then turning the camera to the moon, adjust the slide until the image on the ground-glass is perfectly in focus; measure the distance from the ground-glass to the nearest surface; then with a pair of callipers take the thickness of the lens and divide this thickness by two; now add this half to the first distance, which will be the focal distance exactly if the lens is double-convex and its radii of curvature are equal. Proceed in like manner with a compound lens; the result will be very nearly correct. Where the tube contains two pairs of combinations, a similar method may be adopted without much error. In speaking of the focal distance of a lens, or of a combination, it is customary simply to measure the space between the ground-glass and the nearest surface of the last combination, after focussing the moon or the sun.

To find the Equi-distant Conjugate Foci of a Lens or Combination.—Adjust the object, as, for instance, a card-picture, in front of the lens or combination in the camera, until the image on the ground-glass is of an exactly equal size with the object when in perfect focus. Measure the distance from the image to the object and divide this distance by two; the quotient will be the quantity required.

To find the Comparative Value of Two Lenses or Combinations which produce the same Sized Image of an Object at the same Distance.—Take the difference between the equi-distant conjugate focus and the principal focus of either lens; the smaller this difference the better the lens, because the focal depth or penetration is greater; that is, objects farther apart can be brought into focus consentaneously and with more facility when this difference is small than when it is large. If this difference were zero, a lens would be perfect.

To find the Magnifying Power of a Lens or Combination.—On a sheet of card-board, in the middle, construct a circle one inch in diameter, for instance; place this sheet on a table. Insert the lens or tube into a piece of wood placed horizontally over the circle, and raise or depress it by blocks or books until the circle is seen most distinctly when viewed with one eye. Now, by a little practice, with both eyes open, one looking through the tube and the other on the side upon the paper, marks can be made on the board at the extremities of a diameter of the magnified circle; because the eye which is free can, by sympathy, see the magnified image which the other eye beholds, and the pencil at the same time. After this, measure the distance between the pencil-marks, and divide this distance by the diameter of the real circle; the quotient will indicate the number of times the image is larger than the object, which number is the magnifying power.

To find the Comparative Magnifying Power of Lenses or Combinations.—Measure the distance in either between the lens and the ground-glass when the moon is in focus, or measure the size of the image; the greater this distance or image, the less the magnifying power. The quotient arising by dividing one distance with the other will give the amount of magnifying power in favor of the lens, whose distance is the shorter.

To find a Single Lens equivalent in Power to a Compound Lens.—If a compound lens and a single lens be placed so that their centers are at the same distance from the moon or a distant object, for instance; then, if they produce the same sized picture, one will be equivalent to the other. (For further information *vide* chapters on Microphotography and Macrophotography.)

To ascertain whether a Combination is corrected for Spherical Aberration.—Draw two parallel straight lines, exactly an inch apart, and two or three inches long, on a piece of card-board. Move the slide until they are correctly in focus on the ground-glass, and until the width between the lines is two inches. If this distance remains the same, that is, if the lines do not deviate from straight lines and from parallelism, the combination is aplanatically correct; if, on the contrary, the images of the straight lines are curves, the spherical aberration has not been corrected. Apply a diaphragm of small opening in front of the combination; it will be perceived that the curvature of the lines will diminish as the aperture diminishes. If with a very small aperture

the lines are still curved, the combination is worthless; whereas, if the lens or combination can be used without a diaphragm and still produces straight and parallel lines in the images, such a magnifier will be very valuable.

To ascertain whether a Lens or Combination is corrected for Chromatic Aberration.—Adjust the slide most accurately, so that the image of an object is very clear and distinct. Next see that the surface of the collodionized plate is exactly coincident with the ground-surface of the glass, that is to say, at the same distance from the nearest surface of the lens. Sensitize the collodion film and take a picture. If, when developed and fixed, this picture is as sharp and well-defined as it was on the ground-glass, the lens is achromatic; if, on the contrary, the contrast between light and shade is imperfect, and the definition and sharpness feeble, the combination has been either over-corrected, under-corrected, or not corrected at all. The actinic rays are on the violet side whose refrangibilities are greater than those of the red rays; their focal distance, therefore, is shorter. Focus again, and after this has been accomplished draw the slide containing the ground-glass outward about one sixteenth part of an inch, insert the sensitized plate, expose, develop, and fix, as before. If the picture is better than before, it shows that the actinic focus is longer than the luminous, and that the combination has been over-corrected. By proceeding in this way, it can be ascertained exactly how much the slide has to be drawn out in order to produce a picture as sharp as that on the ground-glass. After this distance is found, the ground-glass has to be advanced or sunk deeper in its frame by this amount, whereby the camera becomes adjusted to the tube. Should it happen that the slide has to be pushed in after focussing in order to obtain sharp definition on the collodion, it is an indication that the lens is under-corrected or not corrected at all. Where a lens requires no adjustment of the ground-glass, it is said to be achromatically correct, or that the actinic and luminous foci are coincident. The value of a lens in this respect is inversely proportionate to the amount of adjustment required; that is, the greater the amount of adjustment, the less its value.

Other methods have been proposed to test the coincidence of the actinic and luminous foci. One consists in pasting a newspaper on a flat board, and erecting the latter perpendicular to the horizon and in front of the opening of the lens, so that the axis of the lens passes through the center of the newspaper and at right angles to it. The operator next ob-

tains a sharp focus upon the central parts, and afterward obtains a positive of the object. If the central parts are still in focus in the picture, the combination has been achromatically corrected; if the parts intermediate from the center to the periphery are in focus, the lens has been over-corrected; and more so if the marginal portions alone are in focus; whereas, if the picture is nowhere sharp, it is probable the lens has not been sufficiently or not at all corrected for chromatic aberration.

A second method is to focus first in the ordinary way; then, placing a piece of violet-colored glass in front of the lens, to focus again; if the two foci coincide, the actinic and luminous foci coincide.

A third method is that proposed by Claudet, which consists in placing printed cards at short distances apart, as, for instance, of one tenth of an inch, in grooves on an inclined plane resting on a table in front of the tube. Let there be five cards so arranged, and focus upon the middle one. If the first or second is in focus, the lens is under-corrected; if the middle one is sharp, the lens is unexceptionable; and if the fourth or fifth is well defined, the combination is over-corrected.

For an over-corrected lens or combination the ground-glass has to be set back by introducing thin pieces of card-board between it and the ledge of the slide in which it rests; and where the correction has been defective, the glass has to be sunk deeper as before mentioned.

If a combination has been thoroughly corrected, I throw aside the ordinary ground-glass slide entirely, and focus upon a piece of glass of the same size as the collodionized plate, and introduced into the self-same aperture which is to contain the negative. In this way the collodion-surface and the ground-surface must necessarily coincide.

How to buy a Good Lens.—Do not purchase a second-hand tube of any one, if you are a *beginner* in the art of photography; but throw yourself implicitly and in full confidence into the hands of a photographic house of *decided reputation*, who will furnish you with a lens and camera in perfect adjustment and in working condition. The tubes manufactured in this country by two or three different firms, are not inferior to the best from abroad; and the advantage you have in dealing directly with them or their immediate agents is, that if by chance a lens turns out in any way defective, you can immediately obtain redress by an exchange. As soon as an operator is sufficiently skilled in optics and their

application to the heliographic art, he will be in a condition to rely upon his own judgment, and to make his purchases where pecuniarily they are the most advantageous. The best criterion by which to ascertain whether, after purchasing an adjusted tube and camera, the actinic and luminous foci coincide, is to take the plate-holder containing a plate of glass with the slide drawn and place it upon a table, collodion side uppermost; by the side of this place the ground-glass slide with the ground-surface uppermost. Placing a rigid flat ruler over either of these, it will be easy to measure the distance from each glass surface to the edge of the ruler. Where these two distances coincide, there has been no need of adjustment; and the lens may be regarded as good. If the difference is well marked, I would recommend you to return the tube and get a better.

Supposing, furthermore, lenses to be aplanatic and achromatic, there exist special differences by which their relative values can be distinctly estimated. The value of such instruments depends upon the extent of picture in perfect definition which can be obtained by them, with a given opening, focal distance, and diaphragm, and on the velocity with which this work can be accomplished. If of two lenses of equal opening and equal focal distance, the one will produce as sharp and large a picture without a stop as the other can with a diaphragm; the former is very much superior, because, with much more light, the operation of actinism will be relatively quicker. In like manner, if of two lenses whose three parts, as enumerated above, are all equal, but the picture of one is considerably larger than that of the other, and in every respect as well defined, the comparative value is easy to determine. Wherever this difference in the size of the picture exists, other things remaining the same, it will be found that the lens which produces the larger picture will likewise comprehend a larger angular space containing objects. Drawing imaginary lines from the two extremities of the landscape, for instance, through the center of the lens or combination, to the corresponding extremities of the picture, two isosceles triangles are formed with their vertical angle at the center. This angle or opening of the two outside rays constitutes what is denominated the *angular aperture* of the lens. The greater this angle, the other values remaining the same, the greater the practical worth of the lens. For the purposes of portraiture, the lenses in general have but a small angular aperture, and produce a picture but little more in diameter than half the focal dis-

tance. The relation between the opening of the lens, the aperture in the diaphragm, the focal distance and the diameter of the picture, as given in the *Chimie Photographique*, are as follows: Calling the focal distance unity, then the diameter of the lens will be $\frac{1}{5}$ of this unity, that of the stop $\frac{1}{40}$, and that of the picture $\frac{3}{5}$. If the diameter of the distinct picture is equal to the focal distance, the angular aperture will be about 53°; and if this angle be 90°, the diameter of the picture will be about twice as great as the focal distance. It is asserted that the new globe-tubes, the invention of C. C. Harrison, have an aperture of ninety degrees, and that they are free from spherical and chromatic aberration; they will therefore be in a condition to produce large pictures with a small focus. The only disadvantages which they probably possess will be a deficiency of light, owing to the smallness of the aperture in the stops; an inequality of action from the center to the peripheral parts; and the production of what is denominated the "ghost" on the center of the picture, owing to reflections between the lenses of the combination. For architectural and landscape photography they must be inestimable, if the assertion of their merits is true.

The firms in this country that have gained a well-earned reputation for the manufacture of portrait, etc., lenses are those of C. C. Harrison & Co., and of Holmes, Booth, and Haydens; in Great Britain, those of Ross, Dallmeyer, Grubb, etc.; in France, of Jamin, etc.; in Germany, of Voightlænder, etc.

CHAPTER V.

SPECIALTIES CONTINUED.—THE CAMERA.

THE *camera obscura* was the invention of Porta,* a Neapolitan; this instrument is, in fact, a miniature glass-house, a conjugate glass-house, which admits no light but that which passes through the lens. The ground-glass is the screen, which must be at right angles, and slide at right angles with the axis of the lens. The model, therefore, or sitter, must likewise be so arranged that the various component parts that have to appear in the picture shall be as much as possible in a plane perpendicular to the optical axis. In this case, it becomes the duty of the photographic artist, as soon as his model is gracefully and compactly arranged, to fix upon the point which is to be the center of the picture, as, for instance, the eye of the sitter, then to reconnoiter the ground, and examine the inclination of the different parts of the figure forming the visible surface, and to ascertain the direction of a line drawn from the eye at right angles to this surface; now bring the camera, raise it and incline it until the axis of the lens coincides with this previously determined direction. In this position, it will be possible to obtain a picture in which the different parts are almost equally in focus. Before you begin to obtain the focus on the ground-glass, fix the lens in its brass slide in the middle of its motion by the rack and pinion. Next move the bellows-slide of the camera until the image on the glass is distinct, and clamp the slide; finally obtain a sharp focus by means of the thumb-screw on the pinion-wheel. With a quick motion backward and forward of the lens, the point of sharpest definition can easily be descried with the naked eye, as long as the image is much smaller than the object; but in copying photographs or engravings, where the picture is to be of equal size with the original, it is not easy to obtain the exact focus; in this case the microscope is called into

* Porta, Giovanni Battiste Della, was born at Naples, in 1540.

requisition. The first thing to be done, where this difficulty exists, is to hunt about upon the original photograph or engraving for some distinct landmark, as a very minute circle, or a couple of lines in apparent juxtaposition, or the opening in the letter *e* or *o*, or the extreme lines on the sides of a blade of grass; the space between these will become very manifest under the microscope, and by a sweep of the lens backward and forward, the boundary-lines can be designated when most sharp. It requires much practice to focus well in copying; hence it is that few photographers are good copyists. The microscope suitable for such purposes may be a common magnifying-glass, the front lens of one of the stereoscopic tubes, or a compound microscope of low power. An error in the focal distance of one sixteenth of an inch, in portraiture, is scarcely perceptible; whereas the same amount of error in copying will produce a total failure in the negative or positive. In taking a view, and in copying, it is frequently a plan to be recommended, to focus a point midway between the center of the picture and the outside. This is said to equalize the definition; it is essentially a means of dividing the error of spherical or chromatic aberration, where either exists. The eye of the sitter may regard some fixed point on a level with its direction; care must be taken that it is neither raised nor depressed nor in any way strained. By looking at some point on the camera, which is situated in the darkest part of the glass-house, the eyes will be able to remain quite at ease, even whilst steadfastly gazing at this point; if, however, the sight were directed to a point brilliantly lighted, the eyelids would involuntarily close, and the pupil contract, by which the picture would be impaired.

The photography of architecture and of landscapes requires absolutely that the camera be *horizontal*, and so does that of card-pictures, when the whole figure is comprehended, in order to avoid the pyramidal inclination of parts which in nature are parallel. This pyramidal distortion is the consequence of the obliquity of the rays as they are thus made to enter the lens, and for which obliquity the lens has not been corrected. On account of the large angle which a card-picture must necessarily comprehend, a long-focussed lens is preferred, much longer than is required for taking a portrait at the same distance. It is a frequent occurrence to those who occupy themselves with out-door photography not to be able to comprehend certain very desirable elevations within the compass allotted to the photo-

graph without inclining the tube upward; but the tube must remain horizontal; therefore the only alternative remaining is to raise the camera upon a platform or to place it on a window-sill, on the roof of a house, on the branch of a tree, or on the spokes of two ladders, tied or hinged at the top, and with the feet drawn out so as to form a large base between them. Lenses with large aperture are exceedingly useful in such cases, as, for instance, in taking views of churches, public buildings, etc., from the opposite side of the street. The great desideratum has been to find a lens of short focus and large angle for such sort of work, which can not be performed with lenses of long focus and small aperture.

If the objects in the foreground of a view, as is the case with a stereograph, are to be the principal items of attention, the lens will have to be focussed either upon the central object or upon one intermediate between the center and the edge. In this case, unless the difference between the focus of parallel rays and the focus at an infinite distance be exceedingly small, almost all remote objects will be slightly out of focus, and the picture in the distant background will be defective. To counteract this effect, a much larger lens is employed, which is carried to some distance from the principal objects, until the picture be of the same size as was intended to be taken with the lens of shorter focus. The camera, too, in such a case, must be raised above the horizon, but focussed parallel to it. The scenery in close proximity can be thus excluded, and the distant view will be nearly equally well defined and in true perspective. A small view taken in this manner can be enlarged afterward either into a negative or positive, as may be required, by the method which is fully explained hereafter.

There are certain rules to be observed in field-photography in reference to the light, as in room-photography.

The first is, not to place the axis of the camera in the same straight line with the sun and the object. This means that a picture is not to be taken in the direction of the sun's rays, where the front and central objects are equally illumined, and consequently must be very flat in the photograph; it would be equally absurd to attempt a picture in the shade, whilst the sun is shining, as it were, into the camera through the lens.

An inclination of the axis of the camera with the direction of the sun's light, to the amount of forty-five degrees, will produce an agreeable contrast of light and shade. It is very possible and very probable that such an illumina-

tion from the unobscured rays will produce too strong a contrast, and thus give rise to a very hard picture. The best effects are attained when the sun is obscured by a white cloud; the lights and shades still exist with the addition of decided middle tints, giving the photograph the appearance of an artistic production.

With these recommendations in view, the photographer must visit the ground previously to his taking a picture, in order to ascertain at what time of the day the light falls upon it, or can fall upon it, so as to produce the best photographic illumination; this sort of proceeding distinguishes the artist from the operator, and gives the same distinction to his work. It may happen that the principal object in a landscape, which it is required to photograph, is so situated as not to receive the direct light of the sun, as is the case with many northern aspects. The artist, in such a case, will have to wait for a cloudy day, when the direct light of the sun can produce no real shadows, and when perhaps a white cloud in the north-east or north-west may be found to make sufficient contrast.

Cameras for lenses of short focus can be roughly adjusted to focus by means of the bellows-slide, and afterward finely adjusted with the thumb-screw on the lens; but when the focus is long, the thumb-screw is useless, unless attached to a long lever, as was formerly used in the Lucernal microscope; in such cameras, the bellows-slide has a rough or quick motion, and a slow or fine motion by means of a thumb-screw in front of the operator or on the posterior part of the slide. Such cameras, too, by reason of their length, have to be supported on two camera-stands, in order to make them rigid.

CHAPTER VI.

SPECIALTIES CONTINUED.—DARK-ROOM.

The chamber intended for all operations of sensitizing, commonly called the Dark-Room, ought to lie contiguous to and open into the common operating or work-room of the photographer; and both these rooms ought to open directly into the glass-house. As before recommended, they can be constructed on the northern aspect of the gallery, each being seven and a half feet wide—that is, half the width of the glass-room—and about ten or twelve feet long. The work-room may be that on the left, whilst the remaining chamber is on the right, with a door in the middle of the partition between them. A single pane of orange-yellow colored glass on the northern end is all that is needed; this window may be about four feet from the ground, in order that, when the operator is standing, the light whilst developing may come from below and through the negative. This mode of admitting light permits the progress of development to be distinctly watched much more effectively than by reflected light. The elevation of the pane of glass above the floor must be regulated in accordance with the stature of the operator and his habits of standing or bending during the process, so that sometimes an elevation of two or three feet above the floor of the room will be found sufficient. The size of the pane will be adequately large, if its sides are eight inches by six, and a dark-colored curtain is adjusted over this, so as to render the room almost dark in case of need. On the north, east, and south sides a shelf is constructed twelve inches wide, and three feet from the floor. In the north-west corner the pail or barrel is placed to contain water for washing the negatives; this pail or barrel is supplied with a brass stop-cock, such as is used for beer or wine; beneath the stop-cock, and on the floor, is placed the large wash-tub or sink for containing or carrying off the refuse dirty water. Beneath the north-west and the north-east corner there will be found abundance of space for the gutta-

percha developing and fixing dishes, as also for the respective solutions used in these processes, and for intensifying, as, for instance, protosulphate of iron, pyrogallic acid, cyanide of potassium, hyposulphite of soda, solution of iodine in iodide of potassium, tincture of iodine, nitrate of silver, bichloride of mercury, and sulphide of potassium. Each of these solutions must be legibly labeled, always placed in the same position, and always carefully corked. As regards the solution of the sulphide of potassium, the necessity for accurate closing of the bottle which contains it is absolute, because the fumes of hydrosulphuric acid, if allowed to escape into the room, would decompose the sensitizing-bath, and injure the prints and negatives. As soon as a negative or positive is complete, the developing and fixing solutions are poured back into their respective vials. Care must be taken here also not to interchange dishes; for the cyanide of potassium decomposes the iron-salt into what soon becomes Prussian blue by oxidation of the iron, and thus renders it a difficult task to clean the dish afterward. The first things in order on the eastern shelf are the plate-holders, leaning in their respective places against the wall; after this comes the sensitizing-bath, on an inclined frame fixed upon the shelf. The inclination may be about fifteen degrees from the perpendicular; if it were more than this, the light particles of the undissolved iodide of silver, and of other insoluble substances, would be apt to settle upon the tender surface of the collodion, and give rise to apertures in the negative. To avoid this calamity of photographers, it is preferable to have some arrangement by which the collodionized plate can be introduced into the sensitizing-bath with its collodion surface downward. For this purpose flat dishes are used with a glass or porcelain ledge on the right side to support one end of the plate, whilst the other end rests on the bottom of the dish on the left side. In this way the left end of the collodionized plate is introduced first into the bath, whilst the right end is gradually and quickly lowered, by means of a silver or glass hook, until it comes in contact with the elevated ledge which is to support it. The plate is to be completely covered with the nitrate of silver when thus lowered upon its support, which need not be more than a quarter of an inch above the bottom of the dish. Naturally, when the plate is in this position, the collodion is nowhere in contact with the vessel which contains it, excepting at the upper and lower edges. By making the above-mentioned ledge still more shallow, a very small quantity of the silver solu-

tion will suffice to cover the plate, and the solution can be filtered, if necessary, after each operation; whereby there can be but small risk of any damage from the deposition of particles of undissolved matter upon the film of collodion. In this country, the vertical or slightly inclined sensitizing-baths are preferred, and consequently in most general use; in France and Germany, the horizontal baths are frequently to be met with, and are certainly to be recommended in order to avoid the trouble above alluded to.

To the right of the silver-bath for collodion-plates is the appropriate place of the horizontal dish to contain the sensitizing solution for the chloridized paper. This dish will have a capacity to meet the requisitions of the establishment, and may contain a whole sheet, a half-sheet, or even less, as the case may be. On a small shelf two feet above this dish are placed, in separate bottles, the plain silver and the ammonio-nitrate of silver solutions, a small filtering-stand and funnel, ammonia, alcohol, and distilled water; and running from the dish to the southern side is constructed an inclined plane with a semicircular groove covered or lined with plates of glass or porcelain, each one overlapping its fellow like tiles. The first one just projects over the edge of the dish. This grooved inclined plane is screwed to the eastern side of the room, and being thus tiled, is situated in the right position for receiving the droppings of nitrate of silver from the sensitized sheets when removed from the dish, and attached by pins through an upper angle to a soft wooden slip immediately above. The first sheet that is taken from the bath is fixed at the most distant point, and so that the lowest angle is just in contact with the uppermost inclined glass tile; the next is pinned close to it, until the row is complete. If the lower corners or angles of the silvered paper touch the glass, the superfluous fluid will easily flow off and down the inclined plane into the dish; if the corners curl up, it will then be necessary, with a small pad of cotton-wool or a glass rod, to remove the accumulated solution, by bringing the corner in contact with the grooved channel. By this arrangement the photographer is able to economize his time and his solution. As soon as one row is thus filled with sensitized papers, those first pinned up will probably be sufficiently dry for removal to another slip situated on the southern side of the dark-chamber, thus making room for a fresh quantity of papers.

The semicircular grooves of glass can be manufactured as follows: Take, for instance, a piece of iron plate about fif-

teen inches long and two inches wide, and get it hammered longitudinally into a hollow groove; next cut up slips of glass of the same length, and about an inch and a half wide. Place one of these slips of glass in the iron channel so that it lies uniformly in the middle. Now heat the iron carefully red-hot, when it will be found that the glass will soften, sink, and assume the shape of the mould. When this has succeeded, allow the iron to cool gradually, in order that the glass may be properly annealed. By arranging these cylindrical glasses so that they overlap each other about half an inch, in the form of tiles, there is no need of applying cement.

WORK-ROOM.

The collodion can be kept on a small shelf in the dark-room, close by the door, in a very convenient place to seize when occasion requires. With this convenience, the plates are flowed in the doorway between the two rooms. At the north end of the work-room there is a good, large window, with the lower part about two feet from the floor, flush with the upper part of a shelf or table constructed right across, from side to side. On the sides of the window-frame, on nails or hooks, hang the various-sized mats for cutting albumen, etc., papers or photographs, as well as the different-sized plate-holders, diaphragms, pliers, scissors, diamonds, rulers, brushes, pencils, etc., used in mounting, printing, etc. On the left side of the table, on small shelves, are kept acetic acid, nitric acid, hydrochloric acid, sulphuric acid, protosulphate of iron in crystals, distilled or rain-water, citric acid, pyrogallic acid, alcohol, pestle and mortar, stirring-rods of glass, weights and scales, graduated measure for drachms and ounces, another for minims and drachms, cyanide of potassium, hyposulphite of soda, gun-cotton, iodide and bromide of cadmium, iodide and bromide of ammonium, nitrate of silver, ammonia, chloride of ammonium, gum-arabic, gelatine, solution of gum-arabic, etc., brush, spatula, and burnishing-tool, carbonate of lime, chlorinetted lime, acetate of soda, phosphate of soda, iodine, iodide of potassium, bromide of potassium, bichromate of potassa, and other chemical materials for experimentation. The preceding articles have to be arranged on narrow shelves in the order in which they can be most conveniently laid hold of, according to their respective merits as necessary or accessory ingredients. On the right side of the window arrange the various-sized glasses, already cut, bath for negatives and

positives, the patent plate-holder or vice for cleaning glass plates, rotten-stone, alcohol, solution of salts of tartar, dilute solution of nitric acid, cotton or linen rags, patches of Canton-flannel, silk cloths, broad camel-hair pencil for dusting off particles or fibers from the polished glasses, triangular file, alcohol-lamp, shell-lac for mending the glass-corners, box of pins, box of tacks, small hammer, large and thick glass plate for cutting out photographs, etc., scale and compasses, vignette-glasses, the different-sized printing-frames, varnish, mats, preservers, cases, transfer-liquid, leather, black paper or velvet, etc., mounts of various sizes.

The sides of this room are furnished with wooden strips to which photographs can be attached by pins in order to dry them after fixation and washing. The toning and fixing dishes are situated on the shelf on the west side; as are also the chloride of gold, test-paper, nitrate of uranium, acetate and phosphate of soda, rain-water, alcohol, and hyposulphite of soda. Beneath the shelf place the tubs for washing prints. In drawers preserve the different sorts of paper in use. Have one drawer for dry but uncut positives, one for the cut positives, one for uncut stereographs, one for the right stereographs and one for the left, one for card-pictures not cut, and one for the prepared card-pictures. One writing-desk near the door and between the door and the window, for containing the day-book, etc. Photographic stock can be stored away on shelves on the southern end and on the sides of this room. Both these rooms are to be supplied with stoves or other means of warmth and ventilation. On the entrance-door affix the sign forbidding all intrusion. Keep all visitors in the antechamber, which must be made comfortable, and somewhat artistically furnished for their reception. The photographer can not perform his duties with ease if crowded with inquisitive, meddling, and talking parties; the lenses do not operate well if the air is saturated with vapor, and the health is impaired in the midst of the mixed effluvia arising from degenerate lungs.

CHAPTER VII.

COLLODION.

In 1851 Legray first suggested the application of collodion for the receptacle of the photographic picture; and in the same year Messrs. Archer and Fry published a detailed account of the practical mode of its application. Collodion is a solution of gun-cotton in ether and alcohol; and gun-cotton, of which there are several varieties, is cotton or linen fiber (that is, cellulose or lignine) altered by combination with peroxide of nitrogen and probably with nitric acid. Cotton consists chemically of carbon, hydrogen, and oxygen; whilst gun-cotton contains an additional element, namely, nitrogen, which communicates explosive tendencies to several of the metalloids. The altered cotton employed for photographic purposes is not the same as gun-cotton proper; in the first place it is not so explosive; it is, secondly, almost perfectly soluble in alcohol and ether, which is not the case with gun-cotton. It is denominated *pyroxyline*. Pyroxyline is soluble also in acetic ether. When this soluble cotton is dissolved in a mixture of ether and alcohol, and afterward poured upon a piece of glass, it leaves on evaporation, when of a normal condition, a transparent film; whereas gun-cotton so dissolved, or *xyloidine*, (another form of altered cotton,) leaves an opaque film after evaporation.

Cotton or ligneous fiber is transformed into pyroxyline by immersing it in a mixture of nitric acid and sulphuric acid; the latter seems necessary only to concentrate the nitric acid; for neither sulphur nor any of its oxides are found in pyroxyline by analysis. This, although the accepted theory, is not satisfactory, because it is found necessary to add water to certain specimens of nitro-sulphuric acid. Another reason for the use of sulphuric acid arises from the fact that pyroxyline is soluble into a gelatinous form in nitric acid, but not in the mixture of nitric and sulphuric acids. Gun-cotton may be precipitated from its ethereal and alcoholic solution into a fibrinous mass like the original, almost. This curious

fact exhibits quite an analogy between solutions of salts and the mineral kingdom, and the gelatinous solutions in the organic kingdom. In the former the precipitate is either amorphous or crystalline, as in chloride of silver and carbozotate of potassa; whilst in organic solutions the precipitated ultimate atoms seem to exist, even in solution, in the form of fiber. This peculiar fibrinous deposit is thrown down by adding water to the mixed ethereal and alcoholic solution of pyroxyline, because this substance is insoluble in water. For this reason the necessity of using only concentrated ether and alcohol is apparent; another deduction is equally apparent from this circumstance, which consists in the employment of such iodizing materials in the preparation of sensitive collodion, as are soluble in ether and alcohol, and in discarding those which are soluble principally in water, or only partially in ether and alcohol. Collodion containing a small proportion of water is thick and flows unevenly, and when dry is not quite transparent; whilst the film from anhydrous collodion is very thin, transparent, and uniform, and flows on the surface of glass very easily.

Preparation of Pyroxyline.—For this purpose the finest cotton or the best Swedish filtering-paper, or old white cotton rags are procured. These materials, especially the first, are not quite pure; a sort of resinous cement adheres with great tenacity to its fibers, and must first be dissolved before the cotton is fit for transformation into pyroxyline. The cotton is therefore boiled in a solution of carbonate of potassa in the following proportion: take one hundred parts of rain-water, two parts of cotton, and one of carbonate of potassa. These materials are maintained at a boiling temperature for a few hours, after which the cotton is taken out and thoroughly washed in several waters, and then left in clean rain-water for at least twenty-four hours, stirring the same from time to time, until every trace of the alkali is removed. It is then taken out, pressed, and dried in thin layers spread upon clean sheets of paper in the sun or on a steam-bath. Care must be taken that all moisture be entirely expelled. In this condition it is ready for the action of nitric acid. Certain rules have to be minutely observed in regard to the temperature of the nitric acid, the quantity of water which it contains, the length of time of immersion, and the intimate mixture of the ingredients; for as these conditions vary so will the pyroxyline. If, for instance, the acids are too strong, or the temperature too low, the pyroxyline will be much heavier than the weight of the cotton used, without

apparently having undergone any other outward change. Such gun-cotton will produce a thick and gelatinous collo dion, giving rise to streaks in the film. If, on the contrary, the resulting pyroxyline is less in weight than the cotton introduced, or about equal to it, this indicates that the acids are too weak or the temperature too high, whereby a portion of the pyroxyline is dissolved. Such a species of gun-cotton is not wholly soluble in a mixture of ether and alcohol; it yields, however, a collodion which flows easily over the plate, is very adhesive to the glass, and yields a soft negative. Any little particles of dust that may fall on the plate are liable to produce with this collodion transparent specks on the positive or negative. The rule, therefore, on the whole is to steer between these two results, in order to obtain a pyroxyline in which the cotton fiber shows an incipient gelatinization in the acids. When the operation is successful, the weight of the dry pyroxyline will be somewhere about twenty-five per cent heavier than the cotton from which it was formed.

No. 1. *Formula for the Preparation of Pyroxyline.*

Commercial sulphuric acid, spec. grav., 1.843 at 60 Fahr.,	24 fluid ounces.
Commercial nitric acid, " " 1.457 " " "	8 " "
Water,	7 " "
Cotton,	1 ounce.

The vessels used in the preparation of pyroxyline may be large porcelain or glass evaporating-dishes, sitting closely in the cover of a water-bath, maintained at a temperature of 150° Fahrenheit. Each dish is furnished with a pane of glass, fitting upon it as a lid or cover. Let the water-bath be first raised to the indicated temperature; then pour the sulphuric acid into one of the dishes, add to this the water, and mix intimately by stirring with a glass rod with a rounded end; finally pour in the nitric acid, and perform the same operation to insure an intimate mixture. The temperature of this mixture will rise from 15 to 20 degrees above the point required. Remove the dish, therefore, from the bath until the temperature falls to 150°. The temperature can be lowered by stirring the mixture with cold stirring-rods or spatulas of porcelain or glass. Whilst the acids are cooling the cotton can be divided into about a dozen lots, and each lot must be gently separated into a loose condition. As soon as the proper temperature has been attained, the dish is reinstated in its position in the water-bath, and the cotton is introduced one lot at a time, so that each is carefully

pressed down beneath the surface by the glass rod. As soon as all the cotton has been introduced and completely covered by the acid mixture, the lid is placed on the dish for six or eight minutes.

The thermometer used on such occasions for ascertaining the temperature of the water or mixed acids, must be strongly made, so that the bulb can be moved about in the fluid with some degree of briskness without any liability to break; it is furnished with a hinged back, which allows the lower portion to be reflected on itself, and the bulb and the lower part of the stem to be exposed. Such thermometers are manufactured for the chemist, and can be purchased at the photographic establishments.

The acids are now poured into another dish close by, allowing the largest portion to drain off, and preventing the cotton from falling out at the same time by the cover which is retained in its place. The dish containing the pyroxyline is then quickly immersed in a large tub of water, and the cotton is well stirred about so as to part with the largest portion of its acidity; it is then taken out with a pair of glass rods and plunged into fresh water in another tub, and again thoroughly washed. After this operation the pyroxyline is placed in a wooden chamber through which a current of water is kept running for twenty-four hours or more, or at least until every trace of acidity has been removed. During this time the agglutinated or adherent portions are carefully separated, so that the stream of water can more easily act upon each fiber. When blue litmus paper is no longer turned red by the water as it proceeds from the cotton, the latter is taken out, again carefully separated and placed in thin patches on sheets of paper in the sun to dry; or it may be dried on zinc plates, being part of a hot-water bath, whose temperature is maintained at about 120° Fahrenheit. At this temperature pyroxyline will not explode. In the hot days of summer, however, it can be dried quite efficaciously when placed out in the sun.

Pyroxyline, when exposed to the air, absorbs moisture; it undergoes decomposition, too, in an air-tight vessel, if light reaches it; the products of decomposition being nitric acid, peroxide of nitrogen, and probably other compounds. It has not yet been thoroughly ascertained by what means it can be preserved in a normal condition permanently; absence of moisture and of light have been found to assist in this preservation.

If a specimen of pyroxyline by keeping manifests an acid reaction, it is advisable to wash the cotton in several waters, as before, and again to dry it. To neutralize the cotton by an alkali, or a carbonated alkali, is scarcely to be recommended, because they both have a tendency to decompose it; and especially if any trace of these should be left in the fiber, decomposition is likely to ensue in the drying.

No. 2. *Formula for the Preparation of Pyroxyline.*

	By Weight.
Commercial sulphuric acid, spec. grav., 1.843, at 60° Fahr.,	18 ounces,
Commercial nitric acid, " " 1.43, " " "	14 "
Cotton,	2 "

Proceed with these ingredients in all other respects as with those in Formula No. 1.

No. 3. *Formula for the Preparation of Pyroxyline.*

Commercial sulphuric acid,	40 ounces,
Pure nitrate of potassa,	20 "
Cotton,	1 ounce.

As soon as the mixture of acid and nitre has been thoroughly mixed, and almost cool, the cotton is introduced in small portions and well stirred. In about a quarter of an hour the whole mixture is thrown into a large tub full of water; in this way the pyroxyline is freed as much as possible from the acid; after this it is washed in warm water, and finally in a running stream, as in Formula No. 1.

No. 4. *Formula for the Preparation of Pyroxyline.*

Disdéri's Pyroxyline.

Sulphuric acid,	4000 grains.
Pulverized pure nitrate of potassa,	2000 "

Place these in a glass vessel provided with a close-fitting cover, and stir them intimately together with a glass rod. Next add 150 grains of fine cotton-wool, in small flocks at a time, and immerse them thoroughly with the glass rod. When all the cotton has been introduced, close the vessel and set it aside for ten or fifteen minutes. After this, the pyroxyline is withdrawn by means of a pair of glass rods, and well washed, as before recommended, and dried.

In all these formulas the acids, when once used, can not be employed a second time; by distillation, the nitric acid

that has not been decomposed might be obtained and used over again, if other combinations and decompositions did not result from the application of so high a temperature. In general the mixture is regarded as useless, and thrown away.

CHAPTER VIII.

ETHER AND ALCOHOL.

The next ingredients employed in the manufacture of plain or normal collodion are alcohol and ether. Both these substances belong to a group of hydrocarbons whose basic compound radical, although hypothetical, is denominated *ethyle*, consisting of four equivalents of carbon combined with five of hydrogen, and represented in symbols by $C_4 H_5$. Ether is the oxide of this base, and alcohol the hydrated oxide; that is, chemically regarded, the only difference between ether and alcohol is, that the latter contains one equivalent of water, constitutionally combined, which is wanting in ether. The hypothetical compound base, ethyle, enters into combination with several of the alkaloids and acids, giving rise to distinct chemical combinations. This fact will lead us to seek a clue for various untoward and, as yet, unaccountable phenomena in the constitution of sensitized collodion, and its frequent want of permanency.

Ethyle Group.

Ethyle, *Symbol Ae*,.....$C_4 H_5$.	Cyanide of ethyle,.....Ae Cy.
Oxide of ethyle, (ether,) ....Ae O.	Nitrate of the oxide of ethyle,..Ae O, NO_5.
Hydrated oxide of ethyle, (alcohol,).Ae O, HO.	Nitrite of the oxide of ethyle,..Ae O, NO_3.
Bromide of ethyle,.....Ae Br.	Oxalate of the oxide of ethyle,..Ae O, $C_2 O_3$.
Chloride of ethyle,.....Ae Cl.	Hydride of ethyle,.....Ae H.
Iodide of ethyle,.....Ae I.	Zinc ethyle, ...Ae Zn, etc.

Some of the compounds of the ethyle series are crystallizable salts; but the most of them are volatile aromatic fluids, denominated *ethers*.

Although an equivalent of water is the only difference between alcohol and ether, yet no direct means have yet been discovered whereby an atom of water can be so combined with ether as to form alcohol, nor abstracted from alcohol constitutionally so as to leave ether. It is supposed, therefore, that the elements that enter into the formation of ether, and water and ether, owe their difference to a difference in the grouping of the elementary atoms.

ETHER.

Ether, sometimes denominated, but very wrongly, sulphuric ether, is obtained by decomposing alcohol by means of sulphuric acid. One method consists in the distillation of equal weights of rectified alcohol (spec. grav. .835) and sulphuric acid. As soon as ebullition commences, a colorless and highly volatile liquid passes over and is condensed into a receiver surrounded with ice or snow. This method is far from being a profitable one; for at a temperature below 260° Fahr. alcohol distils over; and, if the heat be greater than 310°, another of the numerous hydrocarbons, olefiant gas, is generated, together with other gaseous and liquid bodies. By a second method the sulphuric acid is maintained at a temperature of about 300° Fahr., and a stream of alcohol is made to enter the acid gradually. In this way a large quantity of alcohol becomes converted into ether. There are two stages in the preparation of ether; by one an impure and crude ether is the result; by the latter the ether is rectified. The minutiæ are as follows:

Take of alcohol *four pints;* sulphuric acid, *one pint;* potassa, *six drachms;* distilled water, *three fluid ounces.* Add gradually fourteen fluid ounces of the acid to two pints of the alcohol in a tubulated retort, and shake frequently in order to produce an intimate mixture. Connect the retort when placed on a sand-bath with a proper condensing apparatus, furnished with a long connecting-tube, so as to remove the vapors, if any should escape, as far as possible from the flame. Explosions are very apt to take place in the preparation of ether, unless great caution be taken. The temperature is now raised quickly until ebullition commences. As soon as half a pint of ether has distilled over, the remainder of the alcohol previously mixed with two fluid ounces of the acid is allowed to enter gradually through the tubulated aperture by means of a tube dipping beneath the mixture in the retort, and in quantity as near as can be equal to that which distills over. In this way continue the distillation until about three pints have passed over into the condenser.

The product thus obtained contains *sulphurous acid*, *sulphuric acid*, *sulphovinic acid*, and other impurities. By rectification most of these are removed as follows:

Add to the ethereal contents in the condenser the solution of the potassa in the distilled water, and shake them frequently during the twenty-four hours they are kept together

in a stoppered bottle. After subsidence separate the supernatant ethereal solution by means of a syringe, and distill off two pints of this solution at a low and gentle heat. The specific gravity at this stage will be about .750. By further rectification over newly burnt quicklime and chloride of calcium, ether may be obtained of a specific gravity of .720, or even lower. When perfectly pure its specific gravity is .713, and it boils at 95°. The sulphuric ether of commerce is not sufficiently concentrated for photographic purposes; and none can be relied upon excepting that which is obtained direct from establishments that prepare chemical ingredients for the photographer. When the specific gravity is .720, ether boils at 98°; this is the kind which is generally used in the preparation of collodion. When too long kept it undergoes decomposition, being converted partially into acetic acid. It is a very important solvent of oils, resins, and alkaloids, and certain metalloids, as iodine, bromine, sulphur, and phosphorus. It does not dissolve potassa and soda, a very distinct characteristic from alcohol. It unites in all proportions with alcohol and with one tenth its volume of water. The impurities, as before mentioned, are acids, alcohol, water, and oil of wine. The presence of acids are shown by litmus; alcohol combines with water when added in excess, and settles and forms the lower stratum; by decantation the upper stratum is removed, which now contains one tenth its weight of water; water is removed by distillation from fresh chloride of calcium; the acids by distillation from lime or potassa; the oil of wine is shown by the production of a milkiness when mixed with water.

ALCOHOL.

Alcohol is the rectified spirit of wine of the specific gravity of 0.835, containing eighty-five parts of anhydrous alcohol and fifteen of water. When pure and anhydrous it is the hydrated oxide of ethyle, (Ae O, HO.) It contains six equivalents of hydrogen, four of carbon, and two of oxygen= $H_6 C_4 O_2$. All saccharine substances undergoing vinous fermentation give rise to the vapors of alcohol, which by distillation are obtained in a separate and more concentrated form. By the vinous fermentation sugar is converted wholly into alcohol and carbonic acid; and it is only from sugar, or substances which by chemical processes are converted into sugar, that the vinous exhalation can be obtained. The ordinary alcohol of commerce is not sufficiently concentrated

for the purposes of the photographer, because the water which it contains would precipitate a solution of pyroxyline, or produce an opaque solution. Like ether, therefore, it has to undergo a process of concentration. Whisky is the spirit from which the first alcohol is obtained, which contains water, a peculiar oil, and extractive matter. By distilling a hundred gallons of whisky, between fifty and sixty gallons of alcohol are received in the condenser of a specific gravity of 0.835. By a second distillation, taking care to collect only the first portions and cautiously managing the heat, so as not to allow it to rise to the temperature of boiling water, alcohol may be obtained of a specific gravity of 0.825, which is the lightest spirit that can be received by ordinary distillation. At this stage it contains eleven per cent of water and some small portions of fusel oil.

The process by which most of the remaining water is separated from the alcohol is as follows:

Take *one gallon* of the alcohol of commerce; chloride of calcium, (freshly made,) *one pound*. Throw the chloride into the alcohol and, as soon as it is dissolved, distill off seven pints and five fluid ounces. Or, take of rectified spirit *one pint*, (imp. meas.;) lime, *eighteen ounces*. Break the lime into small fragments, mix with the alcohol in a retort properly connected, and expose the mixture to a gentle heat until the lime begins to slake; then withdraw the heat until the slaking is finished. Now raise the heat gently and distill off seventeen fluid ounces. Alcohol thus obtained will have a density, when the operation is carefully managed, of 0.796.

Neither of the preceding fluids, taken separately, dissolves pyroxyline, a mixture of the two is required to perform this operation; the proportion in which they exist in this mixture, in order to attain to the maximum degree of photographic excellence, is a problem which has not yet been absolutely solved. When there is a large excess of ether over the alcohol, the former menstruum will easily dissolve from one to one and a half per cent of the prepared cotton; and this proportion will scarcely exceed, under the most favorable conditions, from two to three per cent without producing a precipitate in the solution. On the contrary, if the alcohol, in its purest state, exists in the mixture in greater quantity than the ether, three per cent of pyroxyline is easily dissolved, producing a collodion of the proper consistency; the mixture, however, will dissolve

from eight to ten per cent without producing any deposit in the collodion.

The property of ether in collodion is to communicate tenacity to the film, which, owing to the excess of this fluid, frequently peels off from the glass in one adherent sheet; beside this, ether is more liable to decomposition than alcohol, and is perhaps one of the causes of the want of permanency in collodion, although most probably pyroxyline is the principal cause. This want of stability, even in *normal* collodion, is increased by the quantity of air contained in the same vessels, giving rise to an ethereal effluvia which it did not possess before. This decomposition is much more rapid when the collodion is exposed to light.

Decomposition of Collodion.—The decomposition of normal or plain collodion is a fact that can easily be verified; but experience shows also that the iodides and bromides when dissolved in pure alcohol and ether are not decomposed, or at any event in a very trifling degree, when properly protected in accurately closed bottles; the fluid does not change color materially, nor does it show the presence either of free iodine or bromine; furthermore the solutions in question, when kept for any length of time, produce the same sensitive effects on plain collodion as if they were freshly made. The decomposition in collodion does not seem, therefore, to be superinduced by ether, alcohol, the iodides, or the bromides; for each, taken separately or in combination, when pure and properly protected, is not liable to any perceptible decomposition. But Van Monckhoven maintains, and all photographers are aware of the fact, that there is a very perceptible difference between freshly-made plain collodion and old plain collodion. The difference is this: if a plate be coated in newly-made plain collodion and then immersed in a solution of nitrate of silver and exposed before an object, and afterward submitted to the action of the developing fluid, no traces of the picture will appear; on the contrary, if the plain collodion be old, and a plate be treated with this as in the preceding case, the film will be whitened by the sensitizing solution, and will be sensitive to the action of light when exposed before an object, and will yield a picture. A second difference is this: the collodion, before thick and consistent, becomes thinner and exhales an odor of nitric ether as it grows older.

Such being the case, it seems evident that the pyroxyline is the cause of the decomposition, or that the pyroxyline

contains sometimes extraneous matter that produces this decomposition; and when the change has once set in, the newly formed bodies may react upon the iodides or bromides when introduced, and tend to produce a variety of decompositions according to the facility or difficulty with which they undergo change.

But the next question is: What are the differences between freshly-made iodized collodion and an iodized collodion that has been kept long? They are as follows:

Firstly. New collodion is more sensitive to light than old collodion.

Secondly. Although more sensitive, it produces images which are much less intense than those produced by old collodion, that is, the shadows are not so deep or black. The images are mere surface-pictures when developed with the sulphate of the protoxide of iron.

Thirdly. If the plates be washed after sensitizing, (in the dry process,) when *freshly-made* collodion is used, no image will appear; on the contrary, with *old* collodion the washing does not prevent the picture from appearing.

Fourthly. The shadows of the picture developed by the protosulphate of iron are *entirely soluble* in nitric acid when a *freshly-made* collodion is used; and are *not* entirely soluble with an *old* collodion.

Fifthly. New collodion is colorless, or nearly so; whereas old collodion sometimes is as deeply red as a strong solution of burnt sugar.

Sixthly. New collodion has the odor only of alcohol and ether; but old collodion has a peculiar ethereal smell resembling that of nitric ether and aldehyde.

We are indebted to Van Monckhoven for the summation of these differences in juxtaposition, and many photographers will recognize the truth of them.

The third question to be asked is then the following: What substance in solution will communicate to recently prepared iodized collodion the properties of old collodion? Hardwich says that grape-sugar, glycyrrhizine, and nitroglucose will render fresh collodion much more intense, but that they diminish its sensitiveness. Such is also the action of the substance, be it what it may, contained in altered collodion, it renders collodion more intense but less sensitive.

Furthermore Hardwich remarks, that, if these substances be employed to increase the intensity of the shadows in the

image, they ought to be added cautiously because they deteriorate from the keeping properties. But nitro-glucose is said to be an impurity in pyroxyline; it is analogous in several respects to pyroxyline; and it is prepared with sulphuric acid, nitric acid, and *sugar;* but ligniue or cellulose yields sugar when treated with sulphuric or nitric acid; hence in the preparation of pyroxyline grape-sugar is formed at the same time, and by the further action of the acids, *nitro-glucose* is produced. That there exists a duplex compound in collodion may be shown by adding water to it; a precipitate will be formed, of which one part is fibrous and the other gelatinous.

But the identity between the unknown substance and nitro-glucose is apparently shown by the identity of properties. If nitro-glucose be dissolved in alcohol, it forms a colorless solution with an odor of alcohol, which has *no effect* at this stage on collodion, nor on an alcoholic solution of nitrate of silver; but, after the expiration of a few days, it assumes a *rose-colored* tinge and the odor peculiar to old collodion; furthermore, at this second stage, it now communicates to fresh collodion all the properties of old collodion, and forms a precipitate in nitrate of silver in alcohol. Van Monckhoven in addition has convinced himself that the precipitate formed in old collodion by an alcoholic solution of nitrate of silver is six times as bulky as that which would be the result from the iodide of silver, and that its properties were the same as those in the precipitate formed by mixing the rose-colored nitro-glucose with alcoholic nitrate of silver.

Preparation of Glycyrrhizine.—This substance is obtained by boiling liquorice-root in water for some time, and adding sulphuric acid to the concentrated syrup. A white precipitate is formed, containing glycyrrhizine, albumen and sulphuric acid. The albumen is removed by washing the precipitate, first in acid-water, then in water, and afterward by solution in alcohol. Carbonate of potash is then added to decompose the alcoholic solution, and to precipitate the sulphuric acid. By evaporating the liquid, glycyrrhizine remains as a yellow, transparent mass.

Preparation of Nitro-glucose.—Add one ounce of powdered sugar to a mixture of two fluid ounces of sulphuric acid, one of nitric acid. Stir the mixture for a few minutes with a glass rod; a tenacious mass may thus be collected from the fluid, and washed in warm water by kneading it until every trace of acid is removed.

Collodion iodized with the ammonium salt is the least stable; whilst a cadmium collodion is the most permanent. Collodion in which the alcohol is in larger abundance than the ether is more stable, and at the same time more fluid; it adheres well to the glass, forms no ridges in flowing, and is in fact quite structureless.

CHAPTER IX.

COLLODION SENSITIZERS — IODIDES AND BROMIDES.

The salts employed for sensitizing plain collodion for the reception of the actinic impression, are the iodides and bromides of different metals, as of potassium, sodium, ammonium, lithium, zinc, iron, calcium, cadmium, etc.

Iodides and bromides, which are soluble in ether and alcohol, can alone be employed in the preparation of sensitized collodion, in order to produce, by decomposition in and on the film, an iodide and a bromide of silver, which are insoluble. In so extensive a choice of materials it is a difficult matter to collect all the advantages of a given iodide or bromide over its neighbors; so that it has not yet been decided which is the most appropriate iodide or bromide.

If each soluble iodide or bromide were equally applicable in a photographic sense, then the choice would be influenced by pecuniary considerations of cost and the quantities required; and if by weight the iodides and bromides were equal in price, the selection would fall upon that iodide and bromide whose chemical equivalent is the least; for the less the combining proportion of a given chemical substance, the less the quantity required to produce a given effect. Guided by this consideration of the subject, the iodide and bromide of lithium would claim our first attention; after lithium come magnesium, ammonium, calcium, sodium, iron, zinc, potassium, cadmium, etc. The solubility of the respective iodides and bromides in a mixture of ether and alcohol will naturally form a second consideration; and, thirdly, a very important property must have its due weight in the scales, and that is the stability of the given salt in the ethereal solution. The alkaline iodides and bromides are all soluble, so that lithium stands, perhaps, quite as high as the rest in this respect. In absolute alcohol the iodide of potassium is not soluble to the same extent as iodide of ammonium. The latter iodide is the most easily decomposed. On this account it is regarded as a more sensitive iodizer; it is also quicker;

but on the same account it is unstable and undergoes spontaneous decomposition. The iodide of ammonium, as well as that of potassium, is very capricious.

The bromide of silver is sensitive to light as well as the iodide and the chloride; but the spectral rays have not the same influence on either of these three salts. The actinic impression on the iodide and bromide of silver is invisible or latent, and requires the aid of some developing agent to make manifest the effect of light; whilst the impression made on the chloride of silver becomes manifest in proportion to the intensity and duration of light.

The photographed image of the solar spectrum is much broader on the bromide of silver film, than on the iodide film. In the former case, the violet, the indigo, the blue, and partially the green produce actinic action; whilst in the latter the blue part is but partially represented. Equal portions on the violet side and external to the violet color produce an equal impression on either of the films. The greater capacity of the bromized film has induced photographers to attribute to bromine qualities specially adapted to landscape-photography, where the greens occupy so large a space. By the introduction of the bromides into collodion, together with the iodides, much discussion has arisen to determine the precise action of the former. Certain collodions with certain baths are acknowledged to undergo an improvement when a bromide is a part of the sensitizer; the picture is softened, that is, the middle tints are more pronounced, or the lights and shades more agreeably graded with the bromo-iodizer, than with the simple iodizer. On this account, probably, bromides have been regarded by many as accelerators, or substances which render collodion more sensitive to light. On this ground alone the deduction would be false. The capacity for comprehending a greater range of colors is possessed by the bromo-iodized collodions. This, perhaps, is the only true and legitimate deduction that can be drawn in the case; they are considered by very high authority, on the contrary, as deduced from experiments carefully conducted, to be retarders of the actinic action. In consequence of the greater comprehensiveness, as regards colors, of the bromides over the iodides, it may be concluded, that there are very few cases in which the bromo-iodized collodion can not be appropriately preferred to the simply iodized collodion; the exceptions being the copying of engravings, plain or uncolored photographs, maps, letter-press printing, etc., where

the iodized collodion alone possesses all the capacity required.

A peculiarity has been discovered in reference to iodized collodion. Some sorts of collodion are suitedfor one iodizer, and some for another. As a general rule, a cadmium iodide glutinizes collodion; whereas an alkaline iodide liquefies it. The natural deduction from these circumstances is this: a glutinous or tenacious collodion is suited for sensitizing with iodide of ammonium, or iodide of potassium; for it becomes thereby less tenacious, and flows better. Such collodion soon attains its maximum amount of sensitiveness, and almost with the same facility begins to deteriorate; it is very unstable, and not permanent in any degree of sensitiveness. On the other hand an alcohol collodion, which is in a condition to flow easily, is, in fact, thin and liquid, can be rendered more glutinous by a cadmium iodide. Collodion thus iodized is much more stable than when iodized with the alkaline iodides, but it attains its maximum degree of sensitiveness very slowly, that is, it takes a longer time to ripen than the first-mentioned collodion; but when ripe, it retains its sensitiveness much longer, is in fact a stable collodion. Coupling these two facts together, attempts have been made to combine the iodide of cadmium with an alkaline iodide in such proportions as to comprehend the peculiar advantages of either, that is, the stability and permanency of the one with the quick sensitiveness of the other, and the mutual tempering of either toward a medium glutinosity or liquefaction. The result of such experiments indicates that the cadmium salt must exceed the alkaline salt in quantity. As soon as the highest degree of sensitiveness and stability can be established by means of the iodides alone, it remains then to combine with these a certain proportion of a bromide to communicate to the collodion a greater capacity for colors. Notwithstanding that this is, in my opinion, the view we have to take of the matter, it must be confessed that the best working quantities of the iodides, or of the bromo-iodides have not yet been satisfactorily determined. The difficulty that stands in the way of this determination is increased by the peculiar condition of the nitrate of silver bath, whether it be acid, neutral or alkaline; and furthermore whether it be rendered acid by nitric acid or acetic acid; or whether it contain carbonate of soda or acetate of soda. A cadmium iodized, or bromo-iodized collodion sensitized in a bath of nitrate of silver rendered slightly acid with nitric acid, produces irreproachable pictures, but not

more rapidly than a bath containing acetic acid, acetate of soda, or carbonate of soda, when these happen to be in a happy mood; but the latter are very unstable, whilst the former remains for a long time constant, and is regarded accordingly the proper bath for the cadmium collodion. It must not be forgotten that acids are retarders of sensitiveness, and that consequently a bath that yields a picture without spots, stains, or fogginess is preferable in the ratio as it approaches neutrality. A bath containing either acetate of soda or carbonate of soda is, when in its best condition, an accelerator; but it is very unstable, deteriorates very quickly, and at present no means are known to rectify the evil and preserve or restore the sensitiveness.

The iodides and bromides most generally employed by the photographer are those of lithium, potassium, sodium, ammonium, cadmium, and silver.

CHAPTER X.

PREPARATION OF THE IODIDES.

Several of the iodides are formed by the direct contact of the elements, as, for instance, the iodide of iron and the iodide of phosphorus. Others by double decomposition, as iodide of silver from a soluble iodide and nitrate of silver. And, finally, others are obtained by combining chemical equivalents of hydriodic acid with the carbonates of the bases required, as, for example, iodide of potassium from hydriodic acid and carbonate of potassa, iodide of barium from hydriodic acid and carbonate of baryta, etc. Iodine or hydriodic acid is the material from which the iodides may be and are prepared.

Iodine.

Symbol, I. Chemical Equivalent, $127\frac{1}{10}$; Specific Gravity, 4.948.

Iodine was discovered in 1812, by Courtois, a chemical manufacturer in Paris. This substance exists in nature combined with metals, such as calcium, magnesium, and sodium; and these are found in many saline springs and mineral waters, as also in sea-water. These salts are absorbed by several marine plants and animals; and it is from such plants that iodine is obtained in considerable abundance. The sea-plants are collected, dried, and burned in large pits, the ashes of which are called *kelp*. Formerly this kelp was collected on account of the carbonated alkali which it contains; its value now is enhanced on account of the iodides and chlorides which are found in it. The powdered mass is dissolved in cold water, which is afterward evaporated until a scum forms on the surface. The solution is then set aside to cool, when a quantity of crystals will be deposited. By a further evaporation, more crystals may be obtained, until finally the mother-liquor ceases to yield any more. The dark-colored liquid contains the iodides, which may be precipitated by a mixture of five parts of sulphate of iron and two parts of sulphate of copper. The precipitate is subiodide of copper, which, by treatment with sulphuric acid, the deutoxide of

manganese and heat, yields iodine in violet vapors, which by condensation form the metallic-looking crystals of iodine. There are other methods of separating the iodides.

Properties.

Iodine resembles plumago or black lead, in outward appearance; it is a crystalline substance, soft and brittle. It melts at 224°, and sublimes at 347°. Its taste is very acrid and astringent; its smell is somewhat like that of chlorine. Water dissolves about one part in seven thousand parts, and receives a brown color. Alcohol and ether dissolve it abundantly; and so do iodide of potassium and hydriodic acid, forming brownish red solutions. Iodine in solution, as tincture, or in iodide of potassium preferably, has very valuable medicinal properties. It is regarded as a specific in the reduction of glandular swellings, and in scrofulous diseases. It is said to cause the pustules of small-pox to abort. In photography, it is impossible to estimate its value; for without it, the art could not exist in its present state.

The impurities in iodine are plumbago, sulphide of antimony, and iodide of cyanogen. If by evaporation on a piece of porcelain there be any residue, one or both of the former impurities may be present; the latter impurity is of rare occurrence.

Tests: *Free* iodine is easily recognized by the formation of a deep blue color when mixed with a solution of starch; and this blue color is volatilized by heat. The iodine in an iodide has first to be set free before it can be thus tested. To effect this, either a current of chlorine is passed through the solution, or nitric acid is added to it; by boiling the solution afterward, the fumes may be obtained and thus tested.

Preparation of Hydriodic Acid.

Hydriodic Acid. — Symbol, I H. Combining Proportion, $128\frac{1}{16}$. Specific Gravity, 4.43.

This substance is a condensable gas; at a temperature of 59°.8, it solidifies into a transparent, colorless mass; and water absorbs a large quantity. The strongest liquid hydriodic acid has a specific gravity of $1\frac{7}{10}$, when it boils at a temperature between 257° and 262°. It is not a stable compound; oxygen from the air is absorbed, and iodine is liberated and dissolved by it. Chlorine and bromine decompose it.

Hydriodic acid may be obtained by several methods.

From the property which iodine possesses of abstracting hydrogen from several of its compounds, as from phosphide of hydrogen, hydrosulphuric acid, ammonia and organic compounds, methods have been devised to obtain hydriodic acid by their mixture. Thus, by diffusing iodine in powder through water, and then passing a current of hydrosulphuric acid through the solution as long as iodine is thus taken up and the fluid is rendered colorless. By this process, sulphur is deposited and iodine takes its place. By filtration, the sulphur is removed; by heat, the superfluous hydrosulphuric acid is driven away. The remaining transparent solution is hydriodic acid.

A solution of iodide of barium may be decomposed by an equivalent proportion of sulphuric acid, and by filtration from the insoluble sulphate of baryta, hydriodic acid is obtained in solution.

Phosphorus combines very vividly with iodine, and the iodide of phosphorus, when it comes in contact with water, is decomposed into hydriodic acid and phosphoric acid. Liebig has availed himself of this property in the preparation of the iodide of lithium, barium, calcium, potassium, sodium, etc.

Lithium.—Symbol, Li. Combining Proportion, $6\frac{2}{10}$.
Barium.—Symbol, Ba. Combining Proportion, $68\frac{5}{10}$. Specific Gravity, 4.
Calcium.—Symbol, Ca. Combining Proportion, 20.
Potassium.—Symbol K. Combining Proportion, 39.
Sodium.—Symbol, Na. Combining Proportion, 23. Specific Gravity, 0.97.
Ammonium.—Symbol NH_4=Am. Combining Proportion, 18.
Cadmium.—Symbol, Cd. Combining Proportion, 56. Specific Gravity, 8.6.

Take one part of phosphorus, twenty-four parts of iodine, and forty of warm water; mix them intimately in a Wedgwood mortar by means of the pestle. The color of the fluid is at first dark brown, but becomes transparent as soon as the decompositions are effectuated. The heat of a water-bath and friction will soon complete the action. By this operation, iodine and phosphorus combine, so as to form iodide of phosphorus, which becomes resolved into *hydriodic acid* and *phosphoric acid* by the decomposition of the water. A little free iodine added to the transparent solution prevents the formation of phosphorous acid.

Iodide of Barium.

To the transparent solution above obtained, by decantation from any remaining phosphorus, add, in the first place, carbonate of baryta as long as effervescence ensues, and afterward

a little water of baryta, so that the mixture becomes slightly alkaline. By this decomposition phosphate of baryta is formed from the phosphoric acid and the carbonate of baryta; and from the hydriodic acid, and the carbonate of baryta, iodide of barium is the resulting formation; and carbonic acid is liberated as gas. The iodide of barium, being soluble, is separated from the insoluble phosphate by filtration. A current of carbonic acid is now passed through the filtrate, in order to combine with any remaining solution of baryta, and the mixture is again filtered.

Iodide of Calcium.

This salt is obtained precisely in the same way as the preceding substituting only milk of lime for the barytic salt. Both these salts crystallize, when slowly evaporated; they are, too, both deliquescent. From either iodide of barium or iodide of calcium the alkaline iodides are easily formed.

Iodide of Lithium.

Add two ounces of carbonate of lithia to the iodide of either barium or calcium solutions produced from seven ounces of iodine by the preceding manipulation. The carbonate is previously levigated in water to an impalpable consistency. The mixture is frequently stirred during the twenty-four hours it is allowed to stand, in order to effect the complete precipitation of baryta or lime. The solution of iodide of lithium is now separated by filtration from the insoluble carbonate of baryta or lime. If the iodide of barium or of lime has not been thoroughly decomposed, add a cold solution of carbonate of lithia as long as any precipitate is formed.

Iodide of Potassium.

Digest a hot solution of sulphate of potassa in a solution of iodide of calcium in the proportion of their equivalents for six or eight hours. Double decomposition ensues, the sulphuric acid and oxygen of the potassa combine with the lime to form sulphate of lime, whilst the iodine and potassium enter into combination to form iodide of potassium. By filtration through cloth these two salts are separated. The liquid, containing probably still some iodide of calcium and solution of sulphate of lime, is evaporated and then treated with pure carbonate of potassa as long as any precipitate is produced. The insoluble lime is again separated,

and the filtrate is evaporated to crystallization. The mother liquor is afterward evaporated to dryness.

Iodide of Sodium and Iodide of Ammonium.

These two salts may be prepared in like manner, either from the iodide of barium or of calcium, by the substitution in one case of sulphate and carbonate of soda, and in the other of sulphate and carbonate of ammonia. The results are better with the iodide of barium, owing to the more perfect insolubility of the sulphate of baryta after decomposition. Both of these iodides, as well as that of potassium, may be obtained by the direct action of iodine on the caustic alkalies. In this way iodine is added to a solution of potassa, for instance, until the latter becomes slightly colored; the solution so obtained contains iodide of potassium and iodate of potash; it is evaporated to dryness, and then heated to redness, in order to convert the iodate of potash into iodide of potassium by driving off its oxygen. The fused mass is afterward dissolved and crystallized. Sulphuretted hydrogen is sometimes used to decompose the iodate.

Another method, similar to the first, consists in first obtaining either the iodide of iron or of zinc, by mixing iodine, water, and iron-filings, or iodine, water, and zinc-filings, together, and then heating the mixture until the combination is complete, which is indicated by its becoming colorless. The filtered solution is next decomposed completely by adding solution of carbonate of potassa as long as any precipitate takes place. The precipitate, which is either carbonate of iron or of zinc, is removed by filtration; and the filtrate is evaporated to crystallization.

Iodide of Cadmium.

This very important iodide is formed precisely in the same way as iodide of iron or of zinc, by gently heating a mixture of the filings of cadmium, water, and iodine, until the solution becomes colorless.

Impurities of the Iodides.

The iodides which are formed by the direct contact of the two elements are quite pure if the materials are pure; whereas, if the iodides arise from double decomposition, the combination may sometimes fail in accuracy, in which case carbonates and sulphates of foreign ingredients and iodates of the same base may be found in such iodides; chlorides may

be present, too, in the decomposing carbonates and sulphates, so that we may sometimes expect to find them with the other impurities.

Tests of the Purity of the Iodides.

No precipitate is produced in a pure iodide by solution of *chloride of barium*. If a precipitate results from the introduction of this test, one or all of the following acids are probably indicated: carbonic, iodic, and sulphuric. Other acids might be indicated, but not probably, because materials are not used in the preparation of the iodides containing the acids hinted at, as, for instance, oxalic, sulphurous, silicic, chromic, hydrofluoric, phosphoric, and boracic. Supposing, however, a precipitate is formed when the test is added, then a carbonate, iodate, or sulphate may be one or all present. The next test is to find out which or how many of the three are present. Add, therefore, *nitric acid* to the precipitate; if it becomes dissolved, there is no sulphate in the iodide. Carbonic acid or an alkaline carbonate added to lime-water produces a milkiness caused by the formation of the insoluble carbonate of lime; and an iodate in solution is recognized by the addition of chlorine-water, or citric, or tartaric acid, which liberates free iodine, afterward made manifest by solution of starch. The chlorides are tested for as follows: in a given quantity of the iodide precipitate with solution of nitrate of silver, until nothing more falls as sediment; dissolve this sediment in ammonia, and then add nitric acid; if a chloride is present, a white flocculent precipitate will be produced, which is chloride of silver.

CHAPTER XI.

BROMINE.

Bromine.—Symbol, Br. Combining Proportion, 80. Specific Gravity, 2.966.

This peculiar substance was discovered in 1826 by Balard, of Montpellier. It was originally obtained from the uncrystallizable mother-liquor of sea-water, called *bittern*. It occurs in sea-water in small quantity as bromide of magnesium, or of an alkali; but in much larger quantities in several mineral springs, as, for instance, at Kreuznach, Cheltenham, etc., and is naturally found in many marine plants and animals.

Preparation of Bromine.

The solution of the bromides obtained by evaporation of sea-water, spring-water, or from the ashes of certain plants and animals, is submitted to a current of chlorine, which takes the place of the bromine in the salts. When the liquid ceases to assume a deeper color from the introduction of chlorine, (and great care must be taken not to add too much, because it combines with the bromine as soon as there is no base present for it to combine with,) it is well shaken with ether, which, taking up the bromine, ascends and swims on the surface. This film is then decanted, or otherwise separated, and mixed with a strong solution of potassa, by which both bromate and bromide of potassium are formed; the ether may now be removed by distillation, and the remaining solution is evaporated to dryness. The residual mass is then fused, whereby the bromate of potassa is converted into bromide of potassium, analogously with the iodate or chlorate under similar circumstances. By distilling the resulting bromide with sulphuric acid and peroxide of manganese, bromine passes off as vapor, and a sulphate of the base remains in the retort together with the manganese in a lower state of oxydation.

Bromine thus obtained contains water and bromide of car-

bon. The water is removed by a second distillation over recently fused chloride of calcium. Bromine is a brownish-red liquid, which solidifies at—$7°\frac{2}{10}$, volatilizes very rapidly when exposed to the air, and boils at about 145°. Its smell is very disagreeable and pungent. A drop on the cuticle destroys it and produces a sore. It is soluble in $33\frac{3}{10}$ parts of water, and this solution is decomposed by exposure to light into hydrobromic acid.

Test: Chlorine liberates bromine from all its soluble compounds. Ether combines with it and collects it; solution of starch produces a yellowish-red color with it; it distills as a liquid.

Hydrobromic Acid.

Symbol, Br H. Combining Proportion, 81. Spec. Grav., 2.73.

This acid is very analogous in its formation and reactions to hydriodic acid. It can be prepared by mixing directly phosphorus, water, and bromine, or from a mixture of six parts of crystallized sulphite of soda, three parts of bromine, and one of water, and by distillation. It can be obtained also by transmitting a current of hydrosulphuric acid through water, holding in solution or suspension a small quantity of bromine; sulphur is deposited; the hydrogen combines with the bromine. By a gentle heat the fumes of hydrosulphuric acid are expelled; and by filtration the hydrobromic acid is obtained in solution.

Bromides.

These binary combinations can be obtained, as a general thing, by manipulating precisely as in the preparation of the iodides, with the single substitution of bromine for iodine. They contain in like manner, and for the same reason, the same impurities which may be manifested by the same tests, with the exception of bromic acid instead of iodic; the former of which is decomposed by chlorine.

Preparation of the Chlorides.

Chlorine.—Symbol, Cl. Combining Proportion, 35.5. Spec. Grav., 2.47.

This substance was discovered in 1774 by Scheele. Its affinity for other elements is very great, so that it does not exist free or uncombined. The great geological formation of rock-salt is a chloride of sodium, to which the ocean owes its saline taste. It combines with most of the metalloids as well as the metals, giving rise to some of the most important and interesting combinations in chemistry. Chlorine, iodine, bromine, and fluorine form analogous binaries with

hydrogen and the metals; but chlorine has greater affinities for bases than any of the others; it is, therefore, employed in separating iodine and bromine from their combinations.

Preparation.

Chlorine may be obtained from any of its binary combinations by double decomposition. Thus hydrochloric acid is a binary consisting of chlorine and hydrogen; now by adding to hydrochloric acid a material in which oxygen is loosely combined, hydrogen and oxygen unite to form water, chlorine is liberated, and a chloride of the base is at the same time formed. Take, for instance, four parts of hydrochloric acid, one part of the binoxide or black oxide of manganese, and the same quantity of water. Mix these ingredients in a flask or retort connecting with a jar filled with warm water and inverted over the pneumatic trough, or by a tube dipping to the bottom of a large tumbler. By applying heat, either from a lamp or sand-bath, an effervescence is produced, being the result of the decomposition just alluded to. The gas as it passes out displaces the water in one case and the air in the latter.

The mode by which it is procured from a chloride consists in first obtaining from the chloride hydrochloric acid, and then proceeding as before. But the two operations are combined in one, that is, they take place consentaneously by mixing all the materials together which are required in their separate formations as follows: take three parts of common salt, five of sulphuric acid, five of water, and four of binoxide of manganese, and apply heat as before; the same result will ensue as in the first case.

Properties.

This substance is a heavy gas of a greenish-yellow color, and exceedingly suffocating odor. Under a pressure of four atmospheres this gas is condensed into a liquid of a bright yellow color, whose specific gravity is 1.33. It is soluble in water, which takes up and dissolves about two volumes of this gas, and receives the taste, odor, and other properties of the gas. With very cold water chlorine enters more abundantly into combination, forming a crystalline hydrate. Chlorine in solution, when exposed to the light, soon decomposes the water, giving rise to hydrochloric acid. Chlorine has an exceedingly great affinity for hydrogen, and removes this latter body from many of its combinations, as, for example, from ammonia; still dry chlorine and hydro-

gen, when mixed and kept in the dark, do not combine; if brought into the full blaze of the sun, they combine and explode; if exposed to diffused light, they combine silently into hydrochloric acid. Its action upon metals in a state of fine division is in many cases very energetic; if a piece of bronze or gold-leaf be injected into a tumblerful of the *moist* gas, the combination is so energetic as to produce flame. The *moist* gas combines with the hydrogen of organic colors and bleaches them; these colors can not be restored, because the hydrogen can not be restored organically; hence we say in such an instance that the color has been destroyed. In like manner *moist* chlorine removes the hydrogen from putrid and miasmatic substances, as from fish, meat, and offensive localities. It is, therefore, denominated a disinfecting agent. Its combination with the hydrate of lime is the form in which it is used both for bleaching and disinfecting.

Chloride of Lime, Chlorinetted Lime, etc.

This substance is prepared by passing chlorine through sets of chambers or compartments of wicker-work containing layers of hydrate of lime. The lime absorbs a large quantity of the gas, and probably combines with it in the formation of a hypochlorite of lime. Chloride of lime is soluble to some extent in water, giving to it an alkaline reaction; its bleaching powers are more effectual when an acid is added, which liberates the chlorine. This substance is now used in photography in the preparation of the gold-toning bath. When added to chloride of gold, which is slightly acid, it renders it alkaline, and at the same time chlorine is liberated, which assists in producing pure whites on the paper, and in furnishing a chloride of gold which is more effectual in toning.

CHAPTER XII.

NORMAL OR PLAIN COLLODION, IODIZED COLLODION, BROMO-IODIZED COLODION.

Normal or plain collodion is a solution of pyroxyline in a mixture of ether and alcohol, ready for being iodized or bromo-iodized. This sort of collodion when preserved in well corked bottles becomes clearer with age, and the sediment occupies continually less space. After it has stood for a week or two, the clear supernatant solution is decanted by means of a syphon, syringe, or stop-cock from the residue of undissolved pyroxyline beneath, and again put aside to settle. There is no fixed rule, arising from chemical equivalents or combining proportions, by which to institute a fixed formula for the preparation of normal or plain collodion. I have selected those which may be relied upon.

Take of ether, specific gravity, .715 1000 parts by weight.
" " Alcohol, (absolute,) . . . 1000 " " "

In another vessel shake together thoroughly—

Alcohol, (absolute,) . . . 850 parts.
Pyroxyline, ... 45 "

As soon as the pyroxyline is completely covered and saturated with the alcohol, add the mixture of alcohol and ether, and shake well until the cotton has completely disappeared. Cork the vessel carefully, which is supposed to be full, and put it aside in a *cool, dark* place for a week or two, as before directed.

If a glutinous collodion, or a collodion with more body be desired, such as is required in the transfer of the collodion film upon glazed leather, etc., as much as fifty parts of pyroxyline may be dissolved in the above proportions of alcohol and ether; on the contrary, if a thin collodion be required for the flowing of large plates, the proportion may be as low as thirty-six or forty parts of the prepared cotton. Normal collodion for present use may be filtered; but it is far from being as pure by filtration as by subsidence. Filters for such

purposes may be procured of the photographic establishments, by which the filtration proceeds without the contents coming in contact with the atmosphere. The above proportions are for the preparation of what is denominated alcohol collodion, which produces a soft, short, and structureless film on the glass plate.

Bromo-idiozing Solutions for the same.

Take of Alcohol, (absolute,) . . . . . 100 parts.
" Iodide of sodium, ... 8 "
" Iodide of cadmium, ... 3 "
" Bromide of cadmium, ... 4 "

Or,

Take of Alcohol, (absolute,) . . . . . 100 parts.
" Iodide of lithium, ... 10 "
" Bromide of lithium, ... 5 "

Or,

Take of Alcohol, (absolute,) . . . . . 100 parts.
" Iodide of lithium, ... 6 "
" Iodide of cadmium, ... 6 "
" Bromide of cadmium, ... 2 "

Or,

Take of Alcohol, (absolute,) . . . . . 100 parts.
" Iodide of cadmium, ... 10 "
" Bromide of ammonium, ... 5 "

Dissolve the salts in each case in the given quantity of alcohol, shaking the mixture frequently, and preserve it in well-closed bottles and in a dark place.

Collodion for photographic purposes is prepared from a mixture of plain collodion, and one of the bromo-iodizers above given, in the proportion of *ten* parts of the former to *one* of the latter. The mixture requires to be placed aside for a day or two, before it arrives at its maximum sensitiveness.

Many operators prepare their collodion directly with the requisite quantity of iodizing and bromo-iodizing materials, of which the following selection contains some of the best formulæ.

Formula of Lieut.-Colonel Stuart Wortley.

Ether, ... 1 ounce.
Alcohol, .802, ... 2¼ "
Iodide of lithium, ... 15 grains.
Bromide of lithium, ... 6½ "

The pyroxyline is first steeped in the bromo-iodiozed alcohol, and the ether then added. These proportions produce

a very fluid collodion, which is quite an advantage in coating large plates, where a very even film is required. It is said to be well adapted for instantaneous pictures. The sensitizing bath, which is used with this collodion, will be found amongst the list of silver baths given hereafter.

Ommeganck's Formulas for Portraits and Landscapes.

For Portraits of short exposure.

Ether,	667	parts.
Alcohol,	333	"
Iodide of ammonium,	6	"
Iodide of cadmium,	6	"
Bromide of cadmium,	3	"
Pyroxyline,	12	"

This collodion is sure to be thick enough; if too thick, however, it can be rendered more fluid by the addition of an appropriate quantity either of ether or absolute alcohol. If more than one tenth of the original volume be added, it will be necessary to mix with this the corresponding quantity of the bromo-iodizers.

For Landscapes, Views, and Direct Transparent Positives.

Ether,	667	parts.
Alcohol,	333	"
Iodide of zinc,	6	"
Iodide of cadmium,	6	"
Bromide of cadmium,	3	"
Proxyline,	12	"

In this, as also in the preceding formula, weigh out the salts first; put them into a bottle of the proper capacity; add the alcohol, and dissolve them by frequent shaking; next add the ether and mix; finally introduce the pyroxyline in small flocks at a time, and shake until the cotton is dissolved. After the solution is effected the collodion is put aside in a cool, dark chamber, and allowed to settle for a couple of weeks. The first collodion will keep for a long time; the latter is less stable, but more sensitive to certain colors of foliage.

Formulas of Disdéri.

NO. I.—COLLODION FOR WINTER.

First Formula.

Alcohol—spec. grav. .813,	4000	grains.
Ether, " " .720,	6000	"
Pyroxyline,	110	"
Iodide of ammonium,	60	"
Iodide of cadmium,	40	"
Bromide of ammonium,	6	"
Bromide of cadmium,	4	"
Iodine,	5	"

Second Formula.

Alcohol—spec. grav. .813,	4000	grains.
Ether, " " .720,	6000	"
Pyroxyline,	110	"
Iodide of ammonium,	50	"
Iodide of potassium,	50	"
Bromide of ammonium,	10	"
Bromide of potassium,	10	"
Iodine,	5	"

The iodide and bromide of potassium are dissolved in the smallest quantity of water. A quarter of the prescribed quantity of alcohol is poured into a clean bottle; the pyroxyline is then introduced, and the mixture is well shaken. After this operation the ether is added. The salts of iodine and bromine are next weighed and dissolved in the remaining quantity of alcohol, and then mixed with the solution containing the cotton. The collodion is put aside for a day or two, and then either decanted or filtered.

COLLODION FOR SPRING.

Alcohol, (as before,)	5000	parts.
Ether, "	5000	"
Pyroxyline,	100	"
Iodide of ammonium,	50	"
Iodide of cadmium,	50	"
Bromide of ammonium,	10	"
Bromide of cadmium,	10	"
Iodine,	5	"

Second Formula.

Alcohol and ether, of each,	5000	grains.
Pyroxyline,	100	"
Iodine of ammonium and of potassium, of each,	50	"
Bromide of ammonium, and bromide of potassium, of each,	5	"
Iodine,	5	"

COLLODION FOR SUMMER.

Alcohol, (as before,)	4000	grains.
Ether, "	6000	"
Pyroxyline,	80	"
Iodide of ammonium,	50	"
Iodide of cadmium,	30	"
Bromide of ammonium,	5	"
Bromide of cadmium,	2	"
Iodine,	2	"

For copying engravings, etc., all that is required is a very simply iodized collodion, without any bromide.

Formula for Copying Collodion.

Alcohol, (absolute,)	5000	grains.
Ether, .720,	5000	"
Iodide of cadmium,	100	"
Pyroxyline, from 75 to	100	"
Iodine,	2	"

The collodion film, whether iodized or bromo-iodized, is rendered sensitive by immersion in a bath of nitrate of silver, which will be described in the following pages.

(Owing to the instability of collodion when once iodized, it has been proposed to invert the operations, and to mix with the collodion an equivalent quantity of the nitrate of silver, instead of the iodizers or bromo-iodizers, and then to sensitize the film in a bath as follows:

Distilled water,	100	parts.
Alcohol,	25	"
Iodide of ammonium,	2	"
Iodide of cadmium,	4	"
Iodide of zinc,	2	"
Bromide of zinc,	2	"

As soon as withdrawn from this bath, the collodion plate is washed in distilled water, and either used immediately by immersing it in a weak solution of nitrate of silver, or put away to dry. This process is due to Ch. D'Orma, and remains to be tried.) Whatever may be the difference of the composition of the collodion, arising from the variety of formulas that exist—for there is scarcely a single operator that does not boast of his own formula—each collodionized plate, when the film has sufficiently dried, is submitted to the chemical influence of a solution of nitrate of silver, in order to obtain by double decomposition in and on the film an iodide, or a bromo-iodide of silver, which is sensitive to the actinic influence of light. If the film contained a pure iodide, or a pure bromo-iodide of silver, without the presence of a nitrate, the results would not be satisfactory. The nitrates, or nitrogenized organic substances seem to be essential as accessories in the photographic operation of producing collodion positives and negatives. The most important salt in photographic chemistry is nitrate of silver; it is the salt from which most of the other silver salts are obtained, and is besides a very costly article, and deserves therefore to be treated with all due respect. Hence the following chapter is devoted to its service chiefly.

CHAPTER XIII.

SILVER—SALTS OF SILVER.

Silver.—Symbol, Ag. Combining Proportion, 108. Spec. grav., 10.474.
Oxide of Silver.—Symbol, Ag O. Combining Proportion, 116.
Chloride of Silver.—Symbol, Ag. Cl. Combining Proportion, 143.5.
Iodide of Silver.—Symbol, Ag. I. Combining Proportion, 234.36.
Bromide of Silver.—Symbol, Ag. Br. Combining Proportion, 188.
Sulphide of Silver.—Symbol, Ag. S. Combining Proportion, 124.
Cyanide of Silver.—Symbol, Ag. Cy. Combining Proportion, 134.
Nitrate of Silver.—Symbol, Ag O. NO_5. Combining Proportion, 170.
Hyposulphite of Silver.—Symbol, AgO. S_2O_2. Combining Proportion, 164.
Sulphate of Silver.—Symbol, AgO. SO_3. Combining Proportion, 156.
Nitrite of Silver.—Symbol, AgO. NO_3. Combining Proportion, 154.

Silver.

Silver, like gold, is found in a native state; frequently too it occurs as an alloy containing gold, which is recognized, when the silver is dissolved in nitric acid, as the black sediment or oxide of gold. Arsenic and antimony are found also alloyed with it. Several of the ores of lead and copper contain silver.

As an ore, the sulphide is the most abundant; *horn silver*, or the chloride, occurs native, as also the carbonate in small quantity.

Native silver, and the silver in the native sulphide, are separated in one case from the investing rocky materials, and in the other from sulphur by a process called that of *amalgamation*. The ores and the rocky mass are reduced to powder, and then roasted in a reverberatory furnace with about ten per cent of chloride of sodium, which converts the silver into chloride of silver. The pulverized mass is next put into barrels, hung horizontally and capable of being rotated by machinery. It is mixed with a certain quantity of *water, iron and quicksilver*. By being kept in continual agitation for eighteen or twenty hours, the chloride of silver becomes decomposed by the iron, whereby chloride of iron is formed, and the silver set free. Coming in contact with the mercury, an amalgam is formed, which flows off out of

the barrel when the contents are made fluid by the addition of water, and by rotating the barrels very slowly. The amalgam is then subjected to pressure through chamois leather, which allows the mercury to permeate through its pores, but retains the amalgam. By distillation, the mercury can be expelled from the silver residue. Copper and lead ores, containing silver, are treated in the same way.

In certain ores of copper and lead, silver exists in small quantities, and is melted or separated by amalgamation along with them. If the quantity is sufficiently great, the silver is separated by a process called *cupellation*, which is practised in the mint in the assay of metals containing silver. A *cupel* is formed out of well-burnt and well-washed bone ashes, kneaded into a thick paste with water, and forcibly pressed in an iron ring. Cupels vary in size from one to two inches in diameter or more, and from a quarter of an inch to three fourths of an inch thick, hollowed on one side in the concave form of a watch-glass. They are afterward dried by a gentle heat, as on a stove, when they are ready for use. The metal, consisting of copper, silver and a large excess of lead, to be assayed, or the silver to be purified, is placed in the concavity of the cupel, which rests on a muffle in a furnace, over which a current of air can flow with some force. It soon melts, and by the access of the draft of air, the surface becomes covered with a film of oxide; this, as it forms, is removed. Lead oxidizes first, and finally the copper is induced to oxidize by means of the oxide of lead, and forms with it a fusible compound, which sinks into the pores of the cupel. As soon as the foreign metals are nearly removed, the silver assay assumes a rounder shape, and when the last trace of oxide disappears, there is a beautiful play of prismatic colors, and finally the silver button becomes very brilliant, and exhibits a bright *flash* of light, indicative of the completion of the operation.

A second process of purifying silver, and one which will be found better adapted to the wants of the photographer, consists in dissolving the silver of commerce, or of the coinage of the country, in pure nitric acid. Take one ounce and a half of silver, in thin laminæ, or in filings, one fluid ounce of nitric acid, and two ounces of pure rain or distilled water. Mix the acid and the water in a glazed porcelain dish, or in a glass dish; then add the silver, and place the vessel with its contents in a sand-bath, and apply a gentle heat. The silver will soon disappear in the solution. By this operation, the nitric acid is easily broken up into its com-

binations; one portion oxidizes the silver and liberates peroxide of nitrogen; whilst a second combines with the oxide so formed, and produces the nitrate of the oxide of silver. If the metal was impure, as is most likely, and it contained copper, the solution will be tinged blue according to the quantity of impurity. A small drop at the end of a glass stirring-rod, will give rise to a brilliant blue color, in a wine-glass full of water, made alkaline with ammonia, if there be any copper present; or a steel knitting-needle, dipped in the solution, becomes coated with a film of copper, on the same conditions.

Supposing the solution, therefore, contains copper, we may proceed as follows to separate it from the silver. Add to the solution of the nitrate, a small quantity of common salt dissolved in water, drop by drop, as long as a flocculent precipitate is formed. When flakes of the chloride of silver, thus produced by double decomposition by means of the chloride of sodium, no longer appear on the addition of the salt solution, the precipitate is allowed to subside in a dark room, or it is poured directly on a filter, and the fluid containing copper, etc., is thrown away. The precipitate is now well washed by repeatedly filtering pure hot water over it, until a drop no longer produces a blue tinge with ammonia. The chloride is now dried. Next weigh the chloride, and take twice its weight of carbonate of potassa, and fuse the latter in a crucible; when fused, add gradually to it the dry chloride of silver, which will be decomposed, as well as the carbonate of potassa. The chloride leaves the silver and gives rise to chloride of potassium, whilst the carbonic acid and oxygen escape, and the silver remains diffused through the mass. By raising the temperature, the silver sinks into a button at the bottom, and the fused chloride of potassium swims on the surface. The melted mass may now be poured out into a pail of water, or upon a hollow stone. The silver thus obtained and washed, will be quite free from copper, and all other metals, excepting lead or mercury, which might be present. If lead were present in the nitrate, the addition of sulphuric acid would produce a precipitate; and the presence of mercury is easily shown by introducing a piece of polished copper wire into a small quantity of the nitrate in solution, by which it will be covered with a film of mercury when the latter is present.

Chloride of silver may be reduced, also, by fusing it with

seventy per cent of chalk, together with four or five per cent of charcoal.

A third method of reduction of the chloride, is one which is very convenient for those who do not possess a furnace, or have the convenience of fusing ores or residues. Moisten the chloride with dilute hydrochloric acid, and immerse a plate of zinc in the moistened mass for several hours. Decomposition will gradually take place, the silver being deposited, whilst the soluble chloride of zinc is formed. After the chloride has been thus completely decomposed, the remaining zinc is withdrawn, and the precipitate is washed with dilute hydrochloric acid, until there is no longer any precipitate formed in the decanted fluid by means either of ammonia or of sulphide of ammonium. The precipitate is next well washed with warm water. It is now in a condition for being dissolved in nitric acid.

Instead of precipitating the silver as chloride, in order to separate it from the copper, the solution is evaporated to dryness, and then heated nearly to redness. By this process the nitrate of silver is fused, but suffers no other change; whilst the nitrate of copper is decomposed, yielding up peroxide of nitrogen and oxygen, and leaving the insoluble black oxide of copper mixed with the fused silver salt. By dissolving a small portion of the fused mass from time to time in water, and testing the solution, after filtration, with ammonia, it can easily be ascertained whether it be free from copper or not. As soon as no copper is indicated, the fused mass is dissolved in pure water and separated from the insoluble residue, evaporated and crystallized.

The oxide of copper may be separated from the nitrate of copper in the solution by substitution of oxide of silver. This oxide of silver is obtained by precipitating a quantity of the given solution by a solution of potassa. The collected precipitates of oxide of copper and of oxide of silver, are then well washed, and afterward boiled with the remaining parts of the impure nitrate. The solution is then finally separated from the residue, evaporated and crystallized.

Finally, the mixed solution may be treated with plates of copper, whereby the silver is precipitated in a state of very fine division, which is afterward obtained on the filter, and thoroughly purified by washing. This silver is then treated with pure nitric acid until dissolved; the solution is then evaporated to dryness, redissolved, evaporated and crystallized.

In every case where the salt thus obtained is intended for

photographic purposes, the crystals when thoroughly dried are dissolved in pure water, and again crystallized; or the solution of the crystals is boiled for some time in a glass flask containing fragments of pure silver, or perfectly well-washed oxide of silver, (procured as just indicated.) In this way the nitrate of silver, after evaporation and crystallization, can be had in an absolute neutral condition.

The mother-liquor remaining after the crystals have been removed, is evaporated to dryness, fused and poured into cylindrical moulds of the size of a quill. In this form it is denominated *lunar caustic*, and used principally by surgeons for cauterizing erysipelatous, ulcerated, etc., surfaces. From this mode of its manufacture, it can not always be relied upon by the photographer as pure. In fact it frequently blackens by exposure to light, whilst pure crystallized nitrate of silver, does not change by a similar exposure. In addition to impurities of an organic nature, it frequently contains, besides, *nitrite* of silver, produced by the decomposition of the nitrate by the heat of fusion.

Properties.

Nitrate of silver crystallizes in colorless square tables; it is an anhydrous salt, and neutral when carefully prepared. This salt may be fused, as before mentioned, into lunar caustic; but if the heat be too great, it is decomposed into nitrite of silver, oxygen being liberated; and by a still greater heat the nitric acid is entirely removed, and pure silver left behind. Nitrate of silver dissolves in one part of cold water, and in less of boiling water. It is soluble also in about four parts of alcohol. The oxide of the nitrate of silver, is precipitated by any of the alkalies or alkaline earths. In ammonia, added in excess, the oxide is redissolved, forming a definite compound of the formula $AgO, NO_5, 2NH_3$, denominated *ammonio-nitrate* of silver, which by evaporation is obtained in the crystalline form.

Photographic Properties of the Nitrate of Silver.

Collodion iodized with a solution of iodide of silver in iodide of potassium does not produce a picture when exposed and developed by the ordinary process; nor is a collodion film, when sensitized in the bath of nitrate of silver, and carefully washed in the dark-room after the operation of sensitizing, any longer as sensitive to the actinic influence as before; or supposing it to be so, it no longer yields a picture by ordinary development. It is, therefore, not the

iodide of silver *alone* which undergoes the actinic impression, but the iodide in connection with the nitrate of silver, or the nitrate of the new base, and probably with free nitric acid, which is easily broken up or decomposed, and yields thus its oxygen to produce or induce further decompositions. Whatever the theory or the true explanation of the photographic impression on the iodides or bromides may be, whether physical, chemical, electrical, or mixed, that is, physico-chemical, etc., one thing as yet is quite certain, (and this is certainly the beginning of knowledge,) that the rationale of actinism on any substance or surface is a *mystery*, has not been hitherto explained on unexceptional grounds, is not satisfactorily deduced from experiments. It is useless then to give a long dissertation on a mere hypothesis. But we do know, if not with certainty, at least nearly so, by what conditions the best results can be obtained in reference to the nitrate of silver bath in combination with the iodized or bromo-iodized collodion. For instance, collodion containing, amongst other chemical ingredients, free iodine, indicates at once that the silver-bath may be *neutral, even slightly alkaline;* whilst if the collodion be new, contain no free iodine or bromine, be colorless, then the bath appropriate for producing a good picture must be the very contrary of the preceding, it must be *slightly acid.* We know that acids *retard* the action of development, *limit* this action to the parts impressed actinically, prevent in consequence what is denominated fogging. We know, moreover, from repeated experiments, that it is immaterial whether the collodion or the silver-bath be slightly acid, the result is the same, the production of a clear picture accompanied with the disadvantage of lengthening the time of action. But we do not yet know the exact conditions of collodion and bath by which clearness and sensitiveness can be attained in a maximum degree in the shortest time without exception.

The iodide of silver, whether produced by the decomposition of iodide of cadmium, of lithium, or of any other base, is, in all probability, equally sensitive; but this sensitiveness is found to be materially changed by the presence of the other salt in the decomposition. From experiments in this direction it is known that the greatest degree of sensitiveness is arrived at when the collodion contains *iodide of iron*, and this probably because the proto-nitrate of iron is very unstable and easily broken up. With such an iodizer, however, the silver-bath would soon be entirely deteriorated by the continual introduction of a developing material; so that

many points have to be taken into consideration before normal conditions can be isolated or legitimate deductions drawn.

Preparation of other Salts of Silver.

Other Salts of Silver.—Sulphate of Silver.—This salt is obtained by dissolving silver in concentrated sulphuric acid by the aid of heat; or by double decomposition of nitrate of silver with sulphate of soda. Sulphate of silver is soluble in eighty-eight times its weight of boiling water, from which it crystallizes on cooling. Like the nitrate it is anhydrous, and forms in like manner a distinct and definite combination with ammonia, whose equivalent is $Ag\ O.\ SO_3 + 2\ NH_3$ in fine transparent crystals.

Hyposulphite of Silver.—This combination is obtained by the double decomposition of an alkaline hyposulphite and nitrate of silver. For instance, add a dilute solution of hyposulphite of soda to a similar one of nitrate of silver; a white precipitate is formed which is soon dissolved in the menstruum; after a while, when the hyposulphite of soda has dissolved the newly formed precipitate to saturation, a flocculent substance is formed of a dull gray color, which is permanent. This second precipitate is hyposulphite of silver in an isolated state. But the hyposulphite of soda contains a large quantity also, thus giving rise to a soluble double salt, which has a very sweet taste. Hyposulphurous acid has a very powerful affinity for silver, so that hydrochloric acid or a soluble chloride produces no precipitate in the solution of the double salt of hyposulphite of silver and of soda. In such a solution, containing a large proportion of waste silver, the best way to obtain or separate the silver is to pass a current of hydrosulphuric acid through the solution, in order that the silver may be precipitated as sulphide of silver. Hyposulphite of silver undergoes spontaneous decomposition into sulphate and sulphide of silver; on this account the fixing-bath is found to contain in general a large quantity of black sediment, which is sulphide of silver. This sulphide, when a sufficient quantity has been collected, is reduced by heat into sulphurous acid and metallic silver.

Iodide of Silver.—This salt is found native, and sometimes in the form of hexagonal prisms. It may be formed artificially by allowing the vapor of iodine to play upon polished plates of silver, as in the Daguerreotype process, or by double decomposition. When excess of nitrate of silver in solution is added to a solution of iodide of potassium or

to hydriodic acid, a yellow precipitate is produced; this is iodide of silver; whereas if the iodide of potassium be in excess, the precipitate is nearly white, its soluble and yellow part having been dissolved by the alkaline iodide. The yellow precipitate is that form of the iodide which is best adapted for photographic purposes. It is insoluble in water and in dilute nitric acid; almost insoluble in ammonia; and is not so soon colored by the action of light as the chloride. It is very soluble in the alkaline iodides, in cyanide of potassium, and hyposulphite of soda, and by evaporation may be crystallized out of them as double iodides, etc. When silver is dissolved in hydriodic acid, crystals of the iodide of silver may be obtained in the solution by spontaneous evaporation. Iodide of silver may be reduced in the same way as the chloride by means of zinc. Hydrochloric acid converts it into chloride of silver. It is decomposed by both chlorine and bromine which liberate iodine. It is soluble to a small extent in solution of nitrate of silver.

Iodide of Silver for the Silver-Bath.—Add to a small quantity of iodide of potassium in solution a larger quantity of dissolved nitrate of silver; allow the canary-yellow colored precipitate to subside; decant the supernatant liquid; wash with water and again decant, and repeat the washing several times. Let this operation be performed in the dark-room. The yellow precipitate, whilst still moist, is added to the bath of nitrate of silver in proper quantity as long as it is dissolved by the same; the solution is then filtered; and as regards saturation with the iodide of silver, is ready for use.

Bromide of Silver.—This salt is found native in Mexico and in Bretagne, sometimes in an amorphous condition, and sometimes crystallized of a greenish-yellow color. It is formed artificially by exposing plates of silver to the vapor of bromine, or by decomposing nitrate of silver by an alkaline, or any other soluble bromide. The precipitate is white at first, but becomes yellow afterward. It may be fused, and when cool its color is intensely yellow. Bromide of silver is very sensitive to light, but the color when so acted upon by light is very different from that of the chloride. It is soluble in strong ammonia and in chloride of ammonium, as also in hyposulphite of soda and cyanide of potassium. The bromides are decomposed by chlorine, whereby bromine is liberated, and may be collected by ether, which, by agitation, collects the bromine and carries it to the surface, from which it may be decanted.

Chloride of Silver.—Next to the nitrate of silver, the chloride is perhaps the most important combination of this metal. It occurs native as *horn-silver* in translucent cubes or octohedra of a grayish-white color; its specific gravity in the native form is 5.55. Like the iodide and bromide of silver, it may be obtained by exposing plates of silver to the vapor of chlorine. The surface of the plates soon becomes covered with a chalky film, which is the chloride in question. It is obtained as an insoluble white powder by decomposing nitrate of silver, or any other solution of silver excepting the hyposulphite, by means of hydrochloric acid or a soluble chloride, by which a complete interchange takes place, and a dense curdy precipitate falls gradually to the bottom. After subsidence the liquid is poured off, and the residue is well washed in several waters. This operation must be performed in the dark-room, because the chloride of silver is very sensitive to light, and soon changes from a white to a violet color in the sun or in diffused light. This violet-colored substance is a sub-chloride or an oxy-chloride, and may be formed directly by chemical means as follows: dip a plate of polished silver into a solution of sesqui-chloride of iron, or of bichloride of mercury; the surface becomes stained black; the iron or mercury parting with a portion of its chlorine, is reduced to a lower chloride, whilst the silver film becomes converted into a sub-chloride of silver. Chloride of silver is insoluble in water; it is very soluble in ammonia, in cyanide of potassium, in hyposulphite of soda, as also in concentrated and boiling solutions of chloride of potassium, chloride of sodium, and chloride of ammonium, from which may be obtained, by evaporation in one case and by cooling in the other, crystals of double salts of chloride of silver and the other substances in the solvents. Hydrochloric acid in a very concentrated state dissolves a minute quantity of chloride of silver, which crystallizes on evaporation of the acid. It is precipitated from all solutions of silver salts, as before mentioned, except from hyposulphite of silver, by means of hydrochloric acid. At a temperature of 500° Fahr. it fuses into a transparent yellowish fluid, which when cool may be cut with a knife like a piece of horn, and has beside some other resemblance to horn; it hence received the name of *horn-silver* by the older pharmaceutists. Chloride of silver can not be volatilized like the protochloride of mercury. The mode of its reduction into pure silver by two or three different processes has already been given under the head of *Silver.* It may be reduced

also by a mixture of carbonate of potassa, cane-sugar, or starch-sugar and water.

Tests: Chloride of silver is distinguished from all other precipitates, having the same color, by the property which it possesses, when exposed on a white saucer or evaporating-dish, of becoming changed into a violet-colored substance. Its insolubility in nitric acid, and solubility in ammonia, is also an excellent test when combined with the preceding.

Photographic Properties of Chloride of Silver.

There is quite an analogy in the application of iodide of silver and chloride of silver; the former being essentially in combination with a nitrate or free nitric acid, the sensitive collodion film; whilst the latter, in combination likewise with a nitrate or free nitric acid, forms the sensitive film on gelatine, albumen, arrow-root, resinized, gutta-percha, or plain paper. These papers have first imbibed, or have been invested with, certain soluble chlorides, as of ammonium, sodium, etc., by floating or otherwise, and then dried. By double decomposition afterward these chlorides are converted, by floating the papers on a solution of nitrate of silver, into chloride of silver. Organic salts of silver are formed simultaneously, such as the albuminate, etc., which assist in, or detract from, the photographic operation. Of this I shall speak more extensively when I have to discuss the theory and practice of *Positive-printing* on paper.

Other Uses of Chloride of Silver.—The solution used in galvano-plasty, or electrolysis, for plating with silver is made by dissolving in a saturated solution of cyanide of potassium the moist and undecomposed chloride of silver to saturation, and then diluting this solution by four or five times its bulk of water.

The grayish-colored powder used for dry-plating or for silvering dial-plates, thermometer-scales, etc., consists of one part of chloride of silver, five parts of cream of tartar, and four of common salt, rubbed on with a piece of flannel or sponge dipped in solution of salt.

CHAPTER XIV.

REDUCING AGENTS—DEVELOPERS.

As already remarked in a preceding chapter, the actinic impression of an object on the prepared collodion film is invisible or latent; it is like the impression of the finger on a plate of copper, or of a warm piece of metal on a glass mirror; after the removal of the finger, or of the metal, the eye can not distinguish the spot where the impression was made; but, as Moeser first illustrated, breathing upon the glass will make the impression manifest, will show that the image was there in a latent or invisible condition. In like manner a plate of polished silver may be substituted for the glass mirror, and excised metallic figures be placed when warm on its surface; the impression is quite invisible, but becomes visible when the silver plate is exposed to the vapor of mercury.

Furthermore, if the glass mirror, or the polished metallic plate be exposed in the camera before an object, and the former be breathed upon, and the latter exposed to the vapor of mercury, in either case the picture becomes visible; but the picture in either case is a *mere breath*, an evanescent shadow. It gives us, however, a distinct idea of what is meant by a developer, it is the prototype of a reducing agent. In chemistry is understood by a reducing agent, a substance, which, when applied to a combination, properly speaking of a metal, will decompose the compound in such a way as to leave the metal in the reguline condition, isolated from the other combining materials. Hydrogen and carbon are the best chemical reducing agents. Pass a current of hydrogen through a glass tube containing oxide of copper heated to redness; in this state the hydrogen has more affinity for the oxygen of the oxide than the copper possesses; the two metalloids therefore pair and pass off in combination as the vapor of water, leaving the copper *reduced* to the metallic state. A solution of nitrate of silver, impressed by blocks upon silk, is reduced to a bright film of silver when exposed to hydrogen gas. Heat a mixture of charcoal and oxide of lead

in a crucible, carbonic acid results from the combination of charcoal and oxygen, whilst the metal lead is reduced. Electricity, Heat and Light are all reducing agents. Fill a tumbler with the solution of chloride of silver in cyanide of potassium, just above mentioned. Next take two copper wires, to the end of one solder a quarter of a dollar, to the other attach on a hook any clean and well-polished article of brass or copper; the other end of the latter wire is now fastened to the negative or zinc side of a galvanic battery, whilst the end of the other copper wire is fixed on the positive or platinum side of the battery. Insert the piece of silver and the brass, etc., object in the tumbler, but not in contact; the silver in the solution will immediately begin to be reduced, and by the electrical current, will be carried to the negative side and deposited on the object to be plated.

By heat alone several of the oxides are reduced to the metallic state, as for instance, oxide of mercury, of silver, etc. Some are reduced by light, as those of gold.

Many of the salts of the metals are reduced by the superior affinity of other metals. Immerse a piece of copper wire in a solution of nitrate of mercury; nitrate of copper will be formed and mercury precipitated on the copper. Mercury precipitates silver from nitrate of silver; zinc precipitates lead from the acetate of this metal, and iron precipitates copper from its nitrate.

Potassium and sodium by their very superior attraction for oxygen are regarded as among the best reducing agents; cyanide of potassium unites the properties of carbon and potassium in the way of reduction. The protosalts of iron are easily changed into the persalts when brought into contact with oxides in which the oxygen has been loosened in its affinities, or when in contact with chlorine or nitric acid; and the metallic base is precipitated. Tannic acid, gallic acid, pyrogallic acid and formic acid are all excellent reducers. The last substances enumerated are those in general use as reducers or developers in photography; but the substance reduced or precipitated by them is not always a pure metal; in some instances it appears pure and metallic, in others black and free from metallic lustre, as if it were mixed with organic material. The act of reduction in photography consists in reducing a silver compound; this reduction is aided by the *presence of nitric acid or a nitrate*; without nitric acid or a nitrate the development in question seems impossible, and it is equally impossible without the *previous action of light.* Now let us see what the action of the protosulphate of iron

is upon the oxide of silver in solution, as also of nitric acid upon the protosulphate of iron. In the first place dissolve a crystal of green vitriol in a drop or two of nitric acid: decomposition ensues; the nitric acid is broken up into parts, fumes of the peroxide of nitrogen are liberated, and a reddish colored persulphate of iron is produced from the absorption of oxygen. Secondly, dissolve a small quantity of the oxide of silver in nitrate of ammonia, and add solution of the protosulphate of iron to the ammonio-nitrate. The mixed solution becomes colored and turbid, and a deposit subsides, which is found to be *pure silver*.

By experience we know that the film on a collodion plate, after development with protosulphate of iron, is also pure silver, soluble in nitric acid. Now coupling the two facts together that both *light* and *nitric acid* are required before the reduction can take place, and also that there must be present the oxide of silver in solution, (for the reduction is ineffectual with the iodide of silver,) it seems as if we were indicated to believe that the *action of light* produced an oxide in all those parts where it struck, or loosened the oxide of the nitrate of silver present on the film, wherever the actinic rays made an impression. This loosening of the oxide of silver from its connection with the acid may be effectuated by the conjoint action of light and iodine or bromine, whereby a double decomposition is instituted the very reverse of that which ordinarily takes place, that is, iodide of silver and nitrate of potassa are reconverted by light into iodide of potassium and nitrate of the oxide of silver in the act of formation, or properly speaking, into nitric acid and oxide of silver, held in abeyance by some power (light or electricity) which prevents their union. If this were so, it seems to me, we have an assemblage of materials in the right condition for producing the effects which in reality take place. With such circumstances and conditions it is easy to see how a solution of protosulphate of iron would reduce the oxide of silver into a film of pure silver, whose thickness would vary as the intensity of the actino-chemical action. There is no absurdity in supposing the possibility of the inversion alluded to. The vapor of water, by passing through an iron or porcelain tube heated to a white heat, is decomposed into its elements; whereas if the heat of flame be applied to a mixture of these gases, they recombine instantaneously and reproduce the vapor of water. Other analogous inversions of chemical affinity are known to the chemist.

Iron Developer.

Iron.—Symbol, Fe. Combining Proportion, 28. Spec. Grav., 7.8.
Protoxide of Iron.—Symbol, FeO. " " 36.
Sesquioxide of Iron.—Symbol, Fe_2O_3. " " 80.

With iron, as with some metals, we have two classes of salts, the *protosalts* and the *persalts*, that is, the salts of the protoxide and the salts of the peroxide. The two classes are not equally permanent, sometimes the protosalts being the stable salts, and sometimes the other. Those salts which are not stable are liable to part with their oxygen, or to take up more oxygen, according to their condition of stability. Thus it happens with the iron compounds. The protonitrate, for instance, is changed by boiling into a salt of the sesquioxide; and the proto-sulphate is apt to undergo decomposition and assume a coppery appearance, by changing into the persalt. This property in salts and acids of communicating to, or of abstracting oxygen from other chemical substances in contact with them is made available in various reactions; as, for instance, in toxicological investigations, arsenic acid is reduced by *sulphurous* acid into arsenious acid; on this account sulphurous acid is properly called a reducing agent. In photography, as already remarked, the sulphate of the protoxide of iron passes easily into the sesquisalt, by abstracting oxygen from somewhere, whereby a picture on the collodion film becomes visible.

Nitrate of the Protoxide of Iron.

Symbol, FeO, NO_5.

This substance is obtained best by decomposing the sulphate by means of nitrate of baryta. The solution has a green color, like all the protosalts; it can not easily be crystallized, because a high temperature decomposes it into a sesquisalt.

Sulphate of the Protoxide of Iron.

Symbol, $Fe\,O, SO_3, H\,O + 6$ Aq. Combining Proportion, 139.

Sulphate of iron is obtained by dissolving iron to saturation in a dilute solution of sulphuric acid, decanting the supernatant liquid, evaporating and setting aside for crystallization. These crystals have a slightly bluish-green color. When exposed to the air the crystals become colored of a brick-red color, by decomposition; and if the crystals be exposed to a temperature of 212° Fahr., or a little upwards, they part with the six equivalents of the water of crystallization, and

crumble into a grayish-white powder; at a higher temperature the remaining equivalent of water may be expelled. It is from the anhydrous salt now left that anhydrous sulphuric acid is obtained, or at least the very strong and fuming sulphuric acid of Nordhausen. In the preparation of this acid from the residual salt above mentioned, a high temperature is required, by which the affinity of the acid for the base is destroyed, and is expelled, leaving in the retort a pulverulent red mass, the *colcothar* of the alchemists, or sesquioxide of iron. Sulphate of iron is soluble in two parts of cold water and three fourths of a part of boiling water; the solution is neutral. This salt is not soluble in alcohol; if alcohol be added to a solution of sulphate of iron, the salt is precipitated in a white granular form, which is very convenient for photographic purposes; by this process it is purified from any superfluous acid which it may contain.

Double Sulphate of Iron and Ammonia.

It has been proposed by Meynier to substitute this double salt for the protosulphate of iron, because of its permanency when exposed to the air, or its less liability to decomposition. This double salt was described by Mitscherlich.

Preparation.

Take equivalent proportions of sulphate of iron and sulphate of ammonia, that is, 139 parts of the former to 75 of the latter, and dissolve the salts in four or five parts of water; when the solution is complete, filter and evaporate, and afterward set aside to crystallize. The solution for photographic purposes can be prepared in quantity, and it keeps well without undergoing much change. The formula for development with this double salt does not differ from the simple protosulphate; it contains alcohol, water, and acetic acid.

Sulphide of Iron.

Symbol, Fe S. Combining Proportion, 44.

This substance is not used directly in any photographic operation; but for the chemist and experimental photographer it has great value, because it assists in the formation of hydrosulphuric acid, which is by far the most valuable reagent in chemistry.

Preparation.

Heat a bar of iron in a blacksmith's forge to a welding heat, and then rub it on a stick of sulphur; combination will

take place very vividly, and the new compound will drop off like melted wax. When cool it has a dark gray color and metallic appearance. Pulverized and thrown into dilute sulphuric acid, it gives rise to hydro-sulphuric acid, which may be collected or used immediately by passing it through a given fluid, as for instance, an old hyposulphite bath, in order to reduce the silver in the form of the sulphide of silver.

Tannic Acid—Gallic Acid—Pyrogallic Acid.

The first substance exists in the vegetable kingdom, and is obtained from the astringent materials in various plants, but especially from oak bark and nutgalls, which are excrescences on the leaves of an oak (*quercus infectoria*) produced by an insect. The second does not exist naturally, or at least in very minute quantity, but is rather a production arising from tannic acid when exposed to moisture and the atmosphere; and the third is obtained from the second by sublimation at a given temperature. The peculiar property of the astringent principle in various barks, is to *occasion a precipitate* in solutions of gelatine, and in several metallic salts. It produces in solutions of the persalts of iron a dark blue or dingy green color, according to the bark from which it is extracted. From the property of acting upon gelatine, by which skins are converted into leather, it is denominated *tannin;* and from its power of combining with metallic bases, and forming precipitates, etc., it is regarded as an acid, and termed *tannic acid.*

The tannin extracted from the wood, the bark, the leaves and the galls of oak, the twigs of the black currant and of the sumac, the petals of the pomegranate, etc., and from the roots of several plants, produces in solutions of the sesquisalts of iron, a *deep blue* color, the foundation of writing-ink.

Whereas the tannin from horse-chestnuts, the different varieties of tea, from catechu and kino, cinchona bark, cinnamon, cassia, etc., yields a *green* precipitate with solutions of the persalts of iron.

Tannic Acid.—Symbol, $C_{54}H_{22}O_{34}$.
Gallic Acid.—Symbol, $C_{14}H_6O_{10}$.
Pyrogallic Acid.—Symbol, $C_6H_3O_3$.

Preparation of Tannic Acid.

Tannic acid is prepared by a process suggested by Pelouze. Take an elongated glass funnel, terminating at the upper orifice like a bottle, which can be closed by a cork. The lower orifice is loosely closed by a plug of cotton-wool, or a

piece of sponge; the body of the funnel is then half filled with powdered nutgalls, over which is poured a quantity of commercial ether, so as to fill the remaining part of the funnel. The cork is then replaced loosely, admitting a little air as the filtration proceeds. The liquid that passes through the funnel, and accumulates beneath, forms two layers; the upper one light and very fluid, and the lower heavier and of a yellowish tinge. Ether is added above the galls, from time to time, until the lower stratum of the filtrate no longer increases in depth. The funnel is then removed from the vessel beneath, and the lower stratum is separated by means of a glass syringe inserted to the bottom; or the whole contents can be placed in a funnel, of which the lower aperture is closed by the finger. In this way the dense fluid is allowed to flow off, and when the whole has been thus removed, the aperture is again closed with the finger, and the light fluid is poured into a retort, and distilled at a gentle heat. It consists principally of ether. The dense fluid is then washed with concentrated ether, from which it is separated as before, and afterward evaporated at a low temperature to dryness. The resulting substance is light and spongy, of an ochreous color. It is pure tannin or tannic acid, in quantity about thirty-five per cent of the galls employed. It has a slightly acid reaction, is very astringent, not bitter. It is soluble in water and alcohol, but sparingly soluble in ether. With mineral acids, albumen, gelatine, salts of the alkaloids, mineral bases, it forms precipitates. Salts of the protoxide of iron are not changed by tannic acid; but those of the sesquioxide give a deep bluish-black precipitate.

Tannic acid is used extensively in photography in the preparation of the dry plates by the Tannin Process of Major Russell. This process is fully described in a subsequent chapter.

Preparation of Gallic Acid.

As before observed, gallic acid exists in minute quantity in nutgalls; but it is rather a product of the decomposition of tannin, than a naturally existing substance. Mix powdered nutgalls into a thin paste, and expose it to the air for two or three months, taking care to replace the water as it evaporates. The mass becomes mouldy, and darker in color by this exposure; it is then pressed in a cloth; afterward, the residue is boiled in water and filtered whilst hot. On cooling, crystals of gallic acid are deposited, which are puri-

fied by boiling in eight parts of water and one fifth of their weight of animal charcoal. After filtration and cooling, pure crystals of gallic acid are deposited, in the form of long silky needles. During exposure to the atmosphere, moist tannic acid absorbs oxygen, and liberates carbonic acid, so that gallic acid is altogether a definite and distinct compound. When quite purified, it has no effect upon a solution of gelatine; it has an acid and astringent taste. The solution is soon decomposed. Gallic acid is soluble in one hundred parts of cold water, and in three of boiling water. It has no effect upon the solution of salts of the protoxide of iron, but upon those of the sesquioxide, it produces a deep bluish-black precipitate, which disappears when the liquid is heated, the sesquioxide being converted into the protoxide by the decomposition of the gallic acid. Gallic acid meets with an extensive application in photography, in various processes, as in the Tannin Process of Major Russell, the Dry Process of Taupenot, etc., and in the process of Positive Printing by Development.

Preparation of Pyrogallic Acid.

The etymology of the word indicates the origin of this substance. When gallic acid is heated to the temperature of 410° Fahrenheit, and kept at this temperature, in an oil-bath, a volatile substance sublimes of a beautiful white color, in crystalline plates. This is *pyrogallic acid*, which is soluble in water, alcohol, and ether. The solution of pyrogallic acid soon turns brown when exposed to the air, by becoming oxidized. It communicates a blackish-blue color to the solutions of the salts of the protoxide of iron, and reduces those of the sesquioxide to the state of the protoxide. When mixed with an alkaline solution, it absorbs a large quantity of oxygen from the atmosphere, and has been used in the analysis of air for this special purpose. When gallic acid is raised to a higher temperature than 410° Fahrenheit, that is, to 480° Fahrenheit, it is decomposed into carbonic acid, water, and a new substance denominated *metagallic acid*, being the black shining residue left in the retort. Pyrogallic acid, at the proper temperature, is in like manner decomposed into metagallic acid and water.

Owing to the property possessed by pyrogallic acid of absorbing oxygen from bodies with which it is in contact, it is as yet the second best developer of the latent image in the collodion process; and taking into consideration the nature of the image produced, where the time of exposure is not

important, it certainly is the most easy and reliable developer. There is no doubt that a solution of protosulphate of iron acts more quickly; or, what is meant, requires a much shorter time of exposure. From the experiments in ordinary landscape photography, I have frequently observed a difference of three to one in the time in favor of the sulphate of the protoxide of iron.

Acids in Developing Solutions.

The solution of protosulphate of iron, or of pyrogallic acid, is frequently much more energetic in reduction than is manageable, and proceeds, after the image has been thoroughly developed, to act upon those parts on which the actinic influence has been but very feeble or almost imperceptible. The difficulty in such a case is two-fold. It consists in flowing the plate *uniformly and instantaneously;* otherwise lines of demarkation will be quite visible at those edges where the fluid was momentarily retarded; and secondly, in stopping the progress of development *uniformly and instantaneously.* Many excellent negatives have been ruined by the misfortunes arising from the difficulties alluded to; and yet Instantaneous Photography has to search in this direction for the surest means of success, rather than upon any fortuitous advantages in the collodion. The operation of light is, practically speaking, instantaneous, because its velocity is greater than conception. A certain time always elapses between the opening and closing of the shutter, before the lenses, in the operation of instantaneity; and in this time light has traveled thousands of miles, or rushed with its thousands of miles' momentum on the sensitized plate. The picture, therefore, is already there; because the impression has been made. It remains, consequently, to find a reducing agent so refined and energetic as to effectuate the proper reduction. With the ordinary quantity of acids in our developers, we can scarcely hope for success; but with their diminution, and a proportionate increase of velocity in the manipulation of flowing the plates, and of stopping the further advance of reduction, instantaneous photography has, in my opinion, to seek a clue for its reliable performance. As a general rule in practice, the photographer requires less acid in the developer according as the time of exposure is less; consequently, the positive on glass, or prepared iron plate, called the ambrotype and the melainotype, requires a much less acid developer than the negative, where the time of exposure is much longer. In like manner, two photographers

may be in the habit of operating, the one with short exposures, and the other with long exposures; but it will be found that the developer of the former is much less acid than that of the latter. Now it may be asked: What is the reason that the same developer can not be used for the two kinds of pictures? Because, in the case of ambrotypes, if the developer be acid as is the case for negatives, the reduction will be *very slow*, and *most likely ineffectual;* whilst in the case of a negative, the non-acidified developer would be *too rapid* and *too unmanageable.*

The temperature is a very influential item in modifying the operation of development. The higher the temperature the greater the quantity of acid required to preserve the exact equilibrium between fogging on the one hand and deficiency of development on the other.

The principal acids used for this special purpose are acetic acid, tartaric acid, citric acid, and formic acid. The latter may be regarded at the same time a developer from its power of reducing metallic salts, and from its analogy to acetic acid as a check upon development.

Acetic Acid.

Symbol, $C_4 H_3 O_3 HO$. Combining Proportion, 60. Specific Gravity, 1.063.

Acetic acid belongs to a small group of which *acetyle* is the base or compound radical derivative from ethyle by the oxidation of two equivalents of its hydrogen in the formation of water. When alcohol and ether burn in the air the products of combustion are carbonic acid and water. But sometimes the oxidation of the hydrogen alone takes place, and water only is formed, together with a small series of new bodies containing the same number of equivalents of carbon. Some of the substances arise from the decomposition of collodion, such as aldehyde, etc. This acid may be formed directly from the oxidation of alcohol or by substituting two equivalents of oxygen in the place of two of hydrogen. Platinum-black acting upon the vapor of alcohol will produce this reaction; or a small quantity of yeast, or almost any other nitrogenized organic material undergoing putrefactive decomposition, added to dilute alcohol and exposed to the air induces the same reaction. In this manner vinegar and alecar arise from the slow acetic fermentation, as it is denominated, of weak wines and beer. When hard dry wood or twigs, or oak, beech, etc., are submitted to destructive distillation at a red heat, acetic acid is one of the products of the distillate. The first part of the sour liquor

which distills over by a second operation is not acetic acid; the second, however, contains the acid, but is impure. It is now saturated with hydrate of lime or carbonate of lime, by which process acetate of lime is formed. Sulphate of soda is then added in solution to the acetate of lime as long as any precipitate of sulphate of lime falls. The resulting acetate of soda is filtered from the lime salt, and evaporated to its crystallizing point and then set aside until crystals are formed. The latter are drained as much as possible from the water and adhering tarry liquor, and then heated cautiously to fusion, by which the tar is decomposed and expelled. The fused mass is again dissolved and crystallized. By decomposing this salt by means of an equivalent of sulphuric acid and by distillation we obtain strong acetic acid, which, by rectification over red oxide of lead, can be concentrated so as to yield crystals at a low temperature. This is denominated glacial acetic acid, and melts into a colorless liquid above 60° Fahr. It boils at a temperature of 240°; its vapor is inflammable. It mixes in all proportions with water, alcohol, and ether. The acetates are very numerous; all of them are soluble; those of silver and mercury the least so.

Its photographic uses are, as above described, to check the vehemence of reduction by the developers; it is used also to acidify the nitrate of silver bath in connection sometimes with acetate of soda, and with this connection it is said to yield much sensitiveness and intensity with a plain iodized collodion.

Formic Acid.

Symbol, $C_2 HO_3 HO$. Combining Proportion, 46. Specific Gravity, 1.235.

This acid is so called because it is found in ants, from the Latin of which the word is derived. It bears the same relation in the methyle group as acetic acid does in the ethyle series; acetic acid being formed by the substitution of two equivalents of oxygen for two of hydrogen in the formula for *alcohol*, whilst formic acid arises from the substitution of two equivalents of oxygen for two of hydrogen in the formula for *wood-spirit*, a substance very analogous to alcohol. This acid can be obtained by distilling ants in water. It is an organic acid, however, which can be formed artificially by heating organic substances, such as sugar, starch, etc., with oxidizing agents. Thus: mix one part of starch or sugar or tartaric acid with four of the binoxide of manganese, four of water, and four of sulphuric acid. By this

mixture carbonic acid will be liberated with effervescence. As soon as this is over the materials are subjected to distillation until four parts and a half have passed over. The acid liquor thus obtained is impure formic acid, which is purified by neutralizing it with carbonate of soda, and evaporating the solution so as to obtain *formiate of soda* in crystals which may be freed from all impurities in the same manner as acetate of soda in the preceding paragraphs. From the pure formiate of soda, any other formiate, or formic acid, may be obtained by neutralizing the formiate with sulphuric acid and by distillation. Hydrated formic acid is a limpid, colorless fluid, of an intensely pungent odor; it fumes slightly; at a temperature below 32° Fahr. it crystallizes in brilliant plates; it boils at 212°. It produces a blister on the skin when concentrated. In very many respects it is very similar to acetic acid, but may be distinguished from the latter by its comportment with oxide of silver or mercury, in which, when heated, it reduces the metal after a while and liberates carbonic acid. This acid is obtained, and perhaps most easily, by the decomposition of oxalic acid in contact with glycerine and by distillation.

Photographic Uses of Formic Acid.

From the similarity between acetic and formic acid it may easily be inferred that either might be substituted for the other in the developer, but the reader will have remarked a decided difference in their action on silver salts; and it is just on these salts that the acid is brought into action; it is in fact an excellent reducing agent, and when heated is used by several distinguished photographers in their developing solutions, of which the formula will be given in the proper place.

Citric Acid.

Symbol, $C_{12}\ H_5\ O_{11} + 3\ HO + 2\ Aq.$

This acid is obtained from the juice of limes, lemons, orange, currant, quince, cranberry, red whortleberry, and other fruits. The juice is imported in the liquid state from the West-Indies, and being in connection with much mucilage and other organic impurities, it is liable to undergo decomposition on the way, and to yield in the preparation of citric acid other acids endowed with different properties On this account it is advisable in many instances for the photographer to prepare his own citric acid.

Preparation.

Take ten ounces of expressed lemon-juice; boil the juice for a few minutes, then add to it after it is cool the whites of three eggs, and stir the mixture so that the albumen is intimately broken up and mixed with the juice. Boil the mixture again, stirring it all the while, and allow the coagulum to settle. When cool, filter the sour liquor and boil it again, adding to it gradually powdered chalk as long as effervescence is produced; citrate of lime is formed, which is but sparingly soluble in water. The dark-colored mucilaginous liquor is filtered off; the residue is well washed, and afterward decomposed by a quantity of sulphuric acid equal in weight to the chalk employed in the previous decomposition. The sulphuric acid is diluted with about seven times its weight of water; and the mixture is stirred about for some time until the citrate of lime is completely decomposed. By filtration the citric acid is separated from the insoluble sulphate of lime, and is afterward evaporated until a pellicle forms on its surface; it is then set aside to crystallize. The dark-colored crystals are removed from the supernatant liquid by a strainer and again dissolved in pure water; the liquid is again evaporated as before, until the formation of a pellicle takes place, and is again set aside to crystallize. By repeating the operation several times the crystals become quite clean and purified. Citric acid has an agreeably sour taste; like phosphoric acid it is tribasic, and gives rise to three classes of citrates. It is soluble in less than its own weight of cold water, and in half its weight of boiling water; it is not very soluble in alcohol.

Citrate of Soda.

This salt is prepared by dissolving citric acid in pure water and throwing into the solution, by degrees, pulverized carbonate of soda as long as effervescence is produced. The liquid is afterward evaporated to a crystallizing consistency and then set aside. In this case, as well as in the preceding, the mother-liquor can be made to yield new crops of crystals by further evaporation or by a repeated decomposition and a repetition of the other proceedings arising out of it.

Photographic Uses of Citric Acid.

This acid is frequently mixed with pyrogallic acid in proper quantity for solution in water instead of acetic acid. It is used as a check on the too rapid action of pyrogallic acid, and as a reducing agent. A frequent impurity in this sub-

stance is malic acid, and sometimes aconitic acid. Citric acid is recognized by its producing in a diluted state no immediate precipitate with *Chloride of Calcium;* but an immediate precipitate is formed when the solution is boiled.

Tartaric Acid.

Symbol, $C_8 H_4 O_{10} + 2$ Aq.

This acid exists in combination with potassa in most kinds of fruit, and sometimes in a free state. Its combinations in fruit are cream of tartar and tartrate of lime. The former exists in abundance in grape-juice, and is denominated, in the crude state, *Argol* or *Tartar*, which is either red or white according to the wine from which it is deposited during fermentation.

Preparation of Tartaric Acid.

This acid is obtained from argol, or from cream of tartar, which is a bitartrate of potassa, by two processes; one consists in abstracting one equivalent of tartaric acid from the bitartrate, and the other in decomposing the residual tartrate in the solution. Following the formula of the London College, and using the imperial gallon, which contains ten pounds of water, the method stands thus: take of bitartrate of potassa four pounds; boiling distilled water, two gallons and a half; prepared chalk, twenty-five ounces and six drachms; diluted sulphuric acid, seven pints and seventeen fluid ounces; hydrochloric acid, twenty-six fluid ounces and a half, or as much as may be sufficient. Boil the bitartrate of potassa with two gallons of the distilled water, and add, by degrees, the half of the chalk; when the effervescence is over, add the remainder of the chalk, previously dissolved in the hydrochloric acid, diluted with four pints of the distilled water. Then set aside until the tartrate subsides; after which pour off the liquor, and wash the tartrate of lime frequently with distilled water as long as it has any taste. Next pour on the diluted sulphuric acid, and boil for a quarter of an hour. Having filtered the liquor from the insoluble sulphate of lime, evaporate it by a gentle heat until a pellicle is formed on its surface; then set it aside to crystallize. By dissolving the crystals in pure water, filtering, and recrystallizing, and by repeating these three operations several times, pure tartaric acid may be obtained.

Tartaric acid is not volatile; when heated it leaves an abundant coaly residue. It is soluble in half its weight of water; it dissolves also in alcohol. The salt itself under-

goes no change when exposed to the atmosphere; but its solution, when long exposed, absorbs oxygen and forms acetic and carbonic acid. When boiled over an excess of oxide of silver, the same decomposition is produced, and metallic silver is liberated. When fused with potassa it is decomposed into acetic and oxalic acid; whilst with binoxide of manganese and sulphuric acid, it gives rise to carbonic and formic acid. Concentrated sulphuric acid, when heated with the crystals of tartaric acid, decomposes it and separates carbon, which renders the mixture black; and carbonic oxide is evolved at the same time, which burns with a blue flame.

CHAPTER XV.

THE NITRATE OF SILVER BATH.

Nothing can be easier to prepare than the bath of nitrate of silver, and yet there is no preparation in the art of photography which produces so many difficulties and troubles to surmount as the sensitizing bath for the iodized or bromo-iodized collodion plates. In consequence of this it becomes a difficult task to prescribe rules by which such a bath can be preserved sensitive under the troubles with which it is so frequently beset. The origin of these troubles may be traced to the materials introduced by the immersion of the collodion plates; but these deteriorating materials are of such a heterogeneous nature, arising from the decomposition of the pyroxyline, of alcohol, of ether, of the iodides, the bromides, their bases, and of the elements combining with them, that it is as yet an unsolved problem, that of determining precisely the cause of any given abnormal action in the nitrate bath. It is true, as regards the introduction of injurious substances into the bath, all effects resulting therefrom can be avoided by using the solution of nitrate of silver *only once*. If this salt were not so expensive, this mode of avoiding trouble would be by far the wisest and the safest. In such a case the photographer would flow his plate with the silver solution in the same manner as with the developing or fixing solution, using just sufficient to cover the film and to sensitize it. All the residual part might be collected, decomposed, and fresh nitrate prepared. But because the silver salt is a dear material, we aim to economize by using the solution over and over again. For this purpose, glass, porcelain or photographic-ware baths are constructed for containing the fluid. They are made so as to accommodate the largest plate with the least quantity of the solution, a great mistake superinduced by false economy. In this country vertical baths seem to be the only ones employed; whereas in France and Germany, for economical and other special reasons already alluded to, horizontal dishes contain the solution, and

the plates lie, as it were, collodion side downward in a thin layer of the same. Some of these baths are especially adapted for the tourist, admitting the fluid to be closed hermetically by means of India-rubber caps, screws and clamps. Nitrate of silver will permeate through the parietes of porcelain baths; the photographic-ware bath and the glass are not subject to this inconvenience.

Preparation of the Sensitizing Solution.

An ounce Avoirdupois contains 437.5 grains; the druggists and photographic dealers retail all their chemicals according to this weight, and not, as many suppose, according to the Troy weight, of which the ounce contains 480 grains. The sensitizing solution is found by experience to be sufficiently strong if it contain from 35 to 40 grains to the fluid ounce of water, or from 8 to 10 per cent.

Formula No. 1.

Nitrate of silver, (recrystallized,) . .	3 ounces.
Distilled or pure rain-water, ...	36 ounces.
Washed iodide of silver, ...	6 grains.
Washed oxide of silver, ...	6 grains.

Dissolve the nitrate of silver in half the water, then add to it the washed iodide of silver, prepared as directed on a preceding page, afterward add to the mixture the six grains of oxide of silver, which is prepared as follows: Take a solution of ten grains of nitrate of silver and drop into it a solution of *pure* caustic potash, as long as a brown precipitate is formed. Then filter and wash the brown oxide on the filter many times with cold water, and afterward with warm water, until the filtrate ceases to have any action on red litmus paper.

The mixture is now boiled in a large glass flask on a sand-bath, and when cold the remaining water is added to it, and the whole of it is filtered through a double filter of Swedish filtering paper. The solution so prepared will be saturated with iodide of silver, so that it will not dissolve any of the iodide of silver on the collodion film; it will be besides perfectly neutral, if the oxide of silver has been thoroughly washed from any adhering alkali. With a collodion containing free iodine, either from decomposition or by insertion, this bath is exceedingly sensitive, and produces at the same time clear pictures. For colorless collodions it is not suitable, nor for collodions which are quite freshly made, without the addition of iodine, that is, for those which have not had time to ripen, as it is termed in ordinary language.

For such collodions, the colorless and pale colored collo-

dions, containing, as they generally do, cadmium salts, the following bath will be found to be quite effective in producing good results :

Formula No. 2.

Nitrate of silver, (recrystallized,) . .	3 ounces.
Distilled or rain-water, ...	36 ounces.
Iodide of silver, (washed,)	6 grains.

Mix as before, and filter without boiling. For each ounce of nitrate of silver add one drop of nitric acid. This amount will probably be found sufficient to produce a clear picture; should the picture show any signs of fogging, add another drop, and so proceed until the details of the development appear without a universal cloudiness over the plate.

Formula No. 3.

Nitrate of silver, (recrystallized,) . .	3 ounces.
Distilled, or pure rain-water, ...	36 ounces.
Iodide of silver, (washed,)	6 grains.

Prepare as before, and after filtration divide the quantity into two lots of 18 ounces each. Neutralize one of these with washed oxide of silver by boiling, and then filter. Add to the other 18 drops of a solution of acetate of soda, (containing 160 grains to the ounce of water,) and 10 drops of glacial acetic acid. Each of these baths may be used separately, or in mixture. The neutral bath is kept neutral without admixture; but to the second, containing the acetate of soda and acetic acid, a portion of the first may be added as required from time to time, if it is found to work too slowly. As a general thing the acetate of soda bath produces very vigorous pictures, and renders the collodion film quite sensitive.

In summer the bath need not be so strong in nitrate of silver as given in the preceding formulas. Six or seven grains of silver per cent of the water will be sufficient when the temperature is high; on the contrary, from eight to ten per cent may be used when the temperature is moderate or low. The sensitizing solution works quicker when warm than when cold.

When the sensitizing solution becomes weak by exhaustion, it can be restored to a good working condition by the addition of a stronger solution of nitrate of silver, containing 40 or 50 grains to the ounce of water. After a bath has been in operation for some time, it becomes saturated with a variety of impurities, such as ether, alcohol, acetic acid, aldehyde, the various nitrates in the collodion, and a variety of sub-

stances arising from the decomposition of this heterogeneous mixture. The best way to get rid of all volatile material is to subject the solution to distillation, until all the ether and alcohol, at least, have been expelled, and then to filter the residue in the retort, and to mix it with a new bath. Although such a restored bath will give good results for a while, it soon gets out of order, and can no longer be relied upon. In such a case it is far more expedient to set it aside for reduction, and to form a totally new bath, than to be at the trouble of a second distillation, because the fixed salts have accumulated to such a degree as to render the bath very capricious and unstable.

When a bath does not yield clear pictures when first formed, or ceases to do so after a given time with the same collodion, or happens not to do so with a new collodion, it is advisable not to trifle with the bath by adding either acid or alkali. It may be well to ascertain by test-paper whether the trouble is attributable to alkalinity or acidity. If no alkali has been added to the bath, it will probably have an acid reaction. In this case it is preferable to boil the bath with the washed oxide of silver, as before prescribed, and then to filter it. Should the bath turn out to be neutral to test-paper, it will be found in general a better practice to add a few drops of tincture of iodine to the collodion, rather than to acidify the sensitizing solution; because the iodine in the collodion liberates an acid by decomposition on and in the film of collodion, which rectifies the evil where the rectification is wanted, and at the proper time, without changing materially the conditions of the bath. Thus the operator will learn to use up a highly colored collodion by mixing it gradually, as it is wanted, with new and almost colorless collodions, in order to clarify his pictures, without resorting to methods of attaining to the same result by adding acid to the bath.

During the time the bath is in use, a quantity of insoluble material of a gray or violet-gray color is precipitated on the bottom and sides of the bath, and frequently floats about in the sensitizing fluid. The particles of this material, as well as of the acicular crystals of acetate of silver in a weak bath are apt to attach themselves to the moist collodion film on its immersion, and thus give rise to the innumerable small apertures sometimes exhibited on the developed negative. These particles are not the sole cause of this evil, so much dreaded; but they frequently cause it by their attachment to the film during the exposure, and owing to their opacity, prevent the actinic action from taking effect on the film be-

neath, and becoming loosened by the developing and fixing solutions, afterward expose the transparent parts on which they had rested. It is advisable, therefore, to expose the bath in a glass vessel to the rays of the sun as often as possible, in order that the organic matter may be precipitated. The bath, too, ought to be filtered very frequently in the same filter, at least once a week; and if every evening, so much the better. After filtration the bath can be strengthened by an addition of fresh solution, in proportion to the daily work performed. See, during filtration, that the sides and the bottom of the vessel are perfectly clean before the solution is poured back again. A long thin wooden spatula, with a piece of sponge at the end, will be found very convenient for clearing away the adhering gray deposit. Use only rain-water for rinsing; rinse thoroughly; then turn the bath wrong side up, and rear it on one corner, in order that every drop of water may thus be removed. Wipe the edges before the sensitizing fluid is again introduced. This exposure to the rays of the sun, and frequent filtration will remedy in a great measure the trouble alluded to, and there is no fear of injuring the property of the solution, for nitrate of silver alone is not acted upon by light, does not change at all when pure.

By exposing the solution in a vessel, such as a glass evaporating dish, much of the superfluous ether and alcohol will pass off in vapor, and thus produce a remedy for another evil which an old bath invariably gives rise to, namely, that of causing oily-looking stains and streaks on the surface of the film.

Where the trouble of recrystallizing the nitrate of silver would be deemed too great, and neutral nitrate of silver can not easily be purchased, I would recommend that the photographer should fuse the nitrate of silver in a porcelain evaporating dish, at a gentle heat, and afterward pour out the fused mass on a silver or marble plate, as directed in the manufacture of lunar caustic. The same proportions of the fused nitrate are used as in the formulas for the recrystallized nitrate. Or a strong solution of the nitrate may be boiled with the washed oxide of silver, filtered, and evaporated to dryness, and used in the same way.

CHAPTER XVI.

THE DEVELOPING SOLUTIONS.

In the ordinary, or wet-collodion process, there are three Developing Solutions, the Protosulphate of Iron Developer, the Pyrogallic Acid Developer, and the New Developer, with the double salt of the sulphate of the protoxide of iron, and the sulphate of ammonia.

Sulphate of Iron Developer.

Formula No. 1. *For Ambrotypes and Melainotypes.*

Crystals of the protosulphate of iron,	3 drachms.
Rain-water,	4 ounces.
Acetic acid,	3 drachms.
Alcohol,	2 drachms.

Pulverize the iron salt, if it has not been precipitated in alcohol, and mix it intimately with the rain-water in the mortar; then add the acid and the alcohol, and see that the solution is complete; then filter and use. From a previous observation on the subject of developing, it will be conceived that the quantity of acid must vary according to several circumstances. In summer, that is, when the temperature is high, more acid will be required to keep the reducing agent in check; in like manner, if the time of exposure has been too long, the development or decomposition is more easily accomplished, and on this account more acid is required. On the contrary, in winter, when the temperature is low, as also when the time has been very short, as for example, for instantaneous operations, the proportion of acid may be diminished, until finally the solution of the iron salt may be used without any acid. In such cases it is well to have a bath of the solution, into which the exposed plate can be immersed almost instantaneously, and treated with the ordinary acid solution afterward. Considerable dexterity is required in this twofold operation. Of course diminishing the iron salt, or increasing the acid are correlative expressions, and signify almost the same thing, the slight difference depending upon

the influence of the water which remains stationary, or relatively increases sometimes in favor of the iron, and sometimes of the acid.

Formula No. 2. For Negatives.

Crystals of the sulphate of the protoxide of iron, .	2 drachms.
Distilled, or rain-water, ...	32 drachms.
Acetic acid, ...	3 drachms.
Alcohol, ...	3 drachms.

Pulverize and mix as before. A negative requires a longer exposure than the ambrotype, or the melainotype; the iron, therefore, is diminished whilst the other ingredients remain the same. In the first formula a drop or two of pure nitric acid may be added, because it produces a more reguline reduction of the silver salt, and leaves a very beautifully white metallic-looking film where the light has acted. Too much nitric acid would spoil the picture by producing too intense a reduction, accompanied with irregularity of deposition.

Formula No. 3. For Negatives.

Pyrogallic acid, (pure,) . . . 24 grains.	No. 1 Solution.
Acetic acid, ... 2 ounces.	

Shake the solution well, and keep in a dark place.

Of No. 1 Solution, ... 2 drachms.	No. 2 Solution.
Distilled water, ... 14 drachms.	

The reduction by this developer is quite appropriate for negatives; its color is grayish, but not metallic in appearance. This developer is very manageable, and very successful. It requires, however, a longer exposure than the iron developer, in the ratio of three to one, from my own experience in out-door photography. It is not so apt to fog a picture as the iron developer.

Formula No. 4. For Negatives.

Pyrogallic acid, . . 24 grains.	Divide into doses of 2 grains.
Citric acid, ... 24 grains.	

When required, dissolve a two-grain dose of the preceding in four drachms of distilled water. The amount of citric acid can be modified according to the same circumstances which regulate the treatment with acetic acid.

Disdéri's Developer.

Sulphate of the protoxide of iron, . . .	4 drachms.
Water, ...	12 ounces.
Acetic acid, ...	4 drachms.

Lieut.-Colonel Stuart Wortley's Developer.

Sulphate of iron, ... 20 ounces.
Distilled water, ... 120 ounces.

Dissolve.

Acetate of lead, ... ½ ounce.
Water, ... 5 ounces.

Dissolve.

Mix the above solutions, and as soon as the precipitate has settled, decant off very carefully. Add

Formic acid, ... 5 ounces.
Acetic ether, ... 1½ ounces.
Nitric ether, ... 1½ "

This mixture is the stock solution, from which a portion is taken, when required, and filtered for use.

Meynier's Developer.

Double sulphate of the oxide of iron and ammonia, . 100 grains.
Water, ... 23 ounces.
Acid acetic, ... 4 to 8 drachms.
Alcohol, ... 4 "

Or the preceding formula may stand as follows:

Sulphate of the protoxide of iron, ... 69 grains.
Sulphate of ammonia, ... 37 "
Water, ... 24 ounces.
Acetic acid, ... 4 to 8 drachms.
Alcohol, ... 4 drachms.

Hockin's Developer.

Formic acid, (strong,) . . . . . 2 drachms.
Pyrogallic acid, ... 20 grains.
Distilled water, ... 9½ ounces.
Alcohol, ... ½ ounce.

This developer is poured upon the plate, and kept there until the intensity is deep enough. It acts more quickly than the pyrogallic acid containing acetic acid, but less so than the iron developer; but it is less liable to fog than the iron developer, and can consequently be retained longer on the plate.

Waldack's Formulas for Collodion Positives.

Formula No. 1. For Dead-Whites.

Sulphate of iron, ... 3 drachms.
Water, ... 6½ ounces.
Acetic acid, ... 4 drachms.
Alcohol, ... 3 drachms.
Nitrate of potassa, ... 30 grains.

Formula No. 2. For Brilliant and Metallic Whites.

Sulphate of iron,	85 grains.
Water,	6¼ ounces.
Acetic acid,	1 drachm.
Alcohol,	1½ drachms.
Nitrate of potassa,	30 grains.
Solution of nitrate of silver,	30 grains.
Nitric acid,	10 drops.

In all the preceding formulas, alcohol may or may not be added, according to circumstances. It is used when the developer does not flow easily over the plate, forming, as it were, oily streaks on the surface. It remains, therefore, with the artist to use or reject it, as it may be found necessary.

CHAPTER XVII.

FIXING SOLUTIONS.

Fixing solutions consist of chemical substances that dissolve the sensitized salts of silver on plates or paper, on which photographic images have been developed. The parts which form the image are covered with reduced silver, or an altered iodide or chloride of silver, which is insoluble in the fixers; whereas those parts which have not been impressed by the actinic rays are made transparent with the fixing solutions, which dissolve the opaline silver compounds, and cause the picture afterward to be unchangeable when exposed to light. The fixing solutions at present in use are: Cyanide of potassium, Hyposulphite of soda, and Sulphocyanide of ammonium.

Cyanogen.

Symbol, C_2N, or Cy. Combining Proportion, 26. Spec. grav. 1.819.

This substance is properly a Bicarbide of Nitrogen; it is a very important material, as being the type of what are denominated compound salt-radicals; it was the first of this class of bodies discovered. Cyanogen is always produced in combination when an alkaline carbonate is heated with organic matter containing nitrogen. It does not exist either in a free or combined state in nature; it is a production of decomposition, in which the elements contained in it are brought together in the nascent state, in connection with some metallic base.

Preparation of Cyanogen.

This compound radical is obtained by heating either a cyanide of silver or of mercury in a flask of hard glass; a gas, the substance in question, is produced, which may be collected, by reason of its greater specific gravity than air, in a tall glass jar, by directing the outlet tube to the bottom; or it may be collected over mercury. It is colorless, but its odor is quite peculiar and characteristic. It burns with a peach-colored flame, yielding carbonic acid and nitrogen. Water dissolves four volumes of this gas, and alcohol as much as twenty-five volumes. An aqueous solution is de-

composed when exposed to light into a variety of ammoniacal compounds. By the pressure of four atmospheres it is reduced to the liquid state. It combines with alkaline solutions precisely in the same way as chlorine, iodine and bromine, and gives rise to salts denominated cyanides.

Hydrocyanic Acid—Prussic Acid.

Symbol, H Cy.

This acid is obtained from the cyanides or the ferrocyanides by the superior affinity of the mineral acids for their bases in a manner similar to that by which the other hydracids are obtained. Take, for instance, three parts of the yellow prussiate of potash (ferrocyanide of potassium) in fine powder, two parts of sulphuric acid, and two of water, and distill the mixture in a flask or retort; the vapor which passes over is condensed in a receiver surrounded by ice. Prussic acid is a colorless liquid of the specific gravity of 0.6969. It is exceedingly poisonous.

Cyanide of Potassium.

Symbol, K Cy.

This substance, so exceedingly useful to the photographer, might be formed by passing the vapor of hydrocyanic acid through a solution of potassa to saturation, and then evaporating to dryness without access of air. It is formed, however, by heating ferrocyanide of potassium in an iron bottle to an intense red heat; the tube of the bottle dips into water to conduct away the gases. The cyanide of iron becomes decomposed into carbide of iron and charcoal, and its nitrogen is given off, whilst the cyanide of potassium remains undecomposed, and when melted swims on the surface of the porous black mass below. It is afterward pulverized and dissolved in boiling weak alcohol, from which it crystallizes as the alcohol cools; or whilst in a fused condition it is poured upon marble slabs and afterward broken up and bottled. This substance is almost as poisonous as hydrocyanic acid, but being a fixed salt it is easily detected in the stomach; whereas hydrocyanic acid, by reason of its volatility, seldom leaves any trace behind by which the cause of death can be recognized. This salt is decomposed by the red oxide of mercury into cyanide of mercury and potassa, showing the superior affinity of cyanogen for mercury. On this account the ordinary tests for mercury do not act on cyanide of mercury, with the exception of hydrosulphuric acid; analogous to hyposulphite of silver in which hydrochloric acid or a soluble chloride does not precipitate

the chloride of silver, hydrosulphuric acid alone being capable of forming a precipitate.

Sulphocyanide of Potassium.

Symbol, $Cy\ S_2\ K$.

This salt is obtained by a process similar to the last with an addition of sulphur to the amount of half the weight of the ferrocyanide of potassium used. It is an excellent test of the persalts of iron, with which it produces blood-red precipitates. I do not see why this salt may not be used instead of the following as a fixer; it certainly can be more easily procured, and is no doubt just as poisonous.

Sulphocyanide of Ammonium.

Symbol, $Cy\ S^2\ NH^4$.

This is the new fixing salt of Meynier which is said to be endowed with properties for photographic purposes as powerful as those of cyanide of potassium, without having the poisonous and otherwise deleterious properties of this salt. Meynier, I think, must have made a mistake as to this latter property. Sulphocyanide of ammonium may be formed by distilling the vapor of hydrocyanic acid into a solution of sulphide of ammonium and evaporating the solution at a very gentle heat; or still better by neutralizing hydrosulphocyanic acid by means of potassa.

Hydrosulphocyanic Acid.

Symbol, $Cy\ S^2\ H$.

This acid is analogous with the hydracids; it is obtained as a colorless liquid by decomposing sulphocyanide of lead by means of dilute sulphuric acid; and sulphocyanide of lead results from the decomposition of sulphocyanide of potassium with acetate of lead.

Hyposulphite of Soda.

Symbol, $N^4\ O,\ S_2\ O^2$.

This very important salt is obtained by digesting sulphur in a solution of sulphite of soda, which dissolves a portion of sulphur. By slow evaporation the salt crystallizes. Hyposulphurous acid can not be isolated from any of its combinations. When this salt is pure it produces no precipitate with nitrate of baryta. The crystals contain five equivalents of water, and are soluble in a very high degree in this menstruum. Its taste is nauseous and bitter.

The photographic properties of the three salts, whose preparations have been just indicated, are to dissolve the chloride, iodide, and bromide of silver in their recently formed

state, without acting as solvents on the altered chloride, iodide, and bromide, after decomposition by light and developers. In all cases of solution they form cyanide, sulphocyanide, or hyposulphite of silver, which frequently enters into combination with the solvent and gives rise to a double salt, as the hyposulphite of silver and the hyposulphite of soda, together with either chloride, bromide, or iodide of sodium. Chloride and bromide of silver are soluble to a greater extent than iodide of silver in hyposulphite of soda. Cyanide of potassium is not only a solvent of the silver salts above mentioned, but also a reducing agent; it thus produces in the ambrotype and the melainotype a *whiteness* in the silver film which can not be effected with hyposulphite of silver. For this reason it is regarded by many photographers as the fixing agent peculiarly adapted for collodion positives by reflected light; whereas in the negative, where the *whiteness* of the silver film is of little or no consequence, hyposulphite of soda is regarded as the proper fixer. Many photographers disregard these refined distinctions, and use, in consequence of the superior solvent properties of cyanide of potassium, this substance as a fixing agent indifferently for negatives and positives. But because cyanide of potassium dissolves the silver salts so easily, it has to be used in a dilute condition, and to be watched very closely, otherwise it will dissolve at the same time the fine parts of the image. Another reason why cyanide of potassium is preferred in all collodion operations, arises from the difficulty of washing the hyposulphite of soda and of silver from the collodion film; for if any trace of these salts be left, the collodion film will eventually be destroyed by crystallization taking place on its surface, accompanied with a decoloration and soiling of the image.

Formula No. 1.

Fixing Solution with Cyanide of Potassium.

Cyanide of potassium,.....1 drachm.
Rain-water,.....4 ounces.

Formula No. 2.

Fixing Solution with Hyposulphite of Soda.

Hyposulphite of soda,.....2 ounces.
Water,.....4 "

Formula No. 3.

Fixing Solution with Sulphocyanide of Ammonium.

Sulphocyanide of ammonium,..... 1 drachm.
Water,.....12 ounces.

CHAPTER XVIII.

INTENSIFIERS.

Intensifiers are substances which, when applied in solution to the developed image, increase the opacity of the shadows and middle tints, rendering them more impermeable to light in direct positive printing. With a proper adjustment of light and developer, and especially in ordinary landscape-photography, an intensifier is seldom needed; but many artists prefer the use of the intensifier on every occasion; they maintain that a negative can *always* be preserved as clear and transparent in the lights as a positive by this process, and yet the density of the shadows may be increased to any extent without any fear of fogging. The intensifying process becomes, therefore, a fixed part in the preparation of a negative. The operation is partly physical and partly chemical; physical, because whatever may have been the action of the light on those parts in which the image is now apparent, they seem still to be endowed with properties of attraction of an intensity in proportion to the development produced, just as they were at the commencement of reduction; but the nitrate of silver, iodide or bromide of silver, having been exhausted, the application of any developer, however sensitive or intense, could produce no more opacity on the shadows for want of material to be reduced — but, mark it well, the physical condition is there to institute this reduction the moment material is supplied.

From my preceding remarks it is supposed that the developed image consists of reduced silver, or an altered salt of silver very different from any with which we are acquainted; there is no more *iodide* or *nitrate* of silver; these have been removed in the fixing and washing. Now in order to restore the partially developed image to the chemical condition requisite for the recommencement of the development, a solution of iodine in iodide of potassium, or a dilute solution of tincture of iodine, is flowed over the plate, and kept in motion over the image in order to preserve uniformity

of action. The iodine thus coming in contact with the silver shadows enters into combination with this metal, and forms a new and thicker deposit of iodide of silver with all the gradations of opacity of the image, and not a uniform film of deposit. The solution of iodine on the collodion loses color all the while; but the collodion film assumes at first a grayish and then a yellowish-gray hue. Even at this stage there is much more opacity in the shadows of the picture than before, and the negative by this proceeding may probably be dense enough; if not, proceed to the second stage. The first stage is the *depositing stage;* the second, the reducing or *developing stage* proper; and yet this deposit of the first stage is a chemical combination of iodine and silver which is now soluble in the fixing solutions, and before it was not. By this process of depositing and fixing, and by regulating the quantity of the iodine solution, a negative which is too opaque may be rendered more transparent and less dense *ad libitum.* Osborne has availed himself of this property to clarify his negatives for the photolithographic process; I would recommend it also in the preparation of clear and sharp negatives for obtaining enlarged positives in the solar camera. As soon as the depositing stage is complete, and the film has been washed, the collodion film is ready for the reception of the next operation.

The second stage consists in communicating to the iodized image a minute quantity of nitrate of silver, either alone and diluted, or in connection with the developer; it is, in fact, a mere repetition of the original process of development; the surface of the collodion is in the same condition as at the commencement when it left the camera; there are present iodide of silver, nitrate of silver, iodide of potassium, the peculiar and unknown physical attraction existing in the formed image, where before the image as yet was unformed, and the developing solution either of sulphate of iron or pyrogallic acid. The second stage is then a system or process of redevelopment. By this operation the intensity may be increased to any extent; the shadows can be made quite opaque and utterly impermeable to the actinic influence. The intensifying part of the collodion process is very much in the power of the artist; success, therefore, will depend principally on the artistic condition of what I denominate the *Foundation Negative.* If the foundation negative, however thin the shadows may be, contain lights, shades, and middle tones in perfect detail, then the artist has it in his power to raise these three conditions gradually and uni-

formly higher, until the shadows become endowed with a proper opacity. At the end of this stage fixing solutions have but little effect, which seems to demonstrate that the yellowish-gray iodide has been converted into an insoluble metallic film or an unknown insoluble silver salt. It is not necessary to use the fixing solution. All that is required is to wash the image well before it is dried and varnished.

Other deposits and other metals may be introduced in the intensifying operations, which will be found described below.

From the recent experiments and observations of Blonquart Evrard,* it appears that a negative may be intensified by a second exposure to light before fixing. Thus, supposing a negative be developed as far as it seems possible to carry on the reduction, in this condition let it be exposed for a short time to diffused light. This physical force, it is said, again acts actinically, but now only upon the parts which contain the image, communicating to these new vigor, and a fresh impulse, which, on the application of the developer, again will assist in the formation of further reduction.

As soon as the image has been fixed, as in the first example, it is sometimes flowed with a saturated solution of bichloride of mercury, by which probably the bichloride is reduced to the protochloride, and the liberated chlorine goes over to the silver, and forms chloride of silver. This application communicates a whiteness to the image, and thickens the deposit. When the negative has been washed, it is flowed with an iodizing solution, containing five per cent of iodide of ammonium in water. In this way the image becomes converted into a double iodide of silver and mercury, which, when washed, is treated with the iron or pyrogallic developer, containing a few drops of nitrate of silver, as before. It frequently happens in this, as in the preceding case, that the film at the end of the first stage is opaque enough. In this case it may be rendered black by flowing it with ammonia, hyposulphite of soda, or cyanide of potassium.

A third method of strengthening the dark parts of a negative takes advantage of the alkaline sulphides, which convert the developed film into a sulphide. By this operation, however, the film as a rule is not increased in thickness, its color alone being changed, which is frequently more agreeable to look at, and apparently more dense, because it is black, or bluish-black. These alkaline sulphides may be used with advantage at the end of the first stage or deposit, in order

* Vide Humphrey's Journal. Vol. XV. No. 1.

to blacken this deposit; but by this mode of intensifying there is a great liability to unequal action, to decomposition after the negative is varnished, to contraction of the collodion film, and its separation from the glass; besides this, sulphur seems to be precipitated sometimes in very irregular patches, giving a speckled appearance to the negative.

Preparation of Bichloride of Mercury—Corrosive Sublimate.

Symbol, Hg. Cl. Combining Proportion, 136.9. Spec. grav., 5.4.

Dissolve red oxide of mercury in hydrochloric acid; evaporate and crystallize; or sublime a mixture of equal weights of sulphate of mercury and common salt in a stoneware retort by heating to redness in a sand-bath. The bichloride, being volatile, passes out, whilst sulphate of soda remains behind in the retort. This substance melts at 509°, and boils at 563°; it dissolves in twenty parts of cold water, in two parts of boiling water, in two and one third of cold alcohol, and in three of cold ether. When hydrosulphuric acid is passed through a solution of this salt, a brownish precipitate is first formed, which eventually becomes quite white. This is a chlorosulphide.

Preparation of Sulphide of Potassium—Hepar Sulphuris.

Symbol, K S_3.

Fuse together, at a low red heat, one part of sulphur, and two of carbonate of potash, as long as effervescence takes place; then pour on to a marble slab, and when cool, break up the mass, and keep it in well-closed bottles. This sulphide has a liver-brown appearance. By the addition of an acid to a solution of the sulphide, hydrosulphuric acid is liberated, a soluble salt formed, and sulphur precipitated of a milk-white color. The alkaline sulphides have the same reaction on metallic salts as hydrosulphuric acid, forming precipitates of different colors, by which frequently the metals can be recognized, as, for instance, antimony, cadmium, etc.

Preparation of Sulphide of Ammonium.

Symbol, $N H_4 S.H S.$

Let a current of hydrosulphuric acid pass through concentrated ammonia to saturation; then add an equal bulk of ammonia. This is one of the most important reagents in chemistry. Hydrosulphuric acid produces precipitates in metallic salts, some of which are soluble in sulphide of ammonium, and others not; from this fact we can distinguish

one metal from another, thus the sulphide of arsenic is yellow, and so is that of cadmium; but the former is soluble in sulphide of ammonium, the latter is insoluble. The alkaline sulphides precipitate silver black from its solutions; thus nitrate of silver, as a dye for the hair, is turned of an intense black, if followed up with sulphide of ammonium.

CHAPTER XIX.

WET COLLODION PROCESS.

If the collodionized plate, after sensitization in the silver bath, is exposed whilst still moist, the process by which the image is obtained, is called the Wet Collodion process; whereas if the sensitized plates are dried, and used afterward at any indefinite time, the process of the operation is denominated the Dry Collodion process. The Wet Collodion process will form the subject of the following chapters. This process is divisible into two branches, comprehending the methods of preparing collodion positives and collodion negatives.

Collodion Positives — The Melainotype — The Ambrotype.

A collodion positive may be viewed either by reflected light or transmitted light; by reflected light, in the same manner as any picture or engraving is beheld, that is, by looking at it; and by transmitted light, when the picture is seen in or on glass, by looking through it, such as the pictorial representation on stained glass, or altar-pieces, etc. Collodion positive pictures, or portraits on glass, when regarded by reflected light, are denominated ambrotypes. Every part of such a picture is laterally inverted; it does not therefore represent nature as it is. For portraits this inversion of the left side for the right side is of no great consequence, excepting in the representation of objects in action, such as a sportsman firing at a woodcock, a soldier parrying off the blows of an antagonist, or a lady sewing, etc., in all which cases the fowling-piece, the sword, and the needle will be exhibited in the left hand, or on the left side. The artist, therefore, has to rectify his model in such a way that he holds, when posed, all these accessories in an inverted order. Landscapes, houses, churches, etc., can not be properly represented in an ambrotype directly photographed from the objects; the application of collodion positives, therefore, is limited to portraiture.

Ambrotype.

There are several things which the photographer must possess, and several arrangements to be made before he can take an ambrotype. He must have a glass-house, or operating room, of course, with all its accoutrements; glass, collodion, developer, and fixer must all be ready, and in their proper places, as already described; the sensitizing bath, plate-holders, water-tanks, etc., all adjusted.

The operation of taking a collodion positive on glass consists of the following subdivisions:

First. Preparing the glass.
Second. Coating it with collodion.
Third. Sensitizing it.
Fourth. Exposing it in the camera.
Fifth. Developing the picture.
Sixth. Fixing the image.

First Subdivision.—Preparing the Glass.

Glass suitable for the photographer must be free from flaws on the surface or in the mass, flat, and quite transparent. It can be procured already cut for the various sizes required; or the photographer can cut it himself from plates of the proper quality. There is quite a knack to cut with a diamond; the line made by a diamond on glass is like the cut made with a sharp razor on a piece of soft wood; it is by no means a scratch. A diamond is wedge-shaped, and its edge not a straight line, but a curved line, something like the edge of a cook's chopping-knife; the edge first makes an incision, and the wedge splits its way as the diamond proceeds. The position of the edge has to be found out, and the diamond studied, before you can cut with it, and not *scratch* with it. If you are determined to cut your own glass, prepare a glazier's board and a ruler for this purpose, and mark off with marks the different-sized glasses used in the art, as one ninth, one sixth, one fourth, one half, four fourths, and steresocopic, etc., plates.

Next see that your glasses, so far cut, are of a right size for your plate-holders; for it is very annoying when the film is sensitized to find that the plate is either too big or too small for the holder. *Never omit this precaution.*

The next duty is to take the glass in the left hand, and with the right hand to run a file along each edge of the cut glass, beginning at the left-hand corner, and proceeding to the right-hand corner all the way round; the glass is then

turned round to the other side, and its edges are treated in the same manner. The object in view, by thus abrading the edges, is firstly to take precautions against the cutting properties of such sharp edges; and secondly, it is found that the collodion film adheres better to the edges of the glass when it is so prepared.

If you are provided with a patent vice, placed right in front of you in an appropriate place, on the table or bench in the operating room, (and such a vice is a very useful accessory,) the plate is fixed in this horizontally. Now take the bottle containing prepared rotten-stone, covered at the wide-mouthed orifice with a piece of gauze, instead of being closed with a cork, and dust a small quantity of rotten-stone upon the center of the plate; then drop upon the rotten-stone on the plate from ten to twenty drops of alcohol, and with a piece of Canton flannel, rub the mixture about from side to side, and in the center until the surface of the glass is perfectly clean. A clean piece of the flannel is then used to remove all the remaining particles of rotten-stone, after which the plate of glass is seized with a silk handkerchief, so that the fingers do not come in contact with the glass, which is turned round, clamped, and its surface is cleaned in like manner. Both sides being now apparently clean, again seize the plate with a clean silk handkerchief in the left hand, remove it from the vice, and, holding a clean silk cloth in the right hand, go round the edges, remove all dust from them, and from either side, then breathe upon either side; if the breath forms a uniform film, and vanishes uniformly without any irregularity, the surfaces are cleaned. By this system of friction the glass becomes electrified, and small fibers of cotton or silk and small particles of dust are very apt to be attracted to the surface; these must be removed by a flat sable or camel's hair pencil. The plate is now ready for the second operation.

Second Subdivision.

Holding the plate horizontally by the smallest portion possible of the left-hand corner, between the thumb and the first finger of the left hand, pour over its surface, beginning at the right-hand corner, a sufficient quantity of collodion to cover it; when it is supposed that there is sufficient collodion poured out, lower the nearest edge and the nearest right-hand corner, so that the collodion can, by the inclination of the plate, be made to flow uniformly over the surface, and its superfluous quantity can be drained into the

collodion bottle. A wide-mouthed bottle containing a couple of ounces will be found to be an appropriate shaped vessel to contain the collodion for present use when the pictures are small. Collodion is apt to indurate around the orifice of the bottle; and if this dry film is not carefully removed every time, it may cause trouble by flowing off in fragments along with the collodion, and thus spoil the collodion film. This trouble is obviated in a great measure by the use of what are denominated "cometless vials;" they are made for this special purpose. If the collodion is thick and glutinous, it will be no easy matter to obtain a film on the glass free from ridges. In such a case an additional quantity of alcohol generally renders the collodion thinner, less glutinous, and more structureless. Supposing the film to be even, free from ridges, from wooliness, and specks of every kind, allow every drop of the collodion to drain off, then wait until it has set, which will be effected in a very short time. It is very easy to ascertain by a touch of the finger on the right-hand corner, whether the film is sufficiently dry or not; if it no longer yields beneath a slight touch, the plate is ready for the next step. By the way, I may here remark, that it is by far the most advisable plan for a practical photographer not to manufacture his collodion; unless he be in some degree a chemist, acquainted with the neatness and accuracy of chemical manipulations, and have plenty of leisure time as an amateur, he can seldom succeed in preparing at all times when required a reliable specimen of collodion; and to prepare small quantities of collodion, as well as of any other chemical compound, seldom comports itself with economy. Beside this, there is no necessity for such a sacrifice of time and economy in a country like this, where collodion can be purchased of so superior a quality for all the ordinary operations of the practical photographer. Only observe this rule, make your purchases at first-class houses in large cities, who make it their sole business to supply unadulterated materials.

Third Subdivision.

When the film has indurated place it upon the ledge of the dipper and lower it in one continuous and rather quick motion into the sensitizing bath. Take care that no actinic rays get to the bath during this operation. After three or four minutes raise the dipper a moment and examine the collodionized plate; if the film is still bluish, and as if covered with streaks or specks of oil, lower it again and let it remain

until the collodion has a yellowish-white creamy appearance, and is free from all oiliness. Withdraw it from the bath, seize the right-hand corner between the thumb and finger of the right hand; allow the silver solution to drain off thoroughly into the bath; with a piece of blotting-paper remove all specks of collodion from the back of the plate, taking care not to disturb the collodion along the edges of the plate or on the film side; remove the last drop of silver from the lowest corner, place it in the plate-holder, and close the slide and the shutter. Previous to this, the camera is supposed to have been fixed before the sitter, and the picture accurately focussed. It is supposed, moreover, that the surface of the ground-glass and the collodion film are exactly at an equal distance, when placed in the groove, from the back lens. As before observed, unless the picture is correct on the ground-glass, free from all haze, bright, sharp, and the light uniformly subdued, it will be very unlikely that the collodion picture will be a successful one; in fine, the image on the film will *never* be better than the one on the ground-glass where the lens has been accurately adjusted; and furthermore, that if the picture on the ground-glass be clear, sharp, distinct, and agreeably contrasted with light and shade, you are legitimately authorized to expect a similar favorable result on the collodion. Be careful, therefore, in bringing every part of the model into as accurate a focus as possible—be careful in the management of the light.

Fourth Subdivision.

Place the cap on the lens; let the eye of the sitter be directed to a given point; withdraw the ground-glass slide; insert the plate-holder; raise or remove its slide; Attention! One, two, three, four, five, six! (slowly and deliberately pronounced in as many seconds, either aloud or in spirit.) Cover the lens. Down with the slide gently but with firmness. Withdraw the plate-holder and yourself into the dark-room, and shut the door. Now comes the

Fifth Subdivision.

Placing the plate-holder, still containing the plate, in an inclined position against the wall in its regular and proper position, open the shutter and take out the collodion plate carefully, so as not to injure the film, by inserting the nail of the first finger along the cavity on the upper part of the plate-frame, and drawing forward the plate so as to let it fall into the left hand; the plate is then seized by the left-

hand corner between the thumb and the finger. In this position the plate can easily be covered with the developing fluid in precisely the same way as with collodion, only the operation must be much quicker, in order to cover the surface without producing any lines of stoppage, which invariably happens unless the plate be flowed all at once. When the plate is large, it is preferable to take it by the right-hand corner and lay it in the left-hand corner of a gutta-percha dish, whose lateral dimensions are about twice as large as those of the plate. Then, holding the dish in the left hand, incline the right side downward, and pour into it a quantity of the developing fluid. By a quick motion the fluid can be made to cover the surface of the plate in one continuous flow. As soon as every part is thus covered the plate is taken out with a quantity of the solution upon it, and the operation watched. By proceeding in this way two difficulties are avoided; the first of which consists in washing away a portion of the nitrate or iodide of silver, etc., on that part on which the solution is allowed to fall if the first method be adopted, whereby a diminution of reduction is observable in this part; secondly, you avoid the liability of forming islands and curved lines of demarkation where there is the slightest stoppage in the flowing of the developer. Supposing the plate to be covered, however, you then watch proceedings. If a bright silver-white film be desired, it is well to make use of a slow developer, such as is used for negative purposes, containing in addition a few drops of nitrate of silver, nitrate of potassa, and nitric acid. Take, for instance, the following, which is found to work well with a white background, giving a roundness of figure more like that of a daguerreotype.

Formula for Developer.

Sulphate of iron,	2 drachms.
Rain-water,	8 ounces.
Acetic acid,	2 drachms.
Alcohol,	1 drachm.
Nitrate of potassa,	½ drachm.
Nitrate of silver solution,	30 drops.
Nitric acid,	12 drops.

The image will gradually appear, and if the time of exposure has been right, you will be able to observe the three grades of contrast in the development, that is, dark parts or shades, middle tones, and lights. You will see, moreover, whether the relative conditions of the collodion and the silver-bath are in good working order, by the mode in which

the development takes place. If the whole surface of the collodion plate soon assumes a foggy, milky, or clouded appearance, with but faint contrast between the lights and shades, (and knowing that the camera is quite impermeable to light excepting through the lens,) you may fairly conclude one of two things, either that the time of exposure was too long, or the condition of the materials was not normally good. Of these difficulties I will speak shortly. By carefully watching the development it is not difficult to observe how the shades increase in density, how, in fine, the picture becomes more and more developed; and particularly the photographer can distinguish the regular shading of the background. At last the development arrives at its culminating point; if it were to proceed any further, the background and the transparent parts would begin to be foggy; the contrast diminishes, and finally the picture is spoiled. The rule is this: the moment the image is complete and the background has received its first shade, pour off the remaining part of the developer, and wash immediately and thoroughly by allowing a small stream of rain-water to play upon the surface until every trace of the iron is removed. Wash also the posterior side of the glass in like manner. We now proceed to the sixth and last operation.

Sixth Subdivision.—Fixing Solution.

Formula.

Cyanide of potassium, ...	1 drachm.
Rain-water, ...	4 ounces.

Have this solution ready. With the right hand place the collodionized plate in a gutta-percha dish held in the left hand, and pour upon the developed image a quantity of the above solution in a gentle stream, until all the white or yellow iodide of silver has been completely dissolved, taking care in the mean while that the fluid is kept moving backward and forward, so as to preserve uniformity of action. After this operation wash the plate again in many waters on both sides and until all traces of the cyanide are removed. Holding the positive now over a piece of black velvet in such a position by a window that the impingent rays shall reach the eye, the quality of the ambrotype can be determined. The picture must be quite clear; the shades dark, almost black; the lights brilliant and white; and in every respect the lines and points must be sharply defined. If there is no regular gradation of light into shade, but almost one mass of shade, and the picture is offensively black, the

time of exposure was too short or the development not carried on far enough; but if in this case the development had been continued until the retrograde action had set in, then certainly the time was too short. The remedy in such a case is quite natural; rub the picture out and take another with a longer exposure. If, on the contrary, the picture is hazy, or foggy as it is technically denominated, and the lights and shades too much blended or too little distinct from each other, and the development was rapid, and a difficulty presented itself in discriminating when the reduction began to assume a retrograde action, in such a case it may be confidently concluded that the time of exposure was too long. The remedy of course is known. But the defects just mentioned might have been caused by carrying on the development too long; and it would be very proper to attribute these defects to this cause, if the development had been slow and carelessly watched. But if the haze and fogginess commenced almost as soon as the developing solution was poured upon the surface, you would be justified in ascribing the cause of this veil over the picture to an abnormal condition of the silver-bath or the collodion. This evil indicates, as a general thing, alkalinity in either one or the other, or in both, and can be remedied by rendering either one or the other acid. It may be caused by a new bath and a new neutral silver solution.

Remedy for Fogginess.

If the collodion is nearly colorless and new, this material is probably the cause of the want of contrast in the picture, of the feebleness in the development, and, it is possible, of the veil that covers the whole plate. Take some highly colored old collodion and add it to the new in the proportion of one drachm in ten, and try another picture; or add to the collodion tincture of iodine, that is, a solution of iodine in alcohol. In either case, most likely, under the circumstances, an improvement will be manifest. If the picture is not yet perfectly clear, proceed in the same direction, that is, add more of the old collodion or of the tincture. If the bath is quite neutral or alkaline, it will be well indeed to drop in a minim or two of nitric acid. To do this take a drachm of distilled water and drop into it five minims of nitric acid. The mixture contains about sixty drops, of which six drops will contain about half a drop of nitric acid. Begin, therefore, and add six drops of the solution to the bath, and keep doing so until the picture is perfectly satis-

factory. I prefer myself keeping the bath as nearly neutral as possible, and to apply the remedial action to the collodion, by adding free iodine or old collodion, of which the former seems by decomposition to liberate an acid in and on the collodion film in proper quantity, at the right time, and in the proper place; and the latter, that is, old collodion, effects the same result, because it has already undergone the decomposition of the pyroxyline that is called ripening, and contains the materials for producing intensity and for avoiding fogginess.

In taking collodion positives beginners are very apt to develop the plate too long, as well as frequently to expose in the camera too long. The right time in both instances can be attained only by practice, after having consulted the best instructions. As soon as the picture is distinctly visible by reflection, stop the development; if it is then faulty, the time was either too long or too short; too short, if the shades are altogether too black, and transparent by transmitted light, and *vice versa*, if the reverse.

Supposing the picture to be correct and satisfactory, we proceed next to the

Seventh Operation,

which consists in drying the plate. The operation is performed by means of the large flame of an alcohol lamp, or by the radiating heat from a stove. Holding the plate by the left-hand corner, between the finger and the thumb of the left hand, first allow all the water to drain off at the nearest right-hand corner, by inclining the plate for this purpose; then holding the lamp in the right hand, move the flame gently over the back of the plate, so as to avoid fracture, beginning at the top and proceeding from side to side, and gradually downward, until the film is thoroughly dried. A second inspection now, by viewing the picture, as before, on a dark background, and by reflected light, decides whether the positive is good, tolerable, or indifferent, because now the final colors of the shaded parts are attained. These shaded parts are of a bright, white silvery hue, with the developer above given. Some tastes are more gratified with a more subdued contrast in which the whites are more deadened. This can be effected by making use of a much more rapid developer, and by omitting the nitrate of silver, and the nitric acid. For this purpose the following formula will be found practicable.

Formula No. 2. For Collodion Positives.

Sulphate of the protoxide of iron,	4 drachms.
Acetic acid,	6 drachms.
Water,	8 ounces.
Alcohol,	2 ounces.
Nitrate of baryta,	2 drachms.

Mix intimately, and filter before using. Prepare fresh every day.

Eighth Operation.

The next step which the artist has to take consists in removing any particles that may have settled upon the surface of the picture, and in coloring the cheeks, hands, and drapery where required. Dry colors are used; those of Newman are regarded as the best. Very little color will produce an agreeable effect. With a fine sable or fitch pencil, take a small portion, and rub it gently on either cheek, on the lips, the hands, and forehead; then brush off the extraneous quantity, or shade the color off from the center of the cheeks, for instance, to the edges. On the lights of the drapery the requisite coloring may be laid on in like manner. This operation of coloring is frequently performed on the varnished surface. Finally with a large broad sable pencil remove all loose coloring particles, and now the positive is ready for the

Ninth Operation.

Whilst the plate is still warm, uniformly warm from the drying operation, flow it with the purest and most transparent crystal varnish, precisely in the same manner as the plate was covered with collodion. The operation must be performed with dexterity and care; with dexterity in order to avoid all ridges caused by stoppage, and with care to avoid loss of varnish by escaping to the posterior part of the plate, upon the fingers, and upon the sides of the bottle, and the floor. The indurated varnish on the back of the positive may be removed by a tuft of cotton wool, dipped either in alcohol, benzole, or chloroform, according as the resins in the varnish are dissolved in either of these menstrua. Do not apply any heat from a large flame on the back of the plate before the varnish has dried, otherwise the ethereal fluid in which it is dissolved will take fire in many instances, and spoil the varnished surface. When the film is somewhat dry and indurated, and not quite smooth, heat may be applied carefully, in order to remove the unevenness, or the want of brilliancy.

Varnishes for Collodion Pictures.

Formula No. 1.

Copal,	1 ounce.
Pure benzole,	15 ounces.

Dissolve and filter through Swedish or ordinary filtering paper.

Formula No. 2.

White stick lac,	3 ounces.
Picked sandarac,	3 drachms.
Alcohol, spec. grav., .815,	40 ounces.
Oil of bergamot,	6 drops.

Dissolve the resins in the alcohol by means of a water-bath, and filter. This varnish is immediately ready for use; and, like all varnishes, is the best when new.

Formula No. 3. *Crystal Varnish. Soft Copal Varnish.*

Finely powdered Dammar resin,	5 ounces.
Benzole,	50 ounces.

Set aside in a closed vessel for a week, shaking the mixture from time to time for a day or two; then allow the insoluble gum to subside. Draw off the supernatant liquid, which, when clear, is ready for use. The collodion plate must be quite dry and cold when this varnish is applied, and the latter is allowed to dry spontaneously.

Formula No. 4. *Amber Varnish, (with Chloroform.)*

Amber in fine powder,	3 ounces.
Chloroform,	50 ounces.

Shake the mixture from time to time for eight or ten days, and then filter. This varnish, like the preceding, is poured, like collodion, upon the cold plate, but with great dexterity, because it dries very rapidly.

Formula No. 5. *Amber Varnish, (with Benzole.)*

Amber,	3 ounces.
Benzole,	50 ounces.

Heat the amber first in a close vessel to a temperature of about 570° Fahr., when it begins to soften and swell, yielding white fumes. It is then dissolved in the benzole. This varnish too is flowed upon the cold plate, and allowed to dry spontaneously. These two varnishes are more especially adapted for negatives.

If it should happen that a collodion picture becomes somewhat spoiled by the cracking of the varnish, it is recommended, if its restoration or preservation be of great importance, to take the following method. First ascertain whether the

solvent of the varnish on the plate be alcohol, chloroform, or benzole, by dropping on one corner a minute drop of each of these menstrua, to ascertain which dissolves the varnish. Next take a tin box, somewhat larger than the picture, about one inch deep. At the bottom of this box solder a ring of tin, about half an inch wide, of the same shape, and nearly of the same size, as a support for the glass plate. Pour a small quantity of the solvent on the outside of the support; place the plate collodion-side upward on the ring; cover the box as nearly air-tight as possible with a piece of glass, and place it in a water bath. The vapor of the solvent will soon cause the varnish to swell, and the edges of the cracks to coalesce. As soon as this end in view is accomplished, the plate is carefully withdrawn, and, when cool, is again varnished with a similar varnish.

The plate having been varnished with a transparent resin varnish, we proceed finally to the last operation.

Tenth Operation.

We have now to make a background for the positive, of some black material, which may consist of a piece of black velvet, black paper, etc., of the same size as the plate; or we may apply a coating of black varnish, either to the collodion surface, or to the posterior surface of the glass. If the varnish on the background be applied to the collodion side, the picture is not laterally inverted, but it loses considerably in transparency by the intervening collodion; in consequence of this inconvenience, the background is generally placed on the side of the glass without the collodion.

Formula No. 1. *For Black Varnish.*

Oil of turpentine,	50 ounces.
Asphaltum,	2 ounces.
Canada balsam,	4 ounces.

Formula No. 2. *For Black Varnish.*

Benzole or coal-tar naphtha,	50 ounces.
Asphaltum,	2 ounces.
India-rubber,	½ drachm.

Formula No. 3. *For Black Varnish.*

Camphene,	50 ounces.
Pulverized bitumen,	10 ounces.
White wax,	2 ounces.
Lampblack,	1 ounce.

Mix these ingredients together, and dissolve by a gentle heat; afterward filter and preserve in a well-corked bottle.

Varnish with bleached Shell-lac.

Formula.

Freshly bleached shell-lac, . . .	4 ounces.
Alcohol, ...	1 quart.
Camphor, ...	2 drachms.
Canada balsam, ...	2 drachms.

Dissolve at a warm temperature; allow to settle, and decant the clear portion for use.

Formula.

The following varnish is used on the cold plate, is very hard when dry, and is not softened at a high temperature when printing.

Gum sandarac, ...	4 ounces.
Oil of lavender, ...	3 ounces.
Alcohol, ...	28 ounces.
Chloroform, ...	5 drachms.

Digest, dissolve, and decant as usual.

The positive print, denominated an ambrotype, is now finished. It remains only to fix it in a case or frame. In the first place a piece of very transparent and unblemished glass, of the same size as the type, is thoroughly cleaned, and its edges filed, as for collodion purposes, and all particles are brushed from its surface. It is then placed in a *Preserver;* over this comes a *Mat;* next the *Ambrotype.* The two latter are then firmly folded within the flexible edges of the preserver, and the compact mass is finally adjusted in its appropriate case.

CHAPTER XX.

ALABASTRINE POSITIVES.

The coloring of collodion positives, as already remarked, may be effected on the whites of the picture, either before the varnish is flowed on, or upon the varnish itself. When well performed, it communicates life and roundness to a picture which before was flat and lifeless. The colors in use are in fine powder, and are laid on with a dry and very fine pencil of camel's, etc., hair. Naturally the operation must be very simple, and but a very small quantity of color must be used, otherwise the operation will become a work of art, and none but an artist could perform it. In all ordinary cases the color lies on the surface, and does not penetrate into the material of the film. In the Alabastrine process, however, the film is so treated as to become *permeable* to varnish, and thus to exhibit the color, as it were, in the collodion; besides this the whites are still retained white, notwithstanding the impregnation of the film with the penetrating varnish. Positives treated in this manner are regarded through the glass and the collodion film; the pictures, therefore, are direct as they ought to be. The mode by which the tones are preserved soft and white, and rendered at the same time permeable, is the following:

Alabastrine Solution.

Formula.

Sulphate of the protoxide of iron, .	20 grains.
Bichloride of mercury, ...	40 grains.
Chloride of sodium, (salt,) . . .	15 grains.
Rain-water, ...	2 ounces.

Select for this operation a vigorous good positive; a faint and thin film does not answer well. One that has been rather under-exposed is most suitable. Then, whilst the collodion film is still moist from fixing, pour upon it a quantity of the above solution, and keep it in motion. At first the picture assumes a dead and gray appearance; but this soon changes, and becomes continually more and more brilliant.

It is sometimes necessary to add a little more of the fresh solution, and to retain this solution on the surface until the whites are perfectly clear. The time required for this operation varies according to the temperature and the thickness of the film. Heat promotes the effect; the plate is therefore frequently supported on the ring of a retort-stand, with the fluid on its surface, whilst a small flame is kept in motion beneath it. Unless this precaution be observed, there will be a liability to break the plate. It happens sometimes that a few minutes are sufficient; but generally more time is required. If no heat is applied, the operation may require in some cases as much as an hour. As soon as the whites have attained their utmost purity, the operation is complete. It is better to be quite certain that the whites have attained the purity required, than to shorten the time, and have the effect underdone. There is no danger in giving too much time; but it is a disadvantage to remove the fluid from the plate too soon; because in drying, the whites in such a case are apt to grow darker again, and the picture assumes then the cold blue tone, which arises from treatment with corrosive sublimate alone.

As soon as the effect has been reached, the plate is thoroughly washed in several waters, and then dried over the spirit-lamp. The plate is now ready for the first coating of varnish, which communicates transparency to the shadows, without at all impairing the whites.

The next operation is to lay on the colors carefully and artistically on those parts that require them. It is unnecessary to apply any to the shades. Where much color is desired on a given surface, it is better to apply it by repetition, and not in one thick blotch. Colors thus tastefully laid on produce a very brilliant effect, by reason of the purity of the whites; and this effect is again increased by the softness communicated to the whole picture by the application of the *penetrative* varnish, which causes the color to permeate into the pores of the film, or to be seen at least in full beauty from the opposite side. This varnish is nothing more than a very pure strong-bodied protective varnish. The picture so far finished is backed up with a piece of black velvet, but never with black Japan, which would injure the film.

CHAPTER XXI.

MELAINOTYPE—FERROTYPE.

The melainotype takes its name from the *black* background upon which it is taken. Ferrotype from the iron of which it is composed. Very thin plates of sheet-iron are covered with a protective varnish or Japan, of which one is of a rich black or brown-black color, highly polished, and without flaw, for the reception of the collodion and the collodion picture. Glass in this sort of picture is entirely dispensed with, and so is also the black Japan, the black velvet, and paper. This type is by far the easiest and the quickest to take, and in general the most satisfactory when taken. Melainotype plates of all the variable photographic sizes, and of variable qualities, can be obtained from the photographic warehouses. The *Excelsior plate* and the Eureka plate in my opinion are the best; the Ferrotype is very good, and much cheaper.

Operation.

With a fine flat sable pencil dust off any particles from the black surface of the plate, and then flow it with collodion in the same way in which the ambrotype glass was covered. Wait for the congelation, or partial desiccation of the film, and then immerse it in the silver until it assumes a creamy opacity, (not blue,) and until the solution flows off without apparent oily streaks. Then raise it from the bath; allow the superfluous fluid to drain off into the bath, and with bibulous paper remove the last drop from the pendent corner of the plate. The plate is next inserted in its holder, and a piece of the same size placed over it. Previous to this part of the operation, the photographer must never forget to clean out the lower corner of the plate-holder, by means of blotting paper or old rag. Nitrate of silver is apt to settle in these corners; and these being formed of separate pieces of glass, cemented together, and not of one solid mass, (which is Lewis and Holt's patent,) the nitrate of silver becomes frequently decomposed by the material of the cement, and running up the plate on the collodion side by capillary attraction, it pro-

duces dark-colored stains and streaks. Make it your duty, therefore, a part of the collodion operation in fine, to clean these corners carefully before you take out the plate from the silver bath.

The time of exposure of a melainotype is the same exactly as for an ambrotype. All the instructions, too, for developing, fixing, coloring, and varnishing the positive on glass are valid here. I regard it as preferable to color after the plates are varnished, both in this as well as in the preceding type. Owing to the better conducting qualities of heat in iron plates over those of glass, more caution is required lest the Japanned film becomes raised into blisters. This misfortune is very common with beginners on certain plates, with the Excelsior, perhaps, less frequently than with some others.

This type is mounted with glass, mat, and preserver, and fixed in a case like an ambrotype; or it may simply be covered with a mat, and thus prepared for mailing in a letter. For this purpose each corner is cut off with a pair of shears, at a distance of one quarter of an inch from the apex, and the corresponding corners of the mat are folded or reduplicated over and under it, so as to form a compact piece out of the two. The melainotype, as thus taken directly from the model, is an inverted picture, like the ambrotype, but, unlike the ambrotoype, it can never by a single operation be otherwise. In the alabastrine process just described, the ambrotype, it will be observed, is not an inverted picture; the plate is inverted, and the image is beheld through the collodion in its natural and direct position.

CHAPTER XXII.

COLLODION NEGATIVES.

A COLLODION negative is an actinic impression, in which the different parts of the image are, as in the positives just described, laterally inverted, and, when viewed by transmitted light, the shades are where the lights ought to be, and *vice versâ*. It is the matrix from which positives are obtained by direct contact, either on glass, or on paper, as also by means of the lens in the ordinary, or in the solar camera. Most of the details of the operation in the negative process are the same precisely as in the positive process.

The glass is filed, cleaned and flowed with collodion, as before directed. It is sensitized too in the same bath, and then exposed. Let the time of exposure be from ten to twenty seconds in the glass-room, probably more; much depends upon the proper adjustment of the light, and its concentration by the lenses. The object in view is to obtain much more actinic action, not only on the film, but through the film, so as to produce a denser metallic reduction for the shades, which in the ambrotype are lights. To guard against the liability to fogging, a much weaker and more acid developer is used than in the positive process. The developing is carried on as long as the shades increase in density by transmitted light. It is quite an advantage in this process to have a small square of orange-colored glass situated lower down than the position of the negative, as you hold it for the operation of development, in order that the light may come from below, and thus through the glass. If fogging sets in, or the density seems to be stationary, or even to retrograde, the negative is developed as far as circumstances in the present instance will permit. If the density of the shades is so great as to prevent you from distinguishing objects through them, and these shades are regularly tempered down through the intermediate tones to the bright lights, and these lights are still clear and transparent, it is very possible that the image is sufficiently negative, and that you have succeeded in your undertaking. It is absolutely necessary that you should know what

you have to do, before you can depend upon what you do, or rely on definite results. A true negative is just what I have described. If the lights are not clear and transparent, with sufficient detail, of course, intermingled; if the shades are transparent, and not comparatively opaque, so much so as to allow the print of a book to be read through them; or if there are no intermediate tints, but your negative is all black and white; then you have not succeeded—your negative is faulty. We will suppose, however, that the three gradations of shades, middle tones, and lights exist, but that the intensity of the shades is not strong enough; there is a general weakness in the negative, and your object is to push on the development, which is found to be ineffectual without producing a haziness or fogginess over the whole print; the conclusion to be drawn from this circumstance is that the time of exposure was too short. Another sitting may remedy the evil. On the contrary, if when the developer is poured on, the reduction on the shades is very rapid, and this reduction commences, rushes with rapidity into the lights before you have time almost to stop it, you may fairly conclude that the time was too long. But a developer sometimes may produce very much the same effect; for, if the proportion of the iron salt, in comparison with the acid and the water, be great, fogging and rapid reduction will certainly be the result. As before remarked, a much weaker developer is required in the preparation of a negative than in that of a positive, and a proportionately larger quantity of acid to check its action, until the proper density of opacity is attained in the shades. (I use the words *shades* and *lights* in the negative, to represent what they really are, and not what they produce on the paper print; shades are dark and opaque; lights are thin and transparent.)

We do not aim to obtain brilliant white silver reductions on the negative; for the color, or metallic brilliancy is altogether a matter of little consequence; on this account we use no silver solution in our negative developer. Where the time of exposure is not necessarily required to be very short, a pyrogallic acid developer produces a very pleasing negative.

Negative Developers.

Formula No. 1. *Iron Developer.*

Sulphate of the protoxide of iron,	4 drachms.
Rain-water,	8 ounces.
Acetic acid,	1½ ounces.
Alcohol,	6 drachms.

Formula No. 2. Pyrogallic Acid Developer.

Pyrogallic acid,	3	grains.
Water,	2	ounces.
Acetic acid,	2	drachms.
Alcohol,	6	drops.

The negatives which produce the softest prints are those which are produced by the first development, where the time of exposure and the action of the reducing agents have been in such relatively due proportion as to produce the three gradations with a proper amount of opacity in the shades. This proportion can not always be determined beforehand, because of the variability of the light, and its actinic powers, of which we know as yet absolutely so little. We can not determine the reason of the widely diverse action of light at six in the morning, and six in the evening, or at the vernal equinox, and the autumnal. In consequence of this want of definite knowledge of the prime cause that institutes the actino-physical changes in the iodo-sensitized collodion film, it will frequently happen that the developed image is not perfect; the shades are not endowed with sufficient opacity. Fortunately in such cases we possess means whereby these shades, middle tones, and detail in the lights can all be in relative proportion rendered more opaque, and as much more opaque as may be desired. The process by which this end is attained, is denominated the Intensifying or Redeveloping process.

The image having been developed as far as possible in accordance with the rules laid down, the plate is thoroughly and carefully washed on both sides, and freed entirely from every trace of nitrate or developer. Cyanide of potassium in solution, the formula of which is given at the end of the positive process, may be employed to remove the undecomposed iodides or bromides, care being taken not to continue the action of the solvent too long, nor to apply it in too concentrated a condition, lest the fine markings of detail are dissolved off at the same time. Because, as already mentioned, cyanide of potassium is a reducing agent, as well as a fixing substance, and giving a silver salt so acted upon a reguline appearance, it is regarded as the fixing agent proper for collodion positives; whereas, owing to the properties possessed by hyposulphite of soda as a fixer alone, and not a reducer, and because its solvent action is not so violent as that of the cyanide, it is properly recommended to fix negative pictures.

Fixing Solutions for Negatives.

Formula No. 1.

Hyposulphite of soda, ... 5 ounces.
Water, ... 10 ounces.

Formula No. 2.

Cyanide of potassium, ... 1 drachm.
Water, ... 5 ounces.

In case the image is fixed with the first formula, that is, with hyposulphite of soda, the plate requires to be washed with the utmost care, for if any of the hyposulphite of silver is left in the film, it will become manifest after the drying of the film, sometimes at the expiration of months, by the formation of a crop of crystals on the surface that completely ruins the picture. As soon as washed, the plate is ready for operations quite distinct from those in the positive process.

Intensifying or Redeveloping Process.

Formula No. 1. *Depositing Fluid.*

Iodine, ... 1 grain.
Iodide of potassium, ... 1 grain.
Rain-water, ... 1 ounce.

Formula No. 2. *For the Stock Bottle of the same material.*

Iodide of potassium, ... 1 drachm.
Water, ... 2 ounces.
Iodine to saturation.

Depositing Operation.

Take from ten to twenty drops of this solution to each ounce of water, and flow the developed plate with it. This operation can be performed in the diffused light of day. The plate must be kept in motion all the while, and the fluid poured off and on, in order to obviate all irregular deposition. The solution will gradually lose color, whilst the film in the mean time assumes a gray or yellowish-gray hue. If the negative does not require much additional opacity in the shadows, it is not necessary to carry on the depositing operation further than the gray film. The plate is now washed again.

Intensifying Operation.

Formula No. 1. *Nitrate of Silver.*

Nitrate of silver, ... 30 grains.
Rain, or distilled water, ... 1 ounce.

Take three drops of this solution with two drachms of water, and cover the plate with the fluid. Pour the fluid off and on several times.

Formula No. 2. Pyrogallic Acid. (Stock.)

Pyrogallic acid, . .	12 grains.	Keep in a dark place.
Acetic acid,. . . .	1 ounce.	

Formula No. 3.

Of this take, ...	1 drachm.	For immediate use.
Water, ...	7 drachms.	
Alcohol, ...	10 drops.	

To two drachms of No. 3, add ten drops of No. 1; mix intimately by shaking, and then pour it upon the plate, and keep it in agitation. The shades will soon increase in blackness and opacity. The operation is carried on to the greatest advantage by holding the negative over a light reflected from below, as in the dark-room, or near a doorway receiving its light from the sky. Stand sufficiently far back, and sidewise of the door, so that the light does not shine upon the negative directly from the sky, but is received as it is reflected upward from the floor, etc., below. The shadows will grow darker and darker; and the process has to be stopped as soon as the opacity is sufficiently dense. Experience alone can tell you exactly when to stop. The denser the background in the negative, if a white screen were used, the whiter the print will be; but the opacity may be so great as to require an hour or two for the subsequent printing operation, which is very inconveniently long. A certain connection exists, therefore, between the negative effect and the positive printing effect afterward, which experience has to teach; and even if you do not execute your own printing, this connection must not be lost sight of. In parts that must really appear white in the paper, the opacity must be dense enough to prevent you from reading print through them; taking this for your guide, separate such a part in the picture; keep your eye steadfastly upon it as it increases in darkness, and when it has arrived at the point indicated, pour off the intensifying solution, and wash very thoroughly. It sometimes happens that the film becomes contracted by this operation, or that the fluid gets between the glass and the film, and thus the latter becomes loosened, and is liable to peel off. Careful experience will teach you how to retain the collodion in its place.

Where many prints have to be taken from a negative, it is quite requisite to varnish the film when dry. But almost all varnishes have a penetrating effect, like oil of turpentine on paper, and thus diminish the opacity of the negative. This has to be taken into consideration, and the negative

must be intensified in accordance deeper than required when without varnish. The property of a varnish, suitable for such purposes, must be a sufficient hardness of film to prevent scratches, insolubility by the heat of the sun, freedom from any liability to cracking by contractility, perfect transparency, as little penetrating power as possible, and freedom from all action upon the film.

Varnish. Formula.

White lac, ...	4 ounces.
Picked sandarac, ...	4 drachms.
Alcohol, (concentrated,)	60 ounces.
Oil of bergamot, ...	20 drops.

Dissolve by the aid of a water-bath, and filter.

To obviate the diminution of opacity by means of the varnish, I frequently flow the plate with a dilute solution of gum-arabic or gelatine, which is allowed to dry; and then the plate is varnished.

CHAPTER XXIII.

TRANSFER PROCESS OF COLLODION POSITIVES ON JAPANNED LEATHER, LINEN, PAPER, ETC.

Before the preparation of the iron plates, known as Melainotype etc., the transfer process had more importance. A transferred positive has all the beauty of a melainotype, with the advantage of being non-inverted, and upon a medium that suffers less from being bent. It is especially suitable for inclosure in letters to distant friends. Any fine substance, as very thin leather, linen, paper, etc., neatly and evenly varnished with black Japan, is adapted for the reception of the collodion transfer. Such substances can be obtained from the wholesale dealers in photographic goods; they can also be prepared in the following manner: Take, for instance, a piece of fine leather, or oiled silk, and fix it on a stretcher, or flat board; then varnish it on one side with the following mixture.

Black Japan.

Chloroform, ...	8 ounces.
Asphaltum, ...	8 ounces.
Canada balsam, ...	2 ounces.

The ingredients when intimately mixed are poured in sufficient quantity upon the side to be japanned, and allowed to dry at a gentle heat. The varnish will soon set, and in a short time will be ready for the transfer operation. If metallic plates have to be japanned, such as the melainotype, that have to be introduced into the silver bath, they must previously be coated with common positive or negative varnish, in order to be prevented from exercising any injurious effect upon the silver bath, and afterward they are japanned on one side, as just described. These plates are not used in the transfer process, but to receive the image instead of glass.

The collodion on glass, when dry, or after it has been dried, adheres to the plate with considerable tenacity. The film for transferring, too, must be of the glutinous kind, containing more ether than alcohol. After the image has been

fixed, and washed, and whilst the film is still moist, it is flowed with the following solution:

Alcohol, ...	5 drachms.
Water, ...	5 drachms.
Nitric acid, ...	from 12 to 16 drops.

The solution is immediately poured off, and the plate drained of its superfluous fluid. The prepared leather, etc., is now cautiously laid upon the film, beginning in the middle, and allowing either end to fall gradually upon the collodion, so as to exclude all bubbles of air. The leather is next pressed with a burnishing tool all over the posterior surface, so as to bring it in intimate contact with the film beneath. If the operation be performed with dexterity and care, bubbles of air may be avoided; if any are observed, they must be removed by drawing up the leather gently before adherence takes place, and then by letting it down again with more caution. Having succeeded in bringing the collodion film and the leather in juxtaposition, without a single bubble, the plate is warmed gently over an alcohol-lamp, after which the leather can be removed, together with the collodion film adhering to it. The leather is now rinsed in pure water, and allowed to dry.

If it be desired that the collodion picture shall be in the form of an oval, circle, or square, etc., we proceed as follows: Place a mat with the proper opening upon the collodion picture, and with a pointed style go round the picture, cutting it as it were from the glass. All the collodion on the outside of this line is next removed with a piece of wood, as for instance, the end of a match cut to a flattened point, and made moist. By using this like a scraper, and keeping it moist, the collodion will gradually disappear, and the surface will be kept clean. The picture is afterward transferred to leather, enamelled cloth, etc., by the method just described.

Transfer Paper.

Paper is prepared as follows for receiving the collodion positive. Dissolve

Asphaltum, ...	3 ounces in
Turpentine, ...	6 ounces.
Boiled oil, ...	8 ounces.

Afterward take—

India-rubber, (belting,)	1 ounce.
Camphene, ...	2 ounces.

Dissolve the latter by a gentle heat, and then add it to the first solution. Shake the solutions well together, and then

allow the mixture to settle for a few days. It is afterward decanted into a dish. Ordinary unruled fine paper, in pieces of the proper size, is floated on this bath, and afterward hung up to dry. By repeating the process, the paper finally receives a very smooth surface. It will keep for any length of time. With a mixture of one ounce of alcohol, and three drops of nitric acid, moisten both the collodion film and the prepared paper surface, and pour the surplus back again into the bottle. Dip the plate and the paper into soft water several times; then, laying the plate on the table, place the paper upon the collodion positive in the manner already prescribed, in order to exclude bubbles; press them close together until the paper is quite smooth. The latter may now be raised, and removed from the glass, and dried.

CHAPTER XXIV.

COLLODION POSITIVES ON GLASS BY TRANSMITTED LIGHT.

Transparent Positives.

This kind of picture is used more especially for stereoscopic slides. Its application to church-windows, etc., for which it is so well adapted, has not yet been introduced to any great extent. A transparent positive may be produced either by means of the camera, or by direct contact of the negative. By means of the camera the proceeding is as follows:

In the first place we require a good orthoscopic lens, or, in fact, any lens that will produce with an inserted diaphragm a clear, well-defined picture of a page of print, without distortion of the marginal lines. Ascertain the length of the equal conjugate focus of the lens, that is, half the distance between the object and its image, when these are of the same size. Then construct a square cylinder of thin wood, in which the camera can slide; let the inside be blackened with a solution of ink, laid on twice. At the end in front of the lens, cut out an aperture of the size of the negative, leaving a ledge of three sixteenths of an inch all round on which the negative can rest. Fix the negative by means of a tack or small pin in each corner. It is inverted laterally, that is, the sides have changed places, left being right, and right left; and the collodion side is inwards, or facing the lens. This compound camera is now pointed either to a white cloud, or directly to the sun. Focus the image on the ground glass with great accuracy; it is much more difficult to obtain the right focus in such work than in ordinary portraiture, and a microscope is invariably required to obtain a sharp and correct copy. It facilitates the operation of focussing to find some small point, or mark, or wrinkle, and then to slide the camera in the cylinder backward and forward, until you think you have got the sharpest definition, and afterward to make the final adjustment with the microscope. Inasmuch as the lens is within the cylinder, all the focussing has to be performed by means of the sliding of the camera; and when

once the right focus has been found, the cylinder and the camera are firmly fastened; and a mark is made by which at any time afterward the adjustment can be quickly made, without resorting to an independent system of focussing on each occasion when a transparent positive has to be taken.

With the bright rays of the sun, and an orthoscopic lens, probably as much as from one to three minutes' exposure will be required; whereas, with an ordinary well-corrected portrait lens, the time will vary from a quarter of a minute upward. It is supposed, of course, that a small stop is used, so as to obtain a sharp and undistorted picture. With a large diaphragm, naturally a much shorter exposure would be quite sufficient. All the rest of the operation of collodionizing, developing, and fixing is the same as that already described. The picture is developed near the pane of glass which admits light from below. A bright, transparent picture is particularly required in this operation; there must be no fogging, and the shades must be pretty deep and distinct.

Such is a general outline of producing transparent positives on glass, by means of the lens and camera; but there are specialties that demand our attention. One of these refers in particular to the nature of the negative. A bright, transparent, and clear negative, somewhat less opaque in the shadows than for the common printing process on paper, is best adapted for the purpose in question. If a negative had to be specially prepared for producing transparent positives, I would recommend its preparation as above described, only giving a trifling less exposure, and using a slightly stronger developer. The reduction, too, must be stopped the very moment there is the slightest tendency to veiling. Finally after the negative is fixed, supposing it to be already sufficiently intense not to require any redevelopment, (which is a very desirable condition,) it is flowed with a solution of iodine in iodide of potassium for a few moments, taking care to keep the fluid in motion; this operation must be very short in duration. Pour off the solution; wash, and again fix with cyanide of potassium. This operation may be appropriately termed the *Clarifying Operation*, for the negative becomes quite clear and transparent, from the fact that in those parts where there was a tendency to a veil or fog, the reduced silver that produced it has been converted into iodide of silver, and dissolved by the cyanide in the second fixing. This clarifying operation must be employed with extreme care, lest the minute details might be carried off at the same time.

Varnishing, it is true, will also reduce the amount of density in the shadows, but it does not remove any of the fogging, and besides this it increases the opacity of the transparent parts; in short, it tends to diminish contrast. On this account it is preferable not to varnish the negative.

By fixing the negative in the holder with the collodion side next to the lens, the positive collodion picture will be on the right side of the glass, erect and free from lateral inversion. If it were fixed otherwise, then the positive would be on the under side of the glass, and would not appear so brilliant when mounted.

Another specialty to be observed, refers to the color of the positive. The shadows, after reduction with the protosulphate of iron, are grayish or silver-white. For viewing by reflected light, if they were in their proper place, they would be endowed with a very pleasing aspect; but viewed by transmitted light, the contrast is by no means agreeable; the shades are too gray. The object, therefore, is to communicate to them a rich black hue. We effect this by pouring over the film a sufficient quantity of a saturated solution of bichloride of mercury free from acidity. As soon as the film is black, pour off the mercury, and wash the plate in rain-water.

The next operation is to flow over the plate a saturated solution of cyanide of silver in cyanide of potassium.

Formula No. 1.

Cyanide of potassium, ...	100 grains.
Rain-water, ...	2 ounces.

Nitrate of silver solution, (50 grains to the ounce,) as long as the precipitate is dissolved.

This solution, after filtration, is ready for use. Or a solution of cyanide of copper may be substituted for the silver salt.

Formula No. 2.

Cyanide of potassium, ...	100 grains.
Rain-water, ...	2 ounces.

Nitrate of copper solution as long as the precipitate is dissolved by shaking. Filter as before, and use.

The image when flowed with either of these menstrua assumes an intense black hue. The solutions can be used over and over again until exhausted.

The plates are now washed carefully and thoroughly, and again fixed with solution of hyposulphite of soda, but *not with cyanide of potassium*, because it reduces the silver to

a white film again. This mode of blackening the silver film may be used also as an intensifier.

When this operation is complete, the plate is washed and dried, also varnished, unless the slide has to be mounted with a glass before it, when the varnishing may be omitted. Previous to mounting, it may be colored either on the picture side or on the back, by which a very rich effect is produced. When positives are thus colored, they are mounted with a plate of ground glass behind them, and thin transparent glass in front.

For the magic lantern, the slides must be preserved as transparent as possible; consequently no ground glass is used behind. The coloring, too, must be laid on, either before varnishing, or afterward, very lightly and artistically, so as to impede the passage of the light as little as possible.

CHAPTER XXV.

ENLARGEMENT OF NEGATIVES BY THE ORDINARY CAMERA.

HAVING obtained a sharp transparent positive, it is evident that, by a reverse process, a negative may be reproduced, and of course as many negatives as may be required. It is thus that photographic negatives may be stereotyped. Not only can we thus procure a matrix for the reproduction of a valued negative, (a proviso which ought never to be omitted,) but from such a transparent positive may be obtained *enlarged negatives.* The enlargement depends upon the capacity of the lens of the camera. The bellows part of the latter admits of greater elongation and correlative lateral expansion than that of the ordinary camera. As soon as we have found the distance of equal conjugate foci, as before directed, then by diminishing the distance between the positive and the lens, we increase the distance between the lens and the new negative. (The transparent positive is placed in the opening in front of the lens, where originally the negative was placed.) But in the same proportion as this distance is increased, in like manner is the new negative enlarged. The amount of enlargement* will depend, as soon as the camera is arranged, upon the perfection of the lens, which, be it ever so good, has to be stopped down to a small aperture, in order to overcome spherical aberration, which causes distortion, and detracts from the sharpness on the peripheral parts. With the bright light of the sun there is no difficulty in thus obtaining a negative magnified ten times diametrically with such a lens, and in a very reasonable time. Thus a stereoscopic portrait or view may be enlarged into a cabinet-sized picture or landscape, with but a small expenditure of time and expense. Nor is a large lens required for this operation. The same lens with which the original negative was taken may be applied to the purposes of enlargement. In making enlarged negatives, however, we require particularly a greater amount or a greater intensity

* Vide Chapter for the table of distances and magnitudes.

of light, so that with a given light the exposure must be so much the longer. In such cases, then, where the enlargement is as great as before mentioned, it is advisable to construct a system of reflectors in front of the aperture for the reception of the negative or positive.

Reflectors used as Condensers of Light.

Let the aperture for the negative, etc., be four inches square; then construct a frustum of a pyramid out of four pieces of silvered glass, of the following dimensions: The narrow end of each piece is four inches, the broad end is $14\frac{73}{100}$ inches; the length of either side is $21\frac{56}{100}$ inches. Fix these pieces of glass in a tin frame, with the silvered side inward, and attach the frustum to the aperture for the negative. When the latter or a transparent positive is in its place, turn the camera (which for this purpose must be fixed upon a universal joint) toward the sun; it will be found that the intensity of the light has been greatly increased. Such a condensing reflector is calculated to condense all the rays that fall upon it, either by one or two reflections, so that they all fall upon the negative. But the amount of light that impinges directly upon the larger base of the frustum is at least thirteen times greater than that which falls upon the smaller base; and if there were no loss of actinic power by reflection, the light condensed on the negative would be thirteen times more than would impinge upon it without the aid of the condensers. If then the light be increased by ten times in intensity, and the picture be enlarged by ten times, the time of exposure would remain the same.

CHAPTER XXVI.

TRANSPARENT POSITIVES BY CONTACT BY THE WET PROCESS.

In this operation, as in the preceding, a very bright, sharp, clear negative is required. Transparent positives by direct contact are obtained best by dry collodion plates; they can, however, be prepared as follows: Let the negative be varnished and thoroughly dry. Place it in the plate-holder, as you would the sensitized collodion plate. Next cut out a piece of thin writing-paper of the same size as the negative, and then cut out of this an interior piece of the same shape, thus leaving a margin all round of about a quarter of an inch in width. Place the marginal rectangle upon the negative, and see that it lies in contact all round. Now prepare a collodion plate; sensitize it, and allow it to drain thoroughly; then place it also in the plate-holder, and in contact with the margin of paper, and close the slide and shutter. Previously a cylinder of thin wood, blackened with ink within, is prepared with grooves at one end for the reception of the plate-holder, and open at the other extremity for the reception of the light. Such a cylinder may be six feet in length. The object in view is to obtain only *direct and parallel rays of light*, to counteract the effect arising from the imperfect contact between the wet plate and the negative. Direct the open end of the cylinder to a white cloud, and then draw the slide for a moment, that is, a fraction of a second, and close it again. Probably this may be too much exposure, in which case it will be well to paste a sheet of white paper over the end of the cylinder, in order to moderate the action of light. The plate is afterward taken out, developed, blackened, and fixed, as already described.

On removing the plate from the holder, the marginal paper will probably adhere to the wet collodion; if so, remove it carefully, and lay it on a flat surface to dry. It is possible too, owing to the inequality of surface, that the negative has been wetted by the superincumbent wet plate, in which case it must be carefully washed in rain-water, and dried. Without the long cylinder, oblique rays would enter from all sides, and destroy all the sharpness of the picture by producing thick lines out of thin ones. Whereas in the manner prescribed, vertical rays alone are admitted to the bottom, and entering perpendicularly are not refracted.

CHAPTER XXVII.

COLLODION NEGATIVES OR POSITIVES COPIED FROM COLLODION OR PAPER POSITIVES.

In this chapter will be described the method of copying photographic or typographic prints. Three things are absolutely requisite in order to secure a good copy; these are, as before, *a good lens*, *good light*, *sharp focussing*.

For the purpose of copying I invariably use the *full blaze of the sun*. Some artists pretend that the system is false. They take their ideas from the effects produced on solid objects, where the contrasts are so immensely exaggerated; and they do not bear in mind that on a flat surface there can be no shadows, because there are no prominences. All the contrast that can possibly be obtained in the copy, exists already in the original.

Upon a light built table or board, two inches wider than the camera, nail down on either side a ledge of wood, within which the camera can slide longitudinally. At one foot's distance from one end erect a piece of board of the same width as the long board, and a foot high; let it be fixed perpendicular to the board and to the direction of the ledges, by means of triangular braces near the end of the long board. On the side fronting the camera, construct two beveled ledges, one on either side, perpendicular to the base-board, of half-inch material; within this a piece of half inch board, six inches wide, is correctly adjusted by planing, so as to slide up and down with facility; on its surface on either side is a similar bevelled ledge running horizontally, in which another thin piece is made to slide with ease. This last piece is the holder of the print to be copied. By the construction it will be seen that the holder admits of motion vertically and horizontally, and that thus the print can be accurately adjusted in a correct position in front of the lens, so that the center of the print and the axis of the lens coïncide. The print, too, will thus be parallel with the ground glass in the camera. Small slips of tin plate are screwed on the surface

of the holder, in order to clamp down the print, and to prevent any unevenness on its surface by cockling from the heat. Pins or tacks are inadmissible here, because of the shadows produced by them on the print to be copied. As soon as this mechanical contrivance is complete, slide the camera up to the holder, and adjust the latter so as to bring its center in front of the cap of the lens, and with a pencil draw a circle around the cap and upon the surface of the holder. Whilst the slides are in this position, mark the vertical and the horizontal slide, so that at any time afterward the holder can be brought into position with great facility. The holder is now taken out, and the print to be copied is fixed, so that its center coincides as near as can be with the center of the circle; it is placed upside down, so that its four boundaries are vertical and horizontal. Now slide the print-holder into its place, and slide back the camera until the picture on the ground glass is of an exactly equal size with the original. A microscope is required in this operation, in order to focus with the utmost accuracy. Do not despise the microscope, it is almost indispensable. Focus whilst the sun is shining upon the picture. Use a very small stop. Let the sun shine from one side slightly, with your back turned toward this orb. The most agreeable time to copy by this method is early in the morning; the light is then clear, and by turning the table on one side, the rays illumine the object very brilliantly, and without any haze; turn the table always so that no shadow of the camera or lens falls upon the object. As long as the sun shines, you can thus copy, and copy perfectly; the morning hours being personally more agreeable, photographically perhaps not as effective as toward noon. The time of exposure will vary according to the power of the lens, the size of the diaphragm, and the magnitude of the copy. With a lens of three inches focus, of C. C. Harrison's manufacture, with a diaphragmatic aperture of one third of an inch, and when the copy is equal to the original, an exposure of fifteen seconds will produce a rich negative. The same conditions remaining, the one fourth orthoscopic lens of Voightlaender, whose focus is about twelve inches, will require an exposure of between two and three minutes to produce the same effect.

By the first-named lens, an ambrotype or melainotype will require only two or three seconds.

By adhering cautiously to the rules prescribed, and above all things by very accurate focussing, and by taking care that the surface of the photograph, plate, or print is perfectly

smooth, and in a plane parallel with the ground glass, copies can be obtained that can scarcely be distinguished from the originals. But a very slight undulation on the surface of the print, or deviation from parallelism is sensibly observable when the conjugate foci are equal, and much more so when the copy is amplified. The camera, when once adjusted for the day, is strapped down firmly to the board, so that the conditions of focussing can not be altered by inserting the tablet, etc. It is necessary to cover the whole camera, and especially the posterior opening, with a dark cloth, lest a single ray might penetrate into the interior. Close the lens always with the cap before you take out or put in the slide, because it is easier to move the cap than the slide. After the slide has been taken out, wait until all oscillation or vibration has ceased, before you remove the cap. Perform all your motions in this operation firmly, but with gentleness, not roughly and in haste. Whilst the ground glass is out, place it where no reflection can interfere with the print to be copied. The board on which the camera slides, as also all the other parts, had better be stained black, or of some neutral tint.

If the light of the sun could be directed through a long cylindrical opening, and then applied directly to the illumination of the print, without interference from reflections in all directions, the operation would be neater and more effectual.

Where copying has to be performed by diffused light, this light must be small in quantity, proceeding from a single pane of glass, as reflected from a white cloud or a white sheet, and all reflections must be carefully avoided. The management of the light in copying is reduced to very simple conditions—a *single light* is all that is required—no more contrast is required ; see that none is communicated by unnecessary and extraneous shadows from neighboring bodies, caused by secondary light. A single light, where there are no bodies in its direction to the print, will produce no shadow, consequently all shadows must proceed from secondary lights; shut up, therefore, every aperture, excepting the one which is to illumine the print or type to be copied. These precautions will bring with them success; the neglect of them will cause you to quit copying with disgust for want of success. With such a contracted light, the illumination can not by any means approach that produced by the direct rays of the sun ; the consequence will be firstly the necessity of using a large diaphragm, and of thus diminishing the sharpness of the copy; and, secondly, of increasing the length of the expo-

sure. The difference of illumination in copying and in direct portraiture is very distinct; for the latter purpose a single light without reflection will not, *can not* succeed; whereas for copying, more lights than one would be not only so much more than sufficient, but at the same time probably in most cases injurious. Do not, therefore, confound the two operations, and blame the light for your mismanagement of it, for in nine cases out of ten your want of success is to be attributed to this mismanagement.

CHAPTER XXVIII.

STEREOGRAPHIC NEGATIVES AND LANDSCAPE PHOTOGRAPHY.

HEREAFTER I shall devote a chapter to the stereograph and its philosophy; in this I shall simply give plain instructions for taking the stereoscopic negatives by the wet collodion process. For in-door work, and for out-door scenery where the objects are close at hand, a camera is required, which is furnished with two lenses of short focus, and of exactly equal power, for the production of stereoscopic negatives. These lenses are fixed in the same horizontal line; and about two inches and a half is the distance between their centers. Each lens can be attached to a separate slide, so that this distance can be slightly increased to two inches and three quarters, if found necessary. In the camera there is a vertical septum in the middle which divides it into two halves, one for each lens. This septum is nearly in contact with the collodion, and consequently makes a division line between the two images, which are taken on the same glass. The glasses for stereoscopic negatives are seven inches long by three and a half wide; I should prefer them eight inches by four, in order to have room for blunders and mishaps on the edges. The operation of focussing is the same here as before, only that there are two lenses to be adjusted. Fix upon a certain object which is to be the central or most important one, and turn the camera so that it is seen in the center of one of the pictures of the ground glass. Where architectural objects occur in such pictures, the camera must be perfectly horizontal, if you intend the vertical lines to be vertical in the negative. If it happen that such architectural objects can not easily be comprehended in the negative, without tilting the camera, use this expedient; for, after all, the distortion which it produces on the print can be rectified in some measure afterward, by tilting the print in the stereoscope to the same amount. If portraits are to be the principal things, they must be placed in such a position artistically and photographically as to appear well, and at the same time in perfect

focus; if certain objects are to be preëminent in esteem, direct your attention upon them when focussing, and regard the rest as secondary; and finally, if the whole landscape is the object, divide up the focus, or focus in such a manner that the view as a whole is tolerably sharp; this can easily be done by focussing an object at some distance, and by excluding all near objects from the print. In such cases, however, we require long-focussed lenses. For in-door operations the portrait combinations are used; for landscapes a pair of triplets, or of ordinary view lenses, produce excellent results. The globe lens of C. C. Harrison is all that can be desired for field work; it comprehends a larger angle than almost any other lens, and produces an irreproachable picture. Ross, Dallmeyer, and Grubb manufacture stereoscopic lenses for landscape photography, with which instantaneous pictures can be produced, and which in all other respects are highly commended by the intelligent amateurs of Great Britain. Jamin's view-lenses produce very neat results, and are besides lower in price than those already alluded to.

In the ordinary stereoscopic negative, as in every negative, the pictures are laterally inverted, and when printed, this inversion is corrected only for each picture individually, for the right-side picture is still inverted and in the place of the left-side picture. In consequence of this, the printed stereographs have to be cut apart, and mounted so that the right-hand photograph is placed on the right side, and the left-hand photograph on the left side. When taking pictures of still life, as also others, where the living objects are not in motion, it is very easy to manage matters so as to invert the photographs on the negative. The method is as follows: Take a large-sized camera-stand, allowing sufficient space for the camera to slide laterally. Placing the camera in the right-hand corner, focus the left-hand lens. Next slide the camera gently, or lift it up and place it in the left corner, and focus the right-hand lens. The space between the centers of the two pictures thus focussed must be about two inches and three quarters. Whilst the camera is in this position on the left side, insert the sensitized plate, take out the slide, uncover the right-side cap for a second or two, and take this picture. Then close up the lens, lift up the camera gently and place it on the right side. In this position uncover the left-side lens for the same length of time. In this way, and in the space of ten seconds or so, the two pictures can be taken in a proper condition for printing so as to produce a non-inverted stereograph. For such work it would

be no difficult task to contrive a slide by which a single lens would be all-sufficient; that is, when the camera is on the left side, the lens must slide to the right side, and *vice versâ* on the right side.

As soon as the negative is thus taken, it has to be developed before it gets dry. The development and fixing can be performed in a dark tent specially arranged for such purposes. Various contrivances have been adopted in landscape photography for these operations. For my own part I consider a simple hand-cart, with iron rods from corner to corner diagonally, in the form of semi-ellipses, and covered with a balloon-shaped tent, a very practical accommodation. But each *successful* photographer is somewhat of a genius, and can easily arrange a dark chamber according to his own taste and materials on hand.

Negatives thus taken and fixed are placed carefully away in slides where they can not be injured during transportation home. In the evening, or the next day, or at any convenient time, the negatives are examined; if clear, transparent in the lights, and sufficiently intense in the shades, they are varnished. On the contrary, if the opacity of the shadows is not deep enough, although the appropriate gradation exists between the lights and shades, it will then be deemed necessary to proceed to intensification. Previously the edges of the negatives must be varnished to the depth of one tenth of an inch upon the collodion, to prevent its peeling off during the operation. This is effected by dipping the quill end of a feather into the varnish, and then running along the edge of the collodion and of the glass, with this portion of the feather slightly inclined, so that the varnish does not drop off, a sufficient quantity is attracted upon the collodion as you proceed. After this put the negatives aside, that the varnish may become thoroughly dry and hard. As soon as it is dry, immerse the plates in rain-water, and allow them to remain there for about a quarter of an hour, by which time the collodion film will have become saturated with this fluid. Now you may commence the intensifying process, as before described in the chapter on collodion negatives.

Instantaneous Stereographs.

There is no branch of photography that has so intensely attracted the attention of wealthy and intelligent amateurs as that of stereography; on this account we owe to them most of the discoveries in the art; and the new incitement that has arisen in this department, that of *Instantaneous Ac-*

tinsim, has communicated a *new impulse* from which we derive fresh deductions and new results. The co-laborers in stereographic pursuits in Europe, but more especially in Great Britain, beginning with royalty downward to the rural gentry, are very numerous, very intelligent, and, best of all, *very communicative*. They take out *no patents* for their discoveries, they make *no commerce* with secrets, odious things which noble minds eschew. It is to such a goodly host of fellow-soldiers in the stereographic camp that we must attribute the riches of our knowledge. That light can act actinically in the twinkling of an eye is no tax upon cultivated conceptions; for in this same wink, which to us is instantaneous, Light has run round the earth several times; in this twinkling, Light has seen more than man in his age can ever see; in this twinkling, millions of fresh portions of light have impinged on the model, and have rebounded to the lens and through it, and have nestled upon the sensitized film—we are justified then in expecting that instantaneity in photography is feasible. The sole questions present themselves: What film is sensitive enough to receive it? What developer refined enough to produce the reduction? The questions are answered by facts. Instantaneous stereographs exist in great number, and the artists that produced them have bequeathed to the public their *modus operandi*. I can not do better than quote a few instantaneous processes. All amateurs agree in certain particulars, which conduce to success. The light must be *very bright;* the atmosphere *very clear;* the glass *very clean;* the collodion *very ripe;* the developer *very sensitive*, and the lens *very well corrected*, and *capable of producing a sharp picture with a large diaphragm;* the *shorter the focus the better* within proper bounds.

Instantaneous Process of Lieutenant-Colonel Stuart Wortley.

Collodion.

Ether,	1 ounce.
Alcohol, spec. grav., .802,	2¼ ounces.
Iodide of lithium,	15 grains.
Bromide of lithium,	6½ grains.

The pyroxyline is first steeped in the iodo-bromized alcohol, and the ether then added.

Silver Bath.

Re-crystallized nitrate of silver,	35 grains.
Distilled water,	1 ounce.

Iodized by leaving a couple of coated plates in the bath for several hours; acidified at the rate of from two to three

drops of nitric acid to the ounce of bath. Leave the plate in the bath longer than you would if the collodion contained only iodine.

Developer.

Sulphate of iron,	2 ounces.
Distilled water,	12 ounces.

Dissolve.

Acetate of lead,	24 grains.
Water,	2½ ounces.

Dissolve.

Mix the above solutions, and when the precipitate has all settled, decant off very carefully, and then add:

Formic acid, (pure,)	2½ ounces.
Acetic ether,	6 drachms.
Nitric ether,	6 drachms.

From this stock-developing solution take as much as is required, and add acetic acid, according to the temperature, generally in about the same quantity as the formic acid. The developer is kept on the plate until the necessary detail is brought out; after which the plate is well washed and fixed with a weak solution of cyanide of potassium.

Intensifier.

Pour on a saturated solution of bichloride of mercury; as soon as the proper color is attained, the plate is thoroughly washed, and a five-grain solution of iodide of ammonium in water is poured on and off until the desired depth has been attained. (The reader will comprehend the rationale of this proceeding by carefully perusing my remarks on this subject in a preceding chapter.) After this the following solutions are used:

No. 1.	Pyrogallic acid,	12 grains.
	Water,	1 ounce.
No. 2.	Citric acid,	50 grains.
	Nitrate of silver,	10 grains.
	Water,	1 ounce.

Pour a few drops of No. 2 into No. 1, and pour on and off, until the negative has assumed the required density. After which wash the plate thoroughly in several waters, dry and varnish.

Valentine Blanchard prefers a bromo-iodized collodion, although under certain conditions he admits that a simply iodized collodion is more rapid, but at the same time there is less contrast. The silver bath is composed of re-crystal-

lized nitrate of silver, forty grains to the ounce of distilled water, and saturated with iodide and bromide of silver. It is always *supposed to be acid*, to which is added a small quantity of moist oxide of silver; after the solution has been sufficiently agitated, it is filtered, and then acidified by a weak solution of nitric acid, containing three or four drops of acid to one hundred of water. This acid solution is added very cautiously, until the picture is quite clear and free from fogging. A bath so prepared is very sensitive whilst new, and it is only whilst new that any bath is likely to produce instantaneous results.

The developer consists of the sulphate of the protoxide of iron, generally thirty, and frequently fifty grains to the ounce of distilled water, acidulated with glacial acetic acid, because the ordinary acid contains impurities.

The negatives, when they require it, are intensified with a saturated solution of bichloride of mercury in cold water, until the film is of a uniform gray color; they are then washed and treated with a solution of iodide of potassium, (one grain to the ounce of water,) by pouring it on and off, until the film assumes a greenish-slate color. There should be no greenish hue on the wrong side of the plate, for this is an indication that the strengthening has been carried too far.

Hockins uses simply iodized collodion; his bath contains thirty grains of nitrate of silver to the ounce of distilled water, and is iodized by throwing in a proper quantity of iodized collodion; it is then filtered. Two minims of pure nitric acid are added to each eight ounces of the bath, which is prepared twenty-four hours before using.

The developer consists of

Formic acid, (strong,)	2 drachms.
Pyrogallic acid, ...	20 grains.
Distilled water, ...	9¼ ounces.
Alcohol, ...	½ ounce.

This is kept on the plate until the operation is complete.

Claudet's Developer.

Pyrogallic acid, ...	20 grains.
Distilled water, ...	7½ ounces.
Formic acid, ...	1 ounce.
Alcohol, ...	6 drachms.

Instantaneous Shutters.

The means by which light is cut off instantaneously, which means *very quickly*, are various, and many of them are very ingenious. Some of these shutters are behind the posterior

combination in the lens, and are so graduated for other than instantaneous purposes as to give a shorter exposure to the sky than to the foreground. For my own part I prefer simplicity, and I use means in which I have been anticipated by Wilson and others. My *cap* is my shutter. Sometimes I use a book. With both I have succeeded, and naturally suppose others can do the same. I do not despise the ingenious shutter.

In very many cases, with all the preparations in a normal condition, as we suppose, success does not attend our manipulations. There is still, therefore, a yearning for some method more reliable. I have frequently succeeded in taking instantaneous positives, that could not be intensified into respectable negatives. But from a collodion positive we know that a collodion negative can very easily be prepared by copying. In this way many a well-valued view is obtained, which otherwise would have to be sacrificed. On such occasions, therefore, where there is the least doubt of success, it is advisable to develop with the ambrotype developer, containing nitrate of potassa, nitrate of silver, and free nitric acid—the latter, however, in very minute quantity. We shall thus probably obtain a good collodion positive on a melainotype or ferrotype plate. This is afterward carefully copied into a negative. In several instances I have obtained a tolerable effect by using solution of sulphate of iron without any acid.

CHAPTER XXIX.

NEGATIVES ON PAPER.

These comprehend the Talbotype or Calotype, and the Wax-Paper Process of Legray, and its modifications.

The Talbotype or Calotype Process.

This process is a negative on paper. Talbot published, six months before the discovery of the Daguerreotype, his process with the chloride of silver; and the year following the Calotype, or, as it is now frequently denominated, the Talbotype, was made known. The object is to obtain a deposit or film of iodide of silver of a fine and even structure upon the surface of paper. The best paper for this purpose is of the English manufacture, being sized with gelatine, the foreign papers being sized with starch.

There are two methods of iodizing:

1st. Float the papers on a solution of iodide of potassium, and allow them to dry; afterward float them on a solution of nitrate of silver. By double decomposition, a film of iodide of silver is formed on the surface in contact with nitrate of potassa.

2d. Add a solution of iodide of potassium to one of nitrate of silver. Collect the yellow precipitate, and dissolve it in a strong solution of iodide of potassium. The paper is floated for a moment upon this solution and dried. It is then floated upon water which decomposes the salt, and precipitates the iodide of silver in a very finely divided state on the surface of the paper. The sheets of paper are then dried. Their color is a pale yellow, and they are as yet not sensitive to light.

To Sensitize Calotype Paper.

Float the papers, or rather brush over their surfaces a solution of nitrate of silver, containing both acetic acid and gallic acid. Acetic acid acts here as elsewhere: it diminishes the energy of the decomposition; it preserves the whites of the paper.

The Talbotype process in more definite terms stands as follows:

Float the paper in the following solution for a minute:

Nitrate of silver,	60 grains.
Distilled water,	2 ounces.

Hang up the paper in a dark room to dry. Next float it in

Iodide of potassium,	1 drachm.
Distilled water,	2½ ounces.

for ten minutes; afterward it is soaked in water for an hour, in order to remove the excess of iodide, and then dried. It is sensitized by brushing over it the following solution:

Nitrate of silver,	25 grains.
Distilled water,	4 drachms.
Glacial acetic acid,	1 ounce.
Saturated solution of gallic acid,	1½ ounces.

In a few seconds the excess is allowed to flow off, and, after draining, it is placed between folds of blotting paper, when it is ready for immediate use. If the sensitized paper has to be kept some time, a much weaker solution of gallo-aceto-nitrate is used than that just prescribed. To every ounce of the above solution add from thirty to fifty ounces of distilled water, according to the temperature of the climate and the time it has to be kept.

An exposure of the paper in the camera whilst still moist for a second or two will produce a latent image, which is developed in full intensity by washing the paper with a mixture of four parts of the saturated solution of gallic acid, and one part of a solution of nitrate of silver, (50 grains to the ounce of water.) The image soon begins to appear, and is fully developed in a few minutes.

Fixing of the Negative.

Immerse the prints in a solution of bromide of potassium of ten grains to the ounce, or in one of hyposulphite of soda, as was afterward indicated by Sir John Herschel, of one part of the salt to ten parts of water, until the yellow iodide has been completely removed. The prints are finally washed in many waters, dried and saturated with white wax, which renders them transparent.

Several distinguished photographers have improved upon this calotype process, amongst whom we may mention Blanquart-Evrard, Legray, Baldus, Geoffray, Tillard, etc. Amongst all these improvements and extensions the wax-paper process of Legray is the most extensively employed. For tourists

it presents undeniable advantages in portability of material, and less liability to fracture. The wax, too, is a decided preservation of organic matter against the action of nitrate of silver.

Wax-Paper Process of Legray.

This is the simplest of all the processes for taking negatives on paper. It differs from the calotype, inasmuch as the paper is first waxed before sensitization in Legray's process, whereas in Talbot's the waxing part of the operation is the last. The paper suitable for this process must be thin, compact, homogeneous, when viewed by transmitted light, and the sizing of the paper must have been carefully performed. The English papers, although perhaps the finest, are not suitable, from the fact that they have been sized with gelatine, which presents great difficulty in the waxing. Saxony negative paper is considered the best.

Waxing of the Paper.

Obtain pure white wax from the bleacher's, or, in case this can not be procured, make use of the purest yellow wax that can be had. Next prepare a water-bath in which water can be kept boiling, either by lamps or a charcoal-fire. On the lid of the water bath place a porcelain or metallic plate, and when hot, rub the surface with the wax until it is covered uniformly with a layer of melted wax. Place upon this a piece of paper to be waxed. Rub its surface in like manner, until it is uniformly covered and transparent; and proceed in this manner until a pile of eight or ten papers is thus formed. If the dish is sufficiently large, place a piece of paper by the side of the pile, and then if the uppermost paper on the pile is quite transparent with wax, place it upon the dry paper; upon this place another sheet of unwaxed paper, and then on this the second one from the pile, and proceed thus until all the waxed papers are interleaved with dry sheets. The intention of this operation is to get rid of the excess of wax. Repeat this operation until the object is effected. Use a pad of cotton, and gentle pressure on the top of the pile as you procced, but be very careful not to make a single crease, otherwise the sheet in question is utterly spoiled. As soon as the paper ceases to shine from the melted wax, it is time to stop any further removal of wax. The sheets of paper, that have served as interleaves, may be used in the preparation of the next batch of waxed papers. The papers thus prepared are separated, and when the wax has congealed in

their fibrous structure, they are put away for future use between plates of clean glass.

Iodizing of the Paper.

Formula of Legray.

Rice-water,*	25 ounces.
Sugar of milk, ...	1 ounce.
Iodide of potassium or ammonium,	3 drachms.
Bromide of potassium, ...	48 grains.

Mix, dissolve, and filter. It is necessary to be supplied with an abundance of this bath, in order that the papers can easily be submerged, in which there is considerable difficulty by reason of the fatty nature of wax. This bath can be preserved a long time if kept, after using, in well-stoppered bottles.

When about to use this bath, pour it into one of the deep dishes employed in other operations in photography, such as for albumenizing or for toning, and let it be two or three inches in depth when poured in.

Take each paper by two opposite diagonal corners, and bending it into a hollow curve, immerse first one of the two other diagonal corners, and then the other; move the paper backward and forward, so as to get the fluid over it, gradually lowering the two corners held in the hands. Finally, by means of a glass triangle or bent glass rods, press the sheet entirely beneath the surface of the liquid, and remove all bubbles. Proceed in like manner with all the rest, carefully avoiding all bubbles between the papers. In about two hours the papers will be sufficiently impregnated with the iodizing solution; after which they are taken out singly by first raising one corner with a glass rod, and then seizing this with the left hand, it is removed from the liquid and allowed to drain for a moment, and finally hung upon varnished hooks to dry; or the papers may be suspended on a line by clamping each upper corner by means of a clothes-pin. Great care is required so as not to produce any wrinkle or crease in the papers in any of these operations. Several iodizing solutions have been proposed; the following with *whey or serum* is found to work well.

* Take seven ounces of rice and bruise it; then boil it in seven pints of rain or distilled water. As soon as the rice yields beneath the fingers, the boiling has been carried on far enough. The water is decanted, and to this are added forty-six grains of isinglass to each pint of rice-water, and the mixture is again boiled.

Whey* or serum, ...	25 ounces.
Sugar of milk,†	4 drachms.
Iodide of potassium, ...	3 drachms.
Bromide of potassium, ...	48 grains.

To the first of the two preceding formulas, containing rice-water, which is that of Legray, the author of the process was in the habit of adding a small quantity of the cyanide and fluoride of potassium, which are regarded now as of little or no consequence.

When removed from the iodizing bath, the papers have changed their appearance; they are now in a spongy condition and devoid of transparence; but by heat they may be restored to their original state. They frequently assume a violet color. When dry, the sheets of paper are placed one over the other, between pieces of blotting-paper, and packed in a well-closed card-board box for future use.

Sensitization of the Paper.

The alkaline iodide in the waxed paper is converted into iodide of silver by immersing the sheets in the following aceto-nitrate of silver bath:

Re-crystallized or pure nitrate of silver, . . .	7 drachms.
Glacial acetic acid, ...	7 drachms.
Distilled water, ...	12 ounces.

Filter the bath into the appropriate dish and sensitize one sheet at a time, or at least do not place one sheet over another, and take care to break up all bubbles on the surface of the wax-paper. After remaining two or three minutes in this bath, each sheet is taken out, immersed in a dish of rain-water, well washed, and then immersed in a second. Afterward it is taken out, allowed to drain, pressed between folds of bibulous paper until it is no longer wet, but simply

* Whey is obtained by boiling a couple of quarts of skimmed milk, and then adding, as soon as it begins to rise, acetic acid drop by drop until the curdling or coagulation is complete. The whole is then poured into a muslin bag and filtered. When it has cooled down to about 100° or blood heat, the white of an egg well beaten is added and stirred up. The liquid is again made to boil, and by the coagulation of the albumen, the whey becomes clarified. It is filtered a second time, and is then ready for use.

† Sugar of milk is concentrated whey, or that part which crystallizes when whey is evaporated to a syrupy consistence. This sugar of milk, or *lactin*, as it is also called, is purified by animal charcoal and again crystallized. It forms white, translucent, four-sided prisms of great hardness. It is soluble in five or six times its weight of cold water; its taste is feebly sweet, and feels gritty between the teeth. It enters into combination with the protoxide of lead, and is converted into grape sugar by boiling with dilute mineral acids. It can be made to ferment, but does not do so spontaneously.

moist. In this condition it may be placed between two pieces of clean glass and exposed immediately, or it may be gummed along the edges, and then pasted upon a sheet of card-board and dried for future use.

De Champlouis has introduced an improvement into this part of the process. As soon as the sheets are removed from the aceto-nitrate bath, each is placed whilst still moist on the glass destined to receive it in the plate-holder; it is then carefully pressed on the surface by means of a small piece of sponge, in order to expel any bubble of air which, by remaining between the paper and the glass, might produce uneven reductions. On the sensitized paper a sheet of blotting-paper is in like manner applied by the sponge, and afterward a sheet of wax-paper or wax-cloth, which subserves the purpose of a final pressure. These two sheets must be thoroughly moistened with distilled water; they form a sort of cushion, which is pressed together by a second glass of the same dimensions as the first. The whole arrangement may then be placed in the plate-holder, for it is ready to receive the view immediately, or at any time within twelve days. By this expedient the paper dries very slowly from the edges to within. No washing is required before exposure, which is a great saving of time.

Iodized wax-paper, whatever may be its color before, whether yellow, reddish, or violet, is very quickly bleached in the silver bath.

Exposure to the View, etc.

The sensitized sheets, however prepared, must be protected against all access of light, otherwise they will be utterly spoiled. There are changing-boxes to be had for the reception of waxed paper sheets as also for dry plates; these are so arranged as to contain a certain number of sheets or plates, and to expose one at a time without any injury to the rest. Without such an arrangement, the tourist will be obliged either to have as many plate-holders as plates, or to have a small dark-chamber in which the hands can make the requisite changes by feel. The time of exposure of course is variable, according to temperature and the brilliancy of the light. Two or three minutes in a good light will in general be sufficient; in ordinary light on an average from ten to fifteen minutes will be required.

Development of the Image.

This operation may be performed right away or any time within twenty-four hours. In extreme cases the develop-

ment may be postponed for a week; but the best results are obtained by developing immediately after exposure. The image, as a general thing, is not visible when taken from the plate-holder, excepting, perhaps, in parts especially where the paper has been well washed. The most constant developer is that of Crookes.

Heat in a glass flask twenty fluid ounces of concentrated alcohol to near the boiling point, and then add four ounces and a half of gallic acid; filter this solution into another vessel containing seventy-two grains of glacial acetic acid. This forms the stock solution of gallic acid which will keep for an indefinite time. It has a brownish color, but it is clear.

When about to develop a picture, measure out two fluid ounces of rain-water, to this add half a drachm of the alcoholic solution of gallic acid and seven minims of a solution of nitrate of silver containing eighty-six grains to the ounce of water.

The sheets of paper are kept submerged in this bath for about half an hour, by means of the glass rod or triangle, when the development will be complete, which must be determined by experience.

De Champlouis develops as follows:

In the first place the paper is previously passed through the silver bath, in order to restore its humidity, if it is already dry; it is next placed on a plate of window-glass and floated with a thin layer of gallic acid solution; the image appears with great rapidity, owing to the quantity of silver in the moistened paper; notwithstanding this, the operator can easily follow the development. By pursuing this plan, spots and other mishaps are avoided.

Whichever plan is pursued, the temperature must always be at about 80°; the developing solutions can be used only once, and are then accumulated and reduced. Whilst the paper is developing, a dirty deposit appears gradually to cover its surface; it need not, however, cause any anxiety. The surface, too, becomes spongy and porous after development—a condition which is removed afterward.

If the exposure has been too short, the image is very slow in appearing, unless an excess of aceto-nitrate of silver be used, and even then there is a want of vigor, and especially of the middle tones. Such a negative will produce only blacks and whites in the positives printed from it.

If, on the contrary, the time has been too long, the surface presents a red tint, and the development commences with

great rapidity on every part simultaneously, and soon assumes a uniform shade which takes away all contrast. For this there is no remedy; so that a short exposure is preferable, because a certain degree of vigor in the latter case, as well as contrast, can in general be obtained. The development is to be observed, as it progresses, by transmitted light, otherwise you might be deceived by the gray deposit already alluded to, and think the negative spoiled.

If the time has been about right, the print will appear possessed of the right gradations of light and shade, and of proper density of shade. As soon as the darkest parts are so opaque as to prevent an object from being distinguished through them, the development may be considered complete. All further action is then stopped by immersing the negatives in water and washing it well by agitation, or by placing it on a plate of glass and then washing it from the tap, first on one side and then on the other.

Fixing of the Image.

This is effected by allowing the paper to remain for a quarter to half an hour in a solution of

Hyposulphite of soda, ...	2 ounces.
Rain-water, ...	16 ounces.

or until all the yellow color on the white parts has disappeared. The print is then well washed as before, and finally left in a vessel of water for a number of hours. Finally it is taken out, allowed to drain, and dried between folds of blotting-paper.

When dry the papers have lost their brilliancy, they have a spongy appearance, and as if covered with an infinite number of small protuberances, such as are caused by the iodizing solution. The brilliancy can be restored and the spongy appearance be removed by holding the papers over a fire, or by placing each between sheets of blotting-paper on a water-bath, or finally by running a hot iron over each, so protected with bibulous paper. The iron, however, must not be hotter than boiling water. The wax-paper negatives are now complete, and are ready for use; from them positives on paper are obtained as from glass negatives. When not in use, they are preserved in a portfolio.

Geoffray's Process with Cerolein for taking Paper Negatives.

The author separates the cerolein from the myricin and cerin of bees-wax as follows:

Dissolve five ounces of yellow or white wax in ten ounces

of alcohol in a retort, by means of heat raised to the boiling temperature; receive the distillate in a cool receiver, until the wax is completely dissolved. The melted wax is then poured into a vessel to cool; gradually the myricin and cerin solidify, and the cerolein remains alone in solution with the alcohol, which is separated by pouring it upon a fine muslin sieve, and finally being mixed with the distillate, it is filtered through paper. This forms the stock solution of cerolein No. 1.

Secondly, dissolve in three drachms of alcohol (spec. grav., .849) four drachms of iodide of ammonium, (or of potassium,) twelve grains of bromide, either of ammonium or of potassium, and twelve grains either of fluoride of ammonium or of potassium.

To twelve grains of freshly prepared iodide of silver add drop by drop of a concentrated solution of cyanide of potassium, until the former is dissolved, and then mix this with the alcoholic solution of the iodides, etc. There will be a deposit of salts undissolved in this mixture, which is bottle No. 2.

Of these two solutions the author takes, when about to use, about twenty drachms of No. 1 and two drachms of No. 2, and filters into a porcelain dish. This forms the bath in which the papers are immersed for about a quarter of an hour, five or six at a time, until the solution is exhausted. The papers when dry have a rosy tinge. The operations of sensitizing, etc., are the same as in Legray's process.

Turpentine and Wax Process of Tillard.

White wax, in small pieces, is digested in the essence of turpentine for several days; the solution is then decanted and filtered. To every three ounces of this solution add seven grains of iodine, which is immediately dissolved without discoloration, or if any be produced, expose the mixture to the sun. Now add about from forty to forty-five drops of castor oil, pure and freshly made, to the above quantity of wax and turpentine. This forms the bath when filtered, in which the papers have to be immersed for five minutes or so. They are then sensitized, when dry, in the following bath:

Nitrate of silver, ...	1 drachm.
Nitrate of zinc, ...	2½ drachms.
Acetic acid, ...	2½ drachms.
Water, ...	3 ounces.

The paper is then washed carefully and dried. After exposure, the prints are developed by immersing them in

Distilled water,	5 ounces.
Saturated solution of gallic acid,	5 ounces.
Acetic acid,	1 ounce.

To which is added a small quantity of a fresh solution of nitrate of silver. This process is said to be very rapid.

As before mentioned, various improvements have been made in the calotype and wax-paper processes, amongst which I shall finally give the wet-paper negative process of Humbert de Molard, owing to its simplicity and the rapidity of its action.

Wet-Paper Negative Process of Humbert de Molard.

The papers are floated for five minutes on the following solution:

Distilled or rain-water,	6 ounces.
Iodide of ammonium,	2 drachms.

They are then taken out, hung up, and dried. This paper will not keep long, and must not, therefore, be prepared long beforehand. With most papers, that is, those which are sized with starch, a violet color is produced by this floating, owing to the free iodine generally existing in iodide of ammonium.

When dry and about to be used, float each sheet on the following bath:

Distilled or rain-water,	6 ounces.
Nitrate of silver,	3½ drachms.
Nitrate of zinc,	1½ "
Acetic acid,	1½ "

It is then placed with its moist side downward on a clean piece of glass and exposed to the object, taking care to make allowance for the thickness of the glass. From three to thirty seconds will produce the required result. The paper is next floated on the developer, which consists of

Water saturated with gallic acid,	6 ounces.
Water saturated with acetate of ammonia,	from 48 to 60 drops.

The image appears with great rapidity, and its development has to be carefully watched. The washing and fixing are performed as usual. When dry, the negative prints are waxed, in order to give them the requisite transparence for the printing operation.

Improved Calotype Process by Prichard.

Take a sheet of iodized Turner's paper, half an inch wider and longer than a plate of glass fitting in the dark slide for the dry collodion process; pin it on to a board in the usual

way, and, with a glass rod, spread over the paper a solution composed of

Nitrate of silver, ...	28 grains.
Distilled water, ...	1 ounce.
Glacial acetic acid, ...	10 drops.

Allow this to remain on the paper *one minute*, and then, carefully and evenly, pour one ounce of water over the paper, which is easily done by holding the board on which it is pinned slantingly, and take care that the lower edge of the paper reaches just beyond the corresponding edge of the board. Repeat this washing a second and a third time, and then pin up the paper to dry, or it may be dried between folds of blotting-paper. Now turn the sensitized surface downward on a sheet of white blotting-paper, and placing the plate of glass upon the non-sensitized side, with a little thick gum attach the overlapped edges of the paper to it. If the paper lies even—and it will do so if, when slightly moist, it be gummed to the glass, and afterward dried—it may then be exposed for a few minutes to the view. The time, of course, has to be learned by experience for given intensities of the light and the power of the lens.

After it has been exposed, separate the paper from the glass with a penknife, and develop the picture with a solution of gallic acid, to which has been added two drops of the silver solution to each drachm of the gallic acid solution. The picture comes out very quickly, and when it is fairly out, the development is completed with the gallic acid solution alone.

Fix with a weak solution of hyposulphite of soda; wash, dry, and wax by means of a hot iron, white wax, and blotting-paper.

The points requiring most care are:

1. To wash evenly, and so as not to allow any portion of the paper to escape washing, as such portion would take no impression and spoil the picture.

2. Not to expose before the paper is evenly *dry*.

3. To be very careful that the back of the paper is kept clean and untouched from any of the chemicals.

CHAPTER XXX.

POSITIVE PRINTING.

Printing on Plain Paper, on Albumenized Paper, on Arrow-Root Paper.

The theory and practice of positive printing are second only in time, not in importance, to the theory and practice of the negative; it is rare, however, that the same amount of care and labor is bestowed upon this department as upon that of taking a negative. We run all sorts of risk, make every effort, incur immense expenses in order to secure a first-rate negative, and then frequently abandon the gem into the hands of an indifferent assistant, which is tantamount in many instances to leaving the negative to print itself. What an analogy exists here between that of planting and cultivating; that of begetting and of educating! Do not some farmers dibble a hole, insert the seed, and then conclude their labor is ended? Do not some parents almost come to the same conclusion? They both leave the cultivation and education of the young germs to the sun, the wind, and the weather, not to Providence; for he that believes in Providence, puts his shoulder to the wheel and works for Providence. In a manner quite analogous, the photographer neglects the execution of the printing department, regards the operation as secondary, concludes that having secured a good negative, prints will grow from it like potatoes from the seedling. This negligence must be abandoned, and more vigorous action commenced.

Positive printing is two-fold, consisting in *direct printing by the rays of the sun, and printing by development or continuation;* in the former case the image becomes visible during the operation by means of light itself; in the latter case the impression made by light is latent, and is rendered visible afterward by chemical reduction. The chemical materials used in the preparation of the paper for the reception of the image are, first, surface materials for communicating a more uniform and smooth layer, such as *albumen, gelatine,*

starch and gums; secondly, substances that undergo some physical or chemical change by the agency of light, and which are mixed with the surface-materials; these are the *chlorides, bromides and iodides* of the various metals. Paper, so prepared, is sensitized in the dark-room in a bath of nitrate of silver; the chloridized paper, when sensitized, yields an image by the direct operation of light. Paper, prepared with the other salts, receives an invisible impression of the image, which is made manifest in a bath of *gallic acid* or some other material, according to the circumstances of the case. The image obtained by the direct agency of light has a beautiful color, but the picture is not permanent, for light continues still to act upon the prepared film, and finally obliterates the image. The positive thus obtained, therefore, has to be *fixed* in the same manner as the collodion picture, and by one of the same fixing solutions, *hyposulphite of soda*. But the color of the image after fixation is far from being bright and agreeable; we have, therefore, to resort to means before fixing, during fixing or afterward, by which the color can be restored, or an agreeable color can be communicated. This operation is denominated the toning of the picture. The chemical substances used in this operation are: *chloride of gold*, and sometimes *nitrate of uranium*, together with certain accessories that modify the action of these two salts, such as *carbonate of soda, carbonate of lime, phosphate of soda, acetate of soda, chlorinetted lime, citrate of soda, etc.* *Direct positive printing* will occupy our attention first. The subject is divisible into the following branches; Description of the principal materials used; Preparation of the paper; Sensitizing of the paper; Printing by exposure to the sun; Washing of the prints; Toning of the prints; Fixing of the prints; Washing of the fixed prints; Drying of the prints; Cutting and Mounting of the prints.

Description of the Materials used in Positive Printing.

Paper, suitable for photographic purposes, must be homogeneous throughout, and of a very fine texture. The surface particularly must be uniform and satinized, free from all marks or specks, or chemical particles which, by decomposition afterward, would spoil the picture. Such paper can be had of the different photographic establishments, from the various paper-mills of America, England, France, Germany, etc. Owing to the different materials employed in the sizing of the paper, arises a difference in the tone of the photographic picture; some sizing consists of starch, others of gelatine.

Albumen.

This substance derives its name from the *white* of egg, of which it constitutes the greatest quantity. It is found also in blood, in the form of serum, (the fluid in which the blood corpuscles swim,) in the serum of milk, in all serous secretions, etc. It exists in two forms, *soluble* and *insoluble*. When *coagulated*, or in the insoluble form, it constitutes a portion of most of the solid tissues of the animal frame. Solid albumen can be obtained by evaporating either the serum of blood, (the watery fluid which separates from the clot after coagulation,) or the white of an egg to dryness, at a temperature not exceeding 120°. The latter substance must first be broken up thoroughly, so as to separate the membranous or fibrous material that holds it together in a compact form, and then after subsidence the fluid portion is decanted. The dry mass is a yellow, transparent, tough and hard substance, consisting of albumen, with a small quantity of the saline substances that exist in this material, and which may be separated by digestion in alcohol and ether. So dried, it swells up when put in water and finally dissolves. Before it is dissolved, it may be heated to a higher temperature than the boiling point of water before it passes into the *insoluble* condition; but when dissolved in water and heated to a temperature between 140° and 150°, it coagulates, and becomes quite insoluble in water. Albumen in solution is precipitated by alcohol, acids, metallic salts, and several organic bodies, such as tannic acid and kreosote. The precipitates of albumen by metallic salts constitute two distinct substances, namely, *albumen with the acid*, and *albumen with the oxide*, of which generally the former is soluble and the latter insoluble. Pure albumen is supposed to be really an insoluble substance, but rendered soluble by the alkalies which it contains; for if the white of egg, or serum of blood, be dissolved in a large quantity of pure water, and the solution be exactly neutralized by acetic acid, a flocculent precipitate is obtained which is insoluble in pure water, but easily soluble when the latter contains a small quantity of caustic alkali. So obtained by precipitation, it has neither color, odor, nor taste. Albumen contains in one hundred parts:

Carbon,	53.5
Hydrogen,	7.0
Nitrogen,	15.5
Oxygen,	22.0
Phosphorus,	0.4
Sulphur,	1.6
	100.0

Common dried albumen, not obtained by precipitation, contains, in addition to common salt, phosphate of soda, and carbonate of soda. It can easily be shown that white of egg contains sulphur, by boiling it in a solution of caustic potassa and acetate of lead, when a black precipitate of sulphide of lead will be formed. The photographic student will also observe that albumen contains the elements of ammonia, which is generated during the putrefactive decomposition of this material. The salts which it forms with metallic oxides are denominated *albuminates;* and the albuminate of silver, which is formed at the same time with the chloride of this metal in the albumen film, is instrumental in producing the difference that exists between a plain print and an albumen print.

Gelatine.

This substance, if it exist in nature, has never yet been obtained otherwise than by the use of boiling water; it is supposed, therefore, by some to be a product of the decomposition of albumen or fibrine. All membranes, such as the skin, tendons, cartilage, hoofs, and bones, yield, when boiled at a high temperature, a solution which, on cooling, concretes into a semi-transparent tremulous mass. This substance is *gelatine* or its congener *chondrin*, (from cartilage.) The jelly obtained from boiling calves' feet, common size, isinglass, and common glue are familiar examples of gelatine. Isinglass (the dried swimming bladder of the sturgeon) dissolves in water, and yields a very pure form of gelatine. When pure and dry, gelatine is colorless and transparent; it swells and softens in cold water, in which it is very sparingly soluble; but in hot water it dissolves very easily. Alcohol and ether do not dissolve it; it is precipitated by alcohol from an aqueous solution. When dry it can be preserved for an indefinite time without alteration, but in a moist state it undergoes decomposition, becomes acid, and ceases to gelatinize. Long-continued boiling produces the same effect. Some metallic salts produce a flocculent precipitate in solution of gelatine, so does chlorine; but its most characteristic property is that of being precipitated from a very dilute solution by means of *tannic acid*, the only acid by which it is precipitated. Acting on this principle, skins are converted into leather by the process called tanning; but skins are not boiled in this process, and hence it is supposed that gelatine, after all, is a natural product.

When gelatine is digested in strong sulphuric acid, or in caustic potassa the same decomposition is effected. *Ammo-*

nia is invariably one of the products, and among other products we may count *sugar of gelatine* or *glycocine* and *leucine.*

Dry gelatine is found to contain in one hundred parts:

Carbon,	50.05
Hydrogen,	6.47
Nitrogen,	18.35
Oxygen,	25.13
	100.00

Amylaceous or Non-Azotized Substances.

Starch, arrow-root, cellulose, gum-arabic, etc., belong to this class of bodies. They are found in the vegetable kingdom in a free state, and produce by slight changes in the vegetable organization, a great variety of substances, containing no nitrogen, and differing essentially only in the different number of equivalents of water with which they are combined, or, as far as regards chemical equivalents, sometimes not differing at all; for starch, dextrin, arrow-root, gum-tragacanth, cellulose, amidin, all contain the same number of equivalents of carbon, hydrogen, and oxygen, and are all resolved into saccharine substances by treatment with acids.

Starch.

Seeds, roots, tubers, and stems of most plants contain this substance in the form of very minute insoluble granules. If pumpkins, potatoes, or horse-chestnuts be rasped, and the pulp be then well washed on a fine sieve, these granules will pass through the meshes, whilst the cellular tissues will be retained on the sieve. The powder will finally subside, and the fluid above it can be poured off. This substance is starch, which has to be washed several times, in order to get rid of impurities, and especially the bitter principle peculiar to certain seeds and plants. After the white residue has thus been thoroughly purified, it is dried at a gentle heat, by which it concretes and cracks into the form in which it generally exists in commerce. Starch is not only insoluble in water, but also in alcohol. When examined in the microscope, these granules, of an oblong shape generally, exhibit concentric rings by which the starch granule is easily designated from other powders, and frequently the granule of one plant can be distinguished from that of another, as, for instance, that of the potato from that of arrow-root. The latter substance is the starch obtained from the roots of the *maranta arundinacea*, growing in the West-Indies. The size of the granule

varies from $\frac{1}{600}$ to $\frac{1}{2500}$ parts of an inch in diameter. Each granule is regarded as a cell of concrete and insoluble material, holding within a soluble pulp. When boiled, the cells are burst or broken up, and the soluble part mixes with the water and forms a thick gelatinous mass, called *amidine*. If the solution of starch be dried at a gentle heat and then digested in cold water, the fluid portion can be separated from the insoluble husks or cells, in a colorless, transparent form. A thin solution of starch is precipitated by several bases, as lime, baryta, and protoxide of lead; a large addition of alcohol has the same effect. Infusion of galls causes a yellow precipitate which dissolves when the solution is heated. The best test of the presence of starch is *free* iodine, which produces a beautiful violet-blue color or precipitate in solution of this substance. The blue color disappears on the application of heat, and returns as the solution cools.

The substance called *British gum* is simply starch that has been heated above 240°, when the latter softens and becomes brown and soluble in cold water. If a solution of starch be boiled with a small quantity of dilute sulphuric, hydrochloric, or, in fact, almost any acid, it soon becomes thin and is then called *dextrine*. The sulphuric acid is afterward removed by adding chalk to saturation, and then by filtering and evaporating the filtrate to dryness. The substance thus obtained resembles gum and is soluble in cold water. By continuing the action of sulphuric acid and the boiling, dextrine is converted into *grape-sugar*. This conversion is produced also in the act of germination of seeds as in malting.

Gum-Arabic.

This substance is the spontaneous exudation from the bark of the *acacia vera* and the *acacia arabica*. In its purest and finest condition, it is in the form of white or slightly yellowish concretions, which are soluble in cold water, forming thus a viscid, adhesive solution. The pure gummy principle, called *arabine*, is precipitated by alcohol and by basic acetate of lead.

Chloride of Gold.

Gold does not dissolve directly in hydrochloric acid, but it enters into combination very vigorously with moist chlorine, or with chlorine in the nascent state. The menstruum in which it dissolves is nitro-hydrochloric acid.

Gold.—Symbol, Au. Combining Proportion, 197. Specific Gravity, 19.3.
Protoxide of Gold.—Symbol, Au O. Combining Proportion, 205.
Teroxide of Gold.—Symbol, Au O^3. Combining Proportion, 221.
Terchloride of Gold.—Symbol, Au Cl_3. Combining Proportion, 303.

Gold dissolves in a mixture of one part nitric acid and four parts hydrochloric acid. In this mixture the nitric acid becomes decomposed, parting with oxygen, which then decomposes the hydrochloric acid and combines with its hydrogen to form water, whilst the chlorine in the nascent state combines with the gold in the solution. This is afterward evaporated on a water-bath in order to drive off all excess of acid. In this way we obtain a red-brown, deliquescent crystalline mass of the terchloride. If the heat be too great, the salt is decomposed, chlorine is set at liberty, and a protochloride or metallic gold is left, according to the temperature. The terchloride is very soluble in water, ether, and alcohol. The solution has a yellow color and an acid reaction; it stains the skin purple. Ether separates this salt from an aqueous solution very effectually by agitation; and the mixture ascends and forms a layer on the surface of the water, which can easily be separated by decantation, by a syringe, or by allowing the water solution to flow off from a funnel; after which the ether is expelled and collected by distillation.

Most of the deoxidizing agents reduce terchloride of gold, such as hydrogen, carbon, carbonic acid, deutoxide of nitrogen, sulphurous acid, phosphorous acid, and their salts, terchloride of antimony, the *proto-salts of iron*, many of the metals, most organic substances, and *oxalic acid.*

The crystallized terchloride has a dark reddish-brown color; but if it contains excess of hydrochloric acid, it has a bright yellow color; the solutions partake of the same color; the color, therefore, is a criterion of the purity of this salt. A strong solution of the salt has a dark olive-green tinge, which becomes yellow by dilution. This salt combines with the analogous potassium, sodium, and ammonium salts, giving rise to definite compounds of these double salts, which are very frequently sold in commerce for the true terchloride. The formulas for these three salts are:

Aurochloride of Potassium.—K Cl. Au Cl_3 + 5 Aq.
Aurochloride of Sodium.—Na Cl. Au Cl_3 + 4 Aq.
Aurochloride of Ammonium.—NH_4 Cl. Au Cl_3 + 2 Aq.

All these salts, as well as the double salt of gold and calcium, are used in toning. They are formed by neutralizing the hydrochloric acid in excess in the terchloride by means of the respective carbonates of the preceding metals.

Refuse gold solutions are reduced in general by either sulphate of the protoxide of iron or by oxalic acid. The brown powder which subsides is well washed, first with

water, then with boiling hydrochloric acid; this is pure gold in a fine pulverulent form, which can be used for gilding and enameling, or for making pure terchloride.

The gold coins of the country are alloyed with either silver or copper, which can be separated by various methods. Both the silver and copper may be removed at the same time by the following means: melt, for instance, a gold dollar together with ten times its weight of silver (ten five-cent pieces) in a crucible; when melted, pour it out on a clean stone, and afterward pass the lump between a pair of rollers so as to reduce it to very thin foil. Digest the foil in pure nitric acid, which will dissolve the copper and the silver, and leave a residue of a bright cinnamon color. Wash this residue, which is gold in a very porous or pulverulent condition, and then dissolve it, as before directed, in nitro-hydrochloric acid; evaporate to dryness, dissolve, and rectify by ether.

Whenever silver is alloyed with gold, it is precipitated during the solution in aqua regia as the insoluble chloride, which can be removed by decantation of the chloride of gold. The copper is afterward precipitated as the green carbonate by adding carbonate of soda to the solution as long as effervescence is produced, which is separated, in like manner, by decantation.

If steel be dipped in an ethereal solution of the terchloride of gold, it becomes covered with a film of reduced gold. Dry gilding is performed by coating the article with an amalgam of gold, submitting the same to heat, so as to drive off the mercury, and then burnishing the gilded surface. An amalgam of gold consists of a solution of gold foil to saturation. The article is first dipped in a solution of nitrate of mercury, and then covered with amalgam.

The gold solution for electro-gilding is made by dissolving to saturation the terchloride of gold in a saturated solution of cyanide of potassium; this solution can afterward be diluted ad libitum.

Nitrate of Uranium.

Uranium is a metal which is not very abundant; in combination it occurs in the mineral *pitch blende*, as the black oxide; with silica, oxide of lead and oxide of iron, as *uranmica* or *chalcolite*, and as *uranite* in combination with lime and phosphorus.

Uranium.—Symbol, U. Combining Proportion, 60.
Sesquioxide of Uranium.—Symbol, $U_2 O_3$. Combining Proportion, 144.
Nitrate of the Sesquioxide of Uranium.—Symbol, $U^2 O_3, NO^5$. Combining Proportion, 198.

This salt is obtained directly from pitch blende by treatment with nitric acid. The ore is first pulverized and acted upon by nitric acid; and the solution is then evaporated to dryness. The residue is then washed with water, which dissolves the nitrate and leaves a quantity of sulphate and arseniate of the sesquioxide of iron. The liquid still contains salts of copper, lead, and arsenic; these are removed by passing a current of hydrosulphuric acid through the solution, which precipitates all these metals. The solution decanted or filtered from the sulphides of the above metals is evaporated to dryness, and the residue is again treated with water, which takes up the nitrate and leaves a residue of sesquioxide of iron. The solution is now evaporated and crystallized.

Nitrate of uranium is a yellow salt, which is very soluble; it contains six equivalents of water, which by heat can be expelled, and by greater heat the salt is decomposed. The alkaline carbonates all produce *yellow* precipitates with the salts of the sesquioxide; whilst ferrocyanide of potassium produces a *red-brown* precipitate. This salt has been latterly used in the toning-bath along with the terchloride of gold.

Acetate of Soda—Citrate of Soda—Phosphate of Soda.

These three salts are easily prepared by adding to each of the acids, acetic, citric, and phosphoric, carbonate of soda as long as there is any effervescence. The solutions are then evaporated and crystallized.

Acetate of Soda.—Symbol, $Na\ O, C_4\ H_3\ O_3 + 6\ HO$.
Citrate of Soda.—Symbol, $3\ Na\ O, C_{12}\ H_5\ O_{11}$.
Phosphate of Soda.—Symbol, $2\ Na\ O, HO.\ PO_5$.

Carbonate of Soda.

Symbol, $Na\ O, CO_2$.

This salt is now obtained from chloride of sodium or common salt. The latter salt is first decomposed into *sulphate of soda;* the sulphate of soda is next roasted with charcoal, by which it is converted into *sulphide of sodium;* and finally the latter substance, by roasting with powdered limestone and coal, is reduced to *carbonate of soda.*

Carbonate of Lime.

Symbol, $Ca\ O, CO_2$. Combining Proportion, 50.

This substance occurs in great abundance, as chalk, marl, marble, and limestone. Chalk is sufficiently pure for the purpose alluded to. When added to the terchloride of gold, car-

bonic acid is liberated, and chloride of calcium formed, giving rise to the double salt, *aurochloride of calcium*, which is to be decanted from the insoluble residue. This salt is more easily prepared in a definite condition than any of the preceding *aurochlorides;* and on this account its employment in the toning-bath is more reliable and to be recommended.

Chloride of Ammonium.—Symbol, NH_4 Cl. Combining Proportion, 52.
Chloride of Sodium.—Symbol, Na Cl. Combining Proportion, 58.
Chloride of Potassium.—Symbol, K Cl. Combining Proportion, 74.
Chloride of Barium.—Symbol, Ba Cl. Combining Proportion, 104.
Chloride of Calcium.—Symbol, Ca Cl. Combining Proportion, 63.

All these chlorides can be so easily prepared by saturating hydrochloric acid with their respective carbonates as long as effervescence is produced, that it is not necessary to describe them separately. There is this to be remarked about them in their application to photography, that the same quantity of either (a thing which I need scarcely remark) will not produce the same effect. Of those already mentioned, the chloride of ammonium by weight requires to be used in the smallest quantity, whilst the chloride of barium, when just twice as heavy, is only equally efficacious in producing a given quantity of chloride of silver.

The *iodides* and *bromides*, as also *gallic acid*, have been already described. We shall, therefore, proceed to the minutiæ of the manipulation of positive printing by contact.

CHAPTER XXXI.

MANIPULATION OF POSITIVE PRINTING.

Preparation of Salted Paper.

For sensitizing paper and for toning, washing, and fixing, we require either porcelain or gutta-percha dishes of an appropriate size. These can be had of the city dealers, of any size that may be needed; those of gutta-percha are the best for large operations. The photographic-ware baths may also be used for these purposes, and are to be recommended on account of their cheapness.

There are several kinds of paper in use, such as Saxony paper, French paper, and English paper. There is a difference in the surface of paper, that is, there is a *right side* and a *wrong side*. The smooth or right side is the one which receives the sensitizing materials; it can easily be distinguished from its opposite or wrong side. Salted paper may be either arrow-root or albumenized paper.

Plain Salted Paper.

Make a solution as follows:

Salting Solution. Formula No. 1.

Chloride of ammonium, ...	100 grains.
Distilled water, ...	10 ounces.

Formula No. 2.

Chloride of ammonium, ...	100 grains.
Distilled water, ...	10 ounces.
Gelatine, ...	10 grains.

Formula No. 3.

Chloride of sodium, ...	40 grains.
Chloride of ammonium, . . .	60 "
Citrate of soda, ...	100 "
Gelatine, ...	10 "
Distilled water, ...	10 ounces.

Dissolve the gelatine in warm water, then add the solution to the chloride and water, and filter into the porcelain or gutta-percha dish. The mixture in each formula is filtered

before use. The object of the citrate is to give a slight rose tinge to the middle tones.

The sheets of paper are now prepared as follows:

Fold back each corner of the sheet so as to form a lip by which to hold it; these lips are from the smooth or satin side backward to the wrong side. Then taking the lip on the right-hand farther corner between the first finger and the thumb of the right hand, and the lip on the left-hand corner between the thumb and the finger of the left hand, raise the sheet, bend it into a curve, and lower the middle part upon the surface of the salting solution; now lower the right hand gradually so that the farther side of the sheet rests upon the fluid; and then lower the left hand in like manner, until the whole sheet swims uniformly upon the surface. The next thing is to see that there are no bubbles beneath the sheet. With a glass rod in the right hand raise the farthest right-hand corner with the left hand, and if any bubble becomes visible break it up with the glass and moisten the paper where the bubble existed, and proceed in this manner with one half of the sheet. Next, holding the glass rod in the left hand, raise the nearest left-hand corner, by the lip, with the right hand, and remove all bubbles from the other half. When these are all broken up, and the paper is moistened on the parts where they existed, the sheet is lowered on the fluid and left there for three minutes. The operation of removing the bubbles is the work of a moment. You have to learn the knack of floating the sheets on the salting solution without soiling the back of the sheet, that is, without getting any of the fluid on this side. If the two sides of the paper are equally smooth, that part which is not covered with the salting solution is marked in one corner with a pencil or stamp-mark. After the expiration of the three minutes, each sheet is raised in the following manner. The lips will have sunk down on the surface of the fluid; with the glass rod in the left hand raise the nearest right-hand corner, seizing this lip with the thumb and finger of the right hand, raise the sheet gradually. Laying aside the rod, seize now the nearest left-hand lip with the left hand and hold the hands apart as far as the paper will permit, and the left hand more elevated than the right, allow the sheet to drain into the bath. Now letting the right-hand corner go, with a pin fix the upper left-hand corner to the wooden partition or slip of wood for this special purpose. If the sheets are large, pin also the upper right-hand corner in like manner, to prevent the sheet from curling upon itself whilst drying.

Remove the accumulating drops of salting fluid from the lowest corner, and then let the sheets dry. After this operation the sheets are piled, with the unsalted sides downward, one upon another, and a smooth board placed above and below the pile, and submitted to pressure until required for use.

Preparation of Albumenized Paper.

Albumen can be used either pure or diluted. With pure albumen the prints are very brilliant, but the paper is not so easily prepared. Take, for instance, the whites of twenty eggs, taking care to separate the yolk thoroughly, and place them in a graduated measure. Remove all the germs with a glass rod, and ascertain the number of ounces. Afterward pour the crude albumen into a clean basin, and add for every ounce ten grains of chloride of ammonium dissolved in the least quantity of distilled water. Beat the mixture into a thick, white froth by means of an egg-beater, and allow it to stand for ten minutes; then remove the froth with a fork, and throw it upon a clean hair-sieve. Proceed in like manner with the residual fluid, until it has been completely converted into froth and strained through the sieve. Now leave the albumen to stand for a day or so, well covered up from dust; after which filter through a piece of sponge, and again allow the mixture to settle for a couple of days, and then pour off the supernatant liquid portion from the settlings into the porcelain or gutta-percha dish for use.

The paper, as usual, must be of the finest quality, and marked or stamped on the back, before floating. Much more care is required in the successful management of laying the paper on the salted albumen than upon the plain salting solution, for bubbles are more likely to be formed, and are less easily removed than in the former preparation. Besides this, if the paper be dry, and the weather also very dry, the albumen does not attach itself easily to the paper, and in this case, although a sheet has been thoroughly floated, and without bubbles, the upper part of the sheet, when hung up, allows the albumen to flow off, so that the film on the upper part is much thinner than on the lower part, and a number of irregular marks and curves are apt to be formed on the lower part. To obviate this, the sheet is suspended by its broadside, by which the distance between the upper and lower side is the least possible. The time of salting in this bath is from two minutes and a half to three minutes. Of course in all cases the time has to be reckoned from the mo-

ment the sheet lies uniformly and without bubbles on the surface of the solution.

In every operation of this nature it is well to have systematic arrangements. For this purpose I recommend the photographer to proceed as follows in the preparation of his drying-chamber. On the side of the room, behind the salting solution, and at an elevation of the eyes of the individual, screw on a slip of wood a couple of inches wide and the length of the room. Supposing then the sheets are twenty-two inches long, then bore two holes twenty-one inches apart through the slip of wood; into the apertures insert corks, fitting firmly, and projecting about half an inch from the surface of the wood. Into the center of each of these corks insert the eye end of a steel needle inclined slightly upward. The sheets when raised by the two interior corners, and after draining, are hooked by the two upper corners upon the projecting needles, which, before their insertion into the corks, have to be varnished to prevent rusting and other troubles. When several rows of sheets have to be dried consentaneously the uppermost slip of wood must be the thickest, as, for instance, three inches, if there are three rows, one over the other; the second, two inches; and the last, one inch thick.

In proportion as the albumen accumulates on the lower border, it is removed with bibulous paper, until the papers finally are dry. They are then taken down and planished between rollers or otherwise, and piled away.

Preparation of Arrow-Root Paper.

Cut out a board a trifle less in length and width than the sheet of paper; fix a sheet at a time by a pin at each corner of each edge, folding the edges of the paper down over the edges of the board. Then, with a very fine, soft and moist sponge cover it over smoothly, longitudinally and laterally with the following salting mixture:

Formula.

Chloride of sodium, (common salt,)	5 drachms.
Citric acid, ...	4 grains.
Distilled water, ...	19 ounces.

Dissolve and filter. Then add four drachms of arrow-root, rubbed with cold water into a cream, so that all lumps have been thoroughly broken up and saturated. Boil the mixture in a glass or porcelain dish, taking care to stir it all the while. When it is cold, and the scum has been removed, it is ready for application with the sponge. By means of a glass triangle or glass rod, all ridges or asperities may be removed,

and the paper is then suspended, as before directed for albumen-paper. Arrow-root paper is well adapted for large portraits, and even for large landscapes; for smaller pictures, where more fineness of grain and sharpness are required, albumenized paper is by far the best. All the papers, prepared as directed, will keep, but they are best when fresh.

Sensitizing Bath.

The preparations for sensitizing are divided into two classes, one containing essentially *nitrate of silver*, and the other *ammonio-nitrate of silver;* these are subdivided by differences in the strength. The ammonio-nitrate of silver solution is certainly much more sensitive than the plain silver bath; the great drawback has been the blackening of the solution by use, for which several remedies have been proposed. Whichever bath is used, its strength has to be maintained at its original point by the addition of fresh silver every time it is used, for the bath soon becomes impoverished by the floating of paper for printing. The sensitizing solution *must always be* slightly acid, in order that the whites may be thoroughly preserved.

Formula for the Plain Silver Solution.

Nitrate of silver, ...	2 ounces.
Rain-water, ...	12 ounces.
Nitric acid, ...	2 to 3 drops.

The paper to be sensitized in this bath is prepared exactly in the same manner as for floating in the salting solution; the corners are turned back, and then, seizing two opposite corners and bending the paper into a curve with the middle and salted part downward, it is lowered into contact with the fluid, while first one end is gradually let down and then the other, taking care afterward to remove all bubbles with the glass rod, by first raising one corner and then the other. Previous to use, the bath ought to be always filtered from innumerable little particles and scum that accumulate on its surface. By means of an *argentometer* the strength of the bath can easily be maintained at a given point, namely, at about 70 grains to the ounce of water; and by the application of test paper, it can be ascertained whether it be acid or alkaline, and thus corrected. I will repeat, the bath must be

Slightly acid.
Filtered every time it is used.
Its strength maintained at 70 grains to the ounce.

The papers are floated on the fluid for five minutes, then

raised, allowed to drain, and hung up on varnished steel needles inserted into corks in a line over the gutter alluded to in a former part of this work; or if such a contrivance be wanting, the silver solution is removed from the pendent corners by blotting-paper, which is afterward thrown aside on a special heap for reduction. The bath by use will become discolored; in such a case, throw in a small quantity of solution of common salt by degrees and shake well. This will remedy the evil after filtration, but it removes also a considerable quantity of silver, which has to be replenished. The black residue, together with the precipitated chloride of silver, is preserved with all other refuse silver for reduction.

Formula for the Ammonio-Nitrate Silver Solution.

Nitrate of silver,	2 ounces.
Rain-water,	8 ounces.
Alcohol,	1 ounce.

Dissolve the silver in six ounces of water; then separate two ounces of the solution, and add ammonia to it, until the precipitate of oxide of silver first formed is redissolved. This solution is then mixed with the alcohol, and the remaining silver solution and water. By the addition of ammonia decomposition takes place, oxide of silver of a brown color is thrown down, and nitrate of ammonia is formed; an additional quantity of ammonia then dissolves the oxide, so that the solution contains nitrate of ammonia and solution of oxide of silver in ammonia. When this part is thrown into the remaining solutions, oxide of silver is again precipitated; the final solution therefore contains free oxide of silver, and solution of oxide of silver in nitrate of ammonia and alcohol. The alcohol prevents the solution of the albuminous film and discoloration probably.

The papers are floated in this bath not more than a minute; half a minute I find in most cases to be sufficient. But there is this caution to be observed: if the papers when removed from the bath appear streaked with oil, it is well to rub the fluid gently over the whole surface with a tuft of cotton wool. The bath can be filtered, but in that case the same filter has to be used over and over again, because the oxide of silver is gradually taken up and dissolved by the ammonia liberated during the operation. I prefer, however, not to filter the bath, but after use to keep it in the stock-bottle, together with the residue of oxide of silver. When about to use it, it is carefully decanted into the dish, and after settling, a small sheet of paper is drawn over the surface to remove any

particles that might be left. The strength of this bath, like any other, has to be kept up by the addition of crystals of nitrate of silver; fresh alcohol and ammonia are added from time to time. The albuminous film is not injured by this solution; the time of floating is much shortened, and although the strength of the solution is higher than that of the preceding, no more silver is wasted or consumed in the operation, because the picture is maintained on the surface of the film, owing either to the diminution of the time of floating, or to the induration or coagulation of the albumen, or to its dryness and consequent impermeability in so short a time.

Fuminating Process.

The advantages of the ammonio-nitrate sensitizing solution are attained by subjecting the sheets of paper, already sensitized by the plain-nitrate of silver solution, to the fumes of ammonia. The *modus operandi* is as follows: Float the papers for four or five minutes in the first bath, containing from sixty to seventy grains of nitrate of silver to the ounce of water, and allow them to dry as usual. This is the first part of the process.

Next prepare the *fuminating box or chamber*. Where the quantity of work to be done is not very extensive, a box three feet long, two feet wide and two feet deep is first constructed. On either side and five inches from the top a piece is cut out, leaving the two ends projecting five inches above the two sides. Construct next on either side a shallow box of the same length as the original one, five inches deep, and two feet wide, and having only three sides. These are fastened by screws to the large and middle box, in such a manner that the open side fits exactly where the piece has been cut out, forming as it were two shelves. By means of triangular supports these shelves are held in a firm and horizontal position, and give an appearance to the box, when regarded from the end, of the letter T. On each end of the deep box, as well as on each side, on a level with the lateral shelves, screw on four narrow slips of inch stuff, on which can rest a board three feet long and two feet wide; this board, therefore, in its place covers the middle box like a lid. When it is in its place, screw down a small piece of wood on either end of one side, so that it can not slide too far. This lid has a sliding motion by means of an iron rod in the middle of one side, lying horizontally, and passing through an aperture in the side of one of the shelves, so that it may be made to close the top of the box or open it when required. On the top of

this T-shaped cavity, there are three doors, each three feet long and one foot ten inches wide, opening by hinges as follows: At a distance of one foot ten inches from either side on the top of this cavity screw on a slip of wood two inches wide; to these slips the hinges are all fixed, so that each lateral door opens toward the middle, and lies when open upon the middle door; whereas the middle door opens toward one side and lies upon the side door. It is intended that one door alone is to be opened at a time. The wood of which these doors are constructed must be soft, so as to allow the insertion of small tacks or pins. This is the *fuminating apparatus.*

The sensitized dried sheets or pieces of paper are fixed upon the inside of each door by sticking a pin obliquely into each corner, with the albumenized surface downward when the door is shut. At the bottom of the deep box place a plate, containing a drachm or more of ammonia. In winter a pan of warm sand may be introduced, with the plate over this in order to increase the evaporation. The sliding door all this while is open. When each door is covered with sheets, or with as many as are required, close them. It is evident that the fumes of the ammonia will soon fill the whole of the interior, and will thus come in contact with the surface of the silvered paper and produce a decomposition of the nitrate of silver into oxide of silver and nitrate of ammonia. After the paper has been exposed for about ten minutes, the sliding door is closed by pushing it forward with the iron rod until it juts against the small pieces of wood on either end of the opposite shelf. By this means the fumes of ammonia in the body of the fuminator are excluded from the air, and only that portion escapes which lies on the shelves. The fuminated papers are then taken out and pinned by one corner on the corks, in order that all superfluous ammonia may escape, when they will be ready for printing. It has been asserted that there is a great saving of silver by this process; that the film is much more sensitive to light, and consequently the time of printing is shortened, and that the tones are more brilliant.

CHAPTER XXXII.

THE PRINTING OF SENSITIZED PAPER.

The operation of printing is performed by the direct rays of the sun or by diffused light. Frames of various sizes are to be had of the dealers for this special purpose. These are oblong dishes, about two inches deep, with a pane of plate glass for the bottom, lying upon a ledge loosely. Upon this the negative is placed, collodion side upward, and over the negative the sensitized paper, albumen side downward. A piece of chamois leather, soft cloth or Canton flannel of the size of the pane of glass is placed over the paper carefully, so as to keep it in its position directly over the negative, and to form a sort of cushion when the folding doors, that come next, are fixed in their place. There is quite a knack in adjusting the leather so as not to produce any friction upon the negative, which would certainly injure if it were not varnished. The negative lies as near the middle of the pressure frame as can be, and in the same direction as to length. The folding doors are two thin flaps of wood joined by hinges in the middle, equal in size together, and lying horizontally to the pane of glass. This door is adjusted in its place over the cloth or leather in the following manner. Whilst the outstretched fingers of the left hand are holding the paper and cloth in their places, without the slightest friction, the nearer flap is put in its place and held down by a gentle pressure, whilst the left hand now relinquishes its hold and closes down the other flap. By means of strips of wood, an inch and a half wide, stretching across the frame and fixed on hinges on one side of the printing frame, and supplied with metallic springs beneath, each flap is pressed down and held in its place by means of a hook on the other side. By such an arrangement it is evident that each folding door is independent of its neighbor, and by opening it the cloth over one half of the negative can be thrown back, the picture can be raised and examined, and again replaced without disturbing the relative position of the paper and negative. So

arranged, the printing frame is now exposed to the sun, by rearing it on a shelf at the outside of the window right in front of this orb. The color of the paper will soon begin to change, and soon the whole picture will be apparent. Some negatives produce the best prints when exposed to a very powerful light; others on the contrary require to be printed slowly. A negative which is *very dense* will yield the best effect by exposing the frame to diffused light; whereas a very thin negative may be exposed to the full blaze of the sun, in order to be printed very quickly. The best prints are obtained from negatives that are neither too dense nor too thin. The frame is taken into a shaded corner of the room from time to time, and one end of the print is examined in order to ascertain the progress of the operation. If the lights are still white, and the shades not yet bronzed in the slightest degree, the print is not yet finished. As a rule it may be concluded that this operation is complete when either the lights have become slightly tinged by reduction, or when bronzing is beginning to appear in any part of the shadows. In this case, take in the frame, and placing it on a table or shelf, remove the folding doors, then the cloth, and finally the print. Be careful not to expose the print to a strong light, otherwise the whites will be injured. Place it between the leaves of a book or in a drawer in the dark-room, until a sufficient quantity has accumulated for the next operation. An experienced printer will be able to obtain satisfactory results as far as circumstances will permit; but it is utterly impossible to force an inferior negative to yield a superior print; a certain relation, a certain *happy relation*, (a remark that I have so many times repeated, but not too often,) *must exist* between lights, middle tones and shades, with a given density of the latter in order to secure normal prints; and where this exists, it is the fault of the printer if he does not arrive at the maximum result of perfection.

Toning of the Prints.

In the dark-room, illumined by the yellow light of a lamp, or by that which passes through the orange-yellow non-actinic glass, examine the points separately, rejecting each in which there is a decided failure, and cut off all extraneous parts that are certainly not required when mounted, allowing, of course, always sufficient margin for the final trimming. Next throw each print separately into a pail or tub of water, taking care that its surface comes in contact with the water, without the intervention of bubbles. Keep the prints in mo-

tion by turning them over and over again for the space of five minutes, and afterward take them out separately and immerse them in another tub of water in the same manner as before. The water from the first pail is poured into a large barrel or tank kept for this special purpose. Move the prints about as before for five minutes, and then proceed to the third pail in like manner. The water from the three pails is poured into the tank, and a tea-spoonful of common salt is added and dissolved by agitation with a wooden stirrer; after the subsidence of the deposit of chloride of silver, the refuse water is allowed to flow off into the sink by a stop-cock inserted within a couple of inches from the bottom of the tank.

Formula No 1. *For the Toning Solution.*

Chloride of gold, (pure,) . . . . . 1 grain.
Distilled water, ... 8 ounces.
Carbonate of soda to neutralize the acidity.
Alcohol, ... 2 drachms.

Formula No. 2.

Double chloride of gold and potassium, 2 grains.
Distilled water, ... 3 ounces.
Carbonate of soda, ... 3-5 grains.

Formula No. 3.

Chloride of gold, ... 1 grain.
Distilled water, ... 8 ounces.
Chalk to neutralize the acidity.
Chlorinetted lime, ... 5 grains.
Alcohol, ... 2 drachms.

Formula No. 4. *Gold and Uranium.*

No. 1.	Chloride of gold, (pure,) . . . 1 grain. Distilled water, ... 4 ounces. Chalk to neutralize the acidity.	Filter each and then mix.
No. 2.	Nitrate of uranium, ... 1 grain. Distilled water, ... 4 ounces. Chalk to neutralize the acidity.	

Formula No. 5.

Chloride of gold, ... 2 grains.
Distilled water, ... 8 ounces.
Phosphate of soda, ... 100 grains.
Neutralize with chalk.

Formula No. 6.

No. 1.	Chloride of gold, (pure,) . . 2 grains. Distilled water, ... 4 ounces. Carbonate of soda to neutralize the acidity, Phosphate of soda, ... 2 grains. Acetate of soda, ... 2 grains.	Filter the latter and mix.
No. 2.	Nitrate of uranium, ... 2 grains. Distilled water, ... 4 ounces. Chalk to neutralize the acidity.	

The acidity of any of the above solutions is neutralized as follows: In the first place throw into the solution a piece of blue litmus paper of the size of a ten-cent piece, its color will be turned red; now throw in either carbonate of soda or carbonate of lime until the blue color is restored. Carbonate of lime (chalk) has this advantage over carbonate of soda, it can be used without litmus paper, taking care only to throw in a superabundance, which does no harm, and can afterward be removed by filtration. I prefer preparing the double chloride of gold and calcium beforehand, and in quantity in a concentrated liquid form. In such a condition a few drops can be added to the toning bath in a moment, whenever it is found that the toning does not commence or proceed satisfactorily.

Pure chloride of gold is a deliquescent salt, is not easily crystallized, and when crystallized is not easily retained in this form. Its color is of a deep reddish color. But the chloride of gold, sold as such, is of a yellowish color, in a *dry* crystalline condition, and is not deliquescent; it is therefore not pure; it is probably in most cases a double chloride, either of gold and potassium, or of gold and sodium. These double salts are used in toning, as recommended in the above formulæ; but it must be remembered, that in buying such an article, double the quantity will be required, and of course you have to pay the price of gold for the soda or potassa in the mixture, which is poor economy.

With any of the preceding formulas baths may be formed which will produce rich tones. Formula No. 5 admits the substitution of citrate of soda, or acetate of soda for the phosphate. The first is the simplest, and I think the most rational; probably the third will please many; its tone is more of a sepia. The aim of the citrate, acetate, and phosphate is to produce a purple tone. The uranium bath produces a rich tone, still I do not think it superior to the simplest alkaline gold bath. Use the bath slightly warm, that is, at a temperature of 90° or 100°. Before the prints are introduced into the toning bath, pass them separately through hot water. Let the bath be sufficiently large to accommodate a number of prints side by side; turn them over continually; keep them in motion. The tone of the prints soon begins to change; *before* it becomes of a slate blue, take each print out, wash in hot water, and immerse in the fixing bath.

Fixing Solution.

Hyposulphite of soda, . . .	2 ounces.	Slightly warm.
Water, ...	12 ounces.	
Alcohol, ...	4 drachms.	

The first effect of the toning bath is to change the color to a reddish hue, and then finally back again. Move the prints about in this bath continually, and keep them in until the whites are perfectly clear when viewed by transmitted light, and the tone has been restored. Where the printing has been well performed, supposing the contrast in the negative to be right, the color of the deep shades is but very little changed in the fixing solution, and very soon returns to the proper tone. If the whites are full of gray spots when the prints are placed between the light and the eyes, it is a sign that the fixing is incomplete, and probably too that the prints during the washing and the toning have been too much exposed to a strong light. All operations, until the fixing is complete, ought to be performed in a room lighted by non-actinic rays. When the tone of the picture and the transparency of the whites are satisfactory, remove the print from the fixing bath and immerse it in a tub of water. Do so with all of them, until the fixing operation is complete. The prints are now kept in motion for a few minutes in the water, in order to remove as much as possible of the fixing solution from their surface. They are then taken out and allowed to drain, and finally immersed in another tub of clean water, where they remain for a number of hours, taking care to move them about, and to turn them over frequently. The water in the washing operation can not be changed too frequently; in fact, it is by far the most desirable plan to have an arrangement by which the prints can be subjected to a running stream of water, which can easily be made in large cities supplied with water works.

The apparatus for this purpose is adjusted on pivots so as to rise and fall like the beam of a pair of scales, and it is put in motion by the weight of the water itself. It consists, in the first place, of a trough of wood of any given appropriate length, as, for instance, three feet; its breadth may be one foot, and its height the same. It is divided into two compartments in the middle, and supported on pivots in the middle of the base-board about six inches above the table or shelf on which it rests; by this means it has an oscillating motion or play of about twelve inches at either end, like a see-saw. This trough is placed so that the middle division is, when horizontal, immediately below the stop-cock; but when one is down and filled with water, and the other up and empty, it is evident that if the stop-cock be open, the water will flow into the empty compartment until this sinks, which it will do when the other is empty. Each compart-

ment is supplied with a syphon, whose arch reaches to a plane nearly level with the top; the calibre of this syphon is somewhat greater than that of the ingress pipe furnished with the stop-cock. Now when either end becomes filled with water, the latter will rise higher than the arch of the syphon, which will then be filled with water. The longer arm of the syphon passes through the end of each compartment and discharges the water from its corresponding end quicker than the water is supplied to the other end by the stop-cock. By this expedient one end becomes alternately light and heavy, and thus produces a constant oscillation of the whole trough up and down. The prints to be washed are placed in these troughs as soon as they leave the fixing bath, and are thus kept in motion and supplied with fresh water for any length of time. Such a machine is called the

Self-Acting Photographic Washing-Machine.

When prints are thus treated an hour's washing will remove every trace of the hyposulphite of soda. They are then taken out one by one and pinned by one corner to slips of wood, or suspended on varnished hooks inserted into corks, as before described in the albumenizing process.

Mounting of Photographs.

Photographs may be cut out of the proper size and shape either before they are starched or gummed or afterward. If before, the following is the mode of proceeding. Place a thick plate of glass before you on the table, on which lay the photograph, picture side upward. Next place over this a heavy mat in such a position as to present the best appearance the print can receive. Holding the mat firmly in its place, by means of the first and second finger stretched far apart, with a sharp-pointed penknife cut along the edge of the mat through the paper to the glass all the distance from the end of the second finger to that of the first. If you stand to perform this operation (a position to be preferred to that of sitting) move gently round to the left, still holding the fingers firmly on the mat. Press upon the mat with the right hand, whilst the second finger advances to the position of the first, and this one is again stretched asunder to a new point along the edge of the mat. Now make another incision along the edge in perfect continuity with the first, and thus proceed to the termination. This act of cutting out the prints requires considerable dexterity in pressing the plate, and making the incision so that the terminal cut is a continuity of the commencement, and that the edge all round is

clean and not dentated. Where the business is extensive, it is advisable to fix up a special mounting-table like that used by potters for the formation of utensils out of the plastic clay. Such a table can be turned by the feet on a vertical pedestal, allowing the operator to sit all the time. A whetstone or hone is a very necessary appendage to the mounting-table.

The prints are now turned over and brushed over with a strong solution of gum-arabic, a mixture of gum-arabic and gelatine, or what is still better, with a solution of patent starch or dextrine, such as is used on the back of post-stamps. Where a number of photographs are mounted upon the same paper, it is usual to brush them over on the back with the solution before they are cut out, and when dry to perform the operation just described. The starched surface is then made moist by going over it with a moist sponge. The print is now adjusted upon an appropriate mount and pressed accurately down by placing first a sheet of clean paper over the print, so that its edges overlap the latter, and then holding the first and second finger far apart and firmly on its surface, the print is pressed upon the cardboard by rubbing the space between the two fingers with a burnishing tool or with the smooth handle of a tooth-brush. The fingers then assume different positions, and the burnishing is continued until the whole print is smoothly and evenly adherent to the mounts beneath.

Photographs, after they have been starched, or moistened after starching, can be mounted much more quickly by first adjusting them to their place on the mounts, and then passing them beneath the rollers of a glazing or planishing machine. The two operations are then performed at one and the same time. This planishing is quite an improvement to a print; it is altogether superior to varnishing or glazing. The best rolling machines are those furnished with a horizontal bed, like that in a lithographic press. Still those that consist simply of a pair of rollers are very efficacious in producing decided improvements in stereographs or card-pictures.

Great care is required in keeping out all particles of sand from the starch or gum, for where these appear they produce protuberances on the photographs or apertures when the prints are submitted to pressure in the rolling-machines. It is therefore *always necessary* to remove them from the starched surface before it is placed on the cardboard, wherever such particles are discovered; and to obviate the repetition of such

troubles or diminish their number, it becomes the duty of the operator to cover his gum carefully up when it is not in use.

What to do with the Clippings of Prints.

Spoiled prints, soiled sensitized paper and the cuttings of pictures may as well be preserved as not, for the labor consists simply in placing them in some corner or box, instead of throwing them away. As soon as the stock is very large, they may be burnt in a clean stove and the ashes collected. These ashes contain silver, oxide of silver and other combinations of silver, together with the minerals in the paper, as, for instance, lime, etc. The ashes so constituted are pressed closely and firmly together into a Hessian crucible, then submitted to a powerful heat and thus reduced. Or these ashes may be mixed with the chloride of silver, obtained by precipitation of old baths or at the bottom of the tanks containing the refuse washing water. The mass is first well dried, then intimately mixed with about one half its weight of either carbonate of soda or potassa, and fused.

In large establishments the refuse silver salts, as well as the cuttings of paper, amount to quite a large quantity annually, and are sold for reduction to parties who make it their business. Where such an opportunity presents itself, it is more advantageous to dispose of the unreduced refuse than to perform the operation of reduction one's self.

Mounting Stereographs.

Stereoscopic negatives taken from nature contain two photographs, which, when printed, are inverted, the left picture being where the right ought to be. Some photographers remedy this defect by cutting the negative in two in the middle, and then proceeding from the middle, right and left, two inches and three quarters, the residual slips are cut off on the ends and thrown aside. The two negatives are now placed upon a thin glass stereoscopic slide, perfectly clean, and side by side in juxtaposition, but inverted, so that the right-side negative is placed on the left side. By means of gummed or glued ribbon on the upper edges, these negatives are held firmly on the slide beneath. The negatives being so arranged, the prints will have the right position, and require only to be pared at the top and bottom previous to mounting. For this purpose a piece of glass, with rectangular corners and ground edges, five inches long and two inches and a half wide, is placed upon the prints on the mounting-table or slab of glass; with a sharp penknife go round the edges, taking care to press the glass form firmly on the prints. In

this way the pair of stereographs will be cut out in one piece ready for gumming and mounting. Copies of stereographs (if taken with a single orthoscopic lens) do not require the negative to be prepared as above described; the requisite inversion exists without it.

But in many instances the negative is not prepared at all in this manner for printing, but left in its natural or unaltered condition. In this case (and it is probably the easiest method of proceeding) the glass form is laid upon the inverted print, and the combined prints are cut out; after which another glass form of exactly half the size is laid upon one end of the combined prints, which are then cut asunder. The larger glass form has a notch on the top and bottom edge in the middle; these notches are placed on the middle line of the print, and serve thus to direct its position. If this middle or dividing line between the two prints has considerable width, which is sometimes the case, the glass form must be in proportion longer; but the smaller form retains its size of two inches and a half. Stereographs of groups and of architectural objects are frequently cut out with rounded corners, sometimes on the top only, and sometimes both on the top and bottom. For this purpose you must prepare for yourself appropriate forms of glass, by grinding down the corners on a grindstone, or you can cut out the requisite shaped mats in brass. Those of glass are by far the easiest to construct.

Mounts for stereographs of various shades of color can be had of the dealers; these, being cut by machinery, are neater and cheaper than those you can make yourself from cardboard. If you do not possess the power, that is, have not cultivated the faculty of seeing stereoscopically without an instrument, you must be very careful not to invert the right and left side pictures between the cutting and mounting. It is well to be provided with two small boxes, one marked *left* and the other *right*, into which the corresponding prints can be thrown as soon as they are prepared for mounting. The mode of pasting, adjusting to position, and passing beneath the roller is the same with the stereograph as that with the ordinary photograph, which has been already described.

CHAPTER XXXIII.

BERTRAND'S NEW PROCESS FOR POSITIVE PRINTING.

Saxony paper is the best for this process; the equality of the mass is not absolutely necessary, but that which contains iron stains must be rejected.

The first preparation of the paper is to impregnate it with a soluble chloride; this is effected by plunging it into the following bath:

Alcohol, spec. grav., .842, . . .	100 parts.
Benzoin, ...	10 "
Chloride of cadmium, ...	5 "

The paper may be floated on the surface or completely immersed. The most expeditious means is to take a dozen sheets and immerse them one by one in the bath, by means of a glass triangle; when a certain quantity has been immersed, they are all turned over at once, and then taken out one at a time and hung up to dry; take care to place a piece of blotting-paper in contact with the lowest corner of each, in order to produce an accumulation of fluid in this place.

The sheets dry very quickly; a few minutes are sufficient. If necessary, they may be dried by artificial heat.

The advantage accruing from the use of benzoin is to fill up completely all the pores of the paper; air and moisture can no longer penetrate into the interior of the print, which is thus protected against the greatest, if not the only cause of deterioration. Besides this, benzoin communicates to paper the gloss of albumen, but in a less degree.

The chloridized paper will keep a long time; in order to sensitize it, place it in contact with the following bath:

Water, ...	100 parts.
Nitrate of silver, ...	15 parts.

exactly as for albumen-paper.

If it be required to keep the sensitized paper for some time,

it may be placed in one of Marion's* boxes, where it will keep perfectly.

The exposure beneath the negative is much shorter than for albumen-paper; the picture may be printed deeper than required at the end after fixing. If the time has been too long, the blacks become deep green, but there is no necessity for anxiety about the matter, the toning bath will restore them to their original black.

The prints may be toned either in the Bayard bath:

Water,	1000 parts.
Chloride of gold,	1 part.
Chloride of ammonium,	20 parts.
Hyposulphite of soda,	4 parts.

or in the acetate bath:

Water,	1000 parts.
Chloride of gold,	1 part.
Acetate of soda,	30 parts.

Glover's Resinized Printing Process.

Salting Solution.

Gum thus,	180 grains.
Gum mastic,	40 grains.
Chloride of zinc,	200 grains.
Alcohol,	8 fluid ounces.
Sulphuric ether,	2 ounces.

The object of adding the ether is to insure the speedy solution of the mastic. The paper is to be immersed in the above for five minutes, covering the dish with a sheet of glass to check evaporation. Take out, drain closely, and dry before the fire. Too much stress can not be laid upon the necessity of *perfect* dryness, so that if the salted paper be put away for future use, it must again be held some time before the fire, previous to floating on the silver bath, or it will not take up the solution evenly. The silver bath is composed as follows:

Alcohol, spec. grav., .805,	4 ounces.	
Gum thus,	80 grains.	Dissolve.
Gum mastic,	10 grains.	
Nitrate of silver,	960 grains.	Dissolve.
Distilled water,	4 ounces.	

Mix the two solutions; shake up well; filter, and add four

* This box is oblong or square, and constructed of zinc, with a tight-fitting cover. At the bottom there is a plate for containing fused chloride of calcium, above this a shelf of wire-gauze, on which the sensitized sheets are placed. When the lid is accurately closed, whatever moisture may be in the box, it will be absorbed by the chloride, which is a very deliquescent salt.

drops of nitric acid. When the paper has been in contact with the above solution a few seconds, it has a tendency to curl up, which must be checked by breathing upon the edges. After it has settled flat on the surface, allow it to remain ten seconds; it is then ready to be removed. Take hold of the sheet by one corner, and stroke it with a glass rod, kept for this purpose alone, to remove the surplus solution, and dry before the fire. It is then ready for fuming over a dish of ammonia. This last operation reduces the exposure in the printing frame about one third, besides insuring success in toning, under almost every condition of the coloring bath.

On removal from the printing frame, wash in tepid water, and tone by any of the alkaline processes. That which answers best in my hands is composed of acetate of soda, prepared at least twenty-four hours before use, with the addition of a few drops of the usual solution of chloride of gold immediately before immersing the prints.

Fix in a nearly saturated solution of hyposulphite of soda, containing five per cent of alcohol.

The subsequent thorough washing must not be neglected in this or any other printing process.

Or in any other bath.

The print soon assumes a black tone, which is difficult to obtain with albumen.

It is finally fixed in

Water, ...	100 parts.
Hyposulphite of soda, ...	20 parts.

As soon as the print is well washed, it is left to dry, and afterward brushed over with a piece of flannel, or a pad of cotton, in order to give it a gloss. It is evident that varnishing is useless.

CHAPTER XXXIV.

PRINTING BY DEVELOPMENT.

During the feeble light of winter in high northern or southern latitudes, as also in the preparation of enlarged views or portraits with the solar camera, printing by development is of very great utility. It is quite analogous to the operation of producing a collodion picture by the agency of a reducer; and the same materials in general are employed in the two branches.

Formula for the Salting Solution.

No. 1. *With the Chlorides.*

Chloride of sodium, (common salt,) . . .	100 grains.
Hydrochloric acid, ...	6 drops.
Rain-water, ...	12 ounces.

Immerse the papers in this mixture and let them remain in it for two or three hours, then take them out and allow them to dry.

Formula for Sensitizing Solution.

Nitrate of silver, ...	1 ounce.
Citric acid, ...	8 grains.
Distilled or rain-water, ...	8 ounces.

Float the papers on this solution for three minutes, and then suspend them on the varnished needles, or on a cord with clothes-pins. Remove all the fluid that accumulates on the lower side or on the corners. As soon as the papers are moderately dry they may be exposed beneath the negative or on the screen of the solar camera until a *faint image* appears. Beneath a negative in the rays of the sun, the time of exposure will not exceed three or four seconds; in feeble light a minute or more may be required. As soon as the print is sufficiently distinct, it is withdrawn and laid upon a piece of glass somewhat smaller in dimensions than the paper, picture side upward; two opposite edges of the paper are folded beneath the glass, and in this position the paper and the glass together are placed on the left side of a capacious gutta-percha developing dish.

Formula for Developing Solution.

Pyrogallic acid,	12 grains.
Citric acid,	6 grains.
Water,	6 ounces.

Of this solution take sufficient to cover the paper. Inclining the dish downward to the right side, pour in the solution; then dexterously raising the right side, the fluid will flow or may be made to flow over the whole surface without producing any lines of stoppage. This is very important, because any stoppage on such paper would be as injurious as on collodion prints. The development commences and proceeds as rapidly as on a collodion negative, and requires just the same amount of vigilance. As soon as the proper contrast has been attained, the further reduction is caused to cease by pouring off the developer into the sink or waste-tub, and then by washing at the tap. The washing must be performed with care and effectually. After this operation the prints are fixed in the following solution:

Formula for the Fixing Solution.

Hyposulphite of soda,	1 ounce.
Water,	16 ounces.

The prints are kept in this solution until the whites are perfectly clear, which will require from ten minutes to half an hour. They are then taken out and submitted to the regular process of washing, in order to remove every trace of the hyposulphites.

Second Method with a Chloride and a Bromide.

Formula for Salting the Paper.

White of egg,	10 ounces.
Distilled water,	15 ounces.
Chloride of sodium,	1 drachm.
Bromide of potassium,	1 drachm.

Dissolve the salts in the water and add the solution to the albumen, which has to be beaten up into a froth and allowed to subside several hours in a cool place. The clear supernatant liquid is decanted carefully or filtered from the deposit into the appropriate dish for salting operations.

The papers are floated in the ordinary way on the surface of this bath for three minutes, and then hung up to dry on cords and attached by means of clean clothes-pins. After this operation the papers are put in a long tin box which is inserted in a deep kettle of boiling water, taking care that none of the water can get access to the paper, but that the

paper is submitted through its whole length to the heat of steam; the operation is still more effectual if hot steam could come in contact with the albumenized surface; such an expedient is intended to coagulate the albumen. The omission of this part of the operation must not deter the operator from trying the process; the results will not materially be changed, because the coagulation can be effected in the sensitizing bath.

Formula for the Sensitizing Solution.

Nitrate of silver,	1 ounce.
Distilled water,	12 ounces.
Citric acid,	3 drachms.
Alcohol,	1 ounce.

The papers are floated on this bath from two to three minutes, and are then allowed to dry as usual. An exposure of from eight to ten seconds in the full sun will be sufficient; whilst as many minutes will be required in a weak light. The picture must be quite visible, or very nearly so, before it can be said that the exposure is long enough.

Developing Solution.

Gallic acid,	5 grains.
Distilled water,	2 ounces.

The operation of development is best performed in a glass or gutta-percha dish; the print is first moistened and then placed on the bottom of the vessel to which it adheres. The developing fluid, being poured on the inclined right-hand side, is flowed over the print almost instantaneously; if any part remains not covered, a slight, quick motion will easily bring the fluid over the part, or a glass triangle will cause the difficulty to disappear, dragging along with it sufficient of the fluid to cover the part denuded. The reduction is very rapid; and where the exposure has been about right, the development of the image will be complete in two or three minutes. In very cold weather it is better either to use a stronger bath or to warm the bath by floating it in warm water. Gallic acid in solution is very apt to become mouldy by keeping, and, consequently, a small piece of camphor, or a drop of oil of cloves, is mixed with the bath to prevent this sort of decomposition. An under-exposed picture develops very slowly, and by a long continuance of the action of the acid it becomes uniformly dark-colored without any gradation of tone; on the contrary, an over-exposed picture is developed with great rapidity, and has to be removed from the bath quickly to prevent its assuming a dark color over

the whites. If printed deep enough in the shades, in such a case, the lights would in the mean while be completely spoiled. The best prints are those in which the gradation is all thoroughly and rather slowly brought out in the printing; these are afterward carefully washed and fixed in a weak solution of hyposulphite of soda, containing as follows:

Hyposulphite of soda,	1 ounce.
Water,	20 ounces.

The prints remain in this solution for a quarter of an hour or so, and are again thoroughly washed. After this proceeding, if the tones are not satisfactory, the prints may be immersed in the gold toning-bath, in order to receive a gold deposit, which modifies the color. Any of the gold-toning formulas given will answer the purpose. If, in the operation of developing, etc., the whites are not clear, an improvement in this respect is effected by immersing the well-washed prints in a bath containing one ounce of chlorinetted lime to ten ounces of water.

Third Method with an Iodide.

Formula for Salting Solution.

No. 1.	Nitrate of silver,	44 grains.
	Distilled water,	2 ounces.
No. 2.	Iodide of potassium,	7 drachms.
	Distilled water,	2 ounces.

Dissolve the two salts, and then mix the solutions together, which will produce a precipitate of the yellow iodide of silver. Add to this a concentrated solution of iodide of potassium, until the precipitate is dissolved. The fluid is then ready for the bath.

Float the papers on this bath in the usual manner for about three minutes, or until they lie flat on the solution. They are then taken out and hung up to dry. After this proceeding they are floated in a quantity of rain-water, two and two together and back to back, for a number of hours, taking care to turn them over from time to time. The surface thus prepared assumes a very uniform but pale yellow color. The papers are again taken out and hung up to dry

Sensitizing Bath. Formula.

Distilled water,	25 ounces.
Aceto-nitrate of silver solution,	4 drachms.

The solution of aceto-nitrate of silver is prepared as follows:

Nitrate of silver,	1 ounce.
Acetic acid,	2 ounces.
Distilled water,	10 ounces.

Or the complete formula may stand as follows, where operators do not wish to keep a stock of the aceto-nitrate of silver:

Distilled water,	25 ounces.
Nitrate of silver,	18 grains.
Acetic acid,	2 scruples.

The papers are floated on this bath for three minutes, and then taken out and hung up to dry. Whilst the surface is still somewhat moist, they are exposed beneath a varnished negative, or on the screen of the solar camera, for a few seconds. The image in this case is quite latent. In dull weather, and when the light is very feeble, half a minute's exposure will suffice. The print is developed by pouring upon it, in the manner already indicated, a saturated solution of gallic acid containing about one third its quantity of aceto-nitrate of silver. If the development is very slow, the exposure has been too short; on the contrary, the development is quite rapid when the exposure has been too long. As soon as the print is completely brought out in all its details, it is immersed in water and very thoroughly washed in order to remove every trace of gallic acid.

The prints are then immersed in a solution of hyposulphite of soda as follows:

Hyposulphite of soda,	2 ounces.
Water,	10 ounces.
Chloride of gold,	2 grains.

The prints do not change much by immersion in the fixing solution, if the time of exposure has been sufficiently prolonged; if the time has been too short, the dark color will become pale and red. If the tones of the shades do not assume a dark color in the developing solution, the cause may be attributed to the want of aceto-nitrate of silver in the gallic acid; and, as a rule to be observed, the aceto-nitrate is gradually added where the development or the intensity relax. If the toning in the fixing solution becomes inky, the gold may be omitted.

Method of Sensitizing by Means of Nitrate of Uranium. (*The Process of Niepce de Saint Victor.*)

The paper used in this operation has to be kept in the dark-room, or at least excluded from light, for several days previous to its employment. It is then floated, without any other preparation, on the following bath:

Sensitizing Bath.

Nitrate of uranium, ... 1 ounce.
Distilled water, ... 5 ounces.

After two or three minutes the papers are removed from the bath, allowed to drain, and then hung up and dried. They will keep a long time when not exposed to light. The time of exposure beneath a negative varies with the intensity of the light; from one to ten minutes in the sun, and from a quarter of an hour to an hour in a feeble diffused light. The image is barely visible.

Developing Solution. No. 1.

Nitrate of silver, ... 1 drachm.
Acetic acid, ... 1 to 2 drops.
Distilled water, ... 2 ounces.

The development is very rapid. Almost as soon as the print is immersed in the fluid, the picture comes out and proceeds to its termination with great velocity. As soon as the development has advanced far enough, the prints are plunged into water, and thus washed and fixed at the same time.

Developing Solution. No. 2.

Chloride of gold, ... 10 grains.
Hydrochloric acid, ... 1 drop.
Distilled water, ... 12 ounces.

Prints are developed in this bath with more rapidity than in the preceding.

Another Method.

Sensitizing Bath.

Nitrate of uranium, ... 1 ounce.
Distilled water, ... 10 ounces.

Developing Solution.

Bichloride of mercury, ... 5 grains.
Distilled water, ... 12 ounces.

Pass the prints through this solution, and then wash them very carefully, after which they are immersed in the following bath:

Nitrate of silver, ... 2 drachms.
Distilled water, ... 12 ounces.

When the image is intense enough, wash the prints thoroughly and hang them up to dry.

CHAPTER XXXV.

THE CARD-PICTURE.

This picture does not differ from any other photograph in the essential parts of its structure or preparation. No picture has ever had so wide a sphere of action, has gratified taste so long, or has been as productive of gain to the photographer as the card-picture. It is the picture of the day, and has tended considerably to simplify the photographic establishment. A few years past a number of cameras were required, ranging from the quarter to the extra four fourth tube; now, a single tube, either a *one fourth* or a *one third* will be a complete outfit as regards lenses for an ordinary practitioner, with which, *Deo volente*, and the war to boot, a fortune may soon be realized. The card-picture generally comprehends the whole figure, either sitting, standing, gracefully leaning against a pillar or balustrade, performing some natural and easy operation, as playing the piano or guitar, trimming a flower in the arbor, or sailing in the yacht; in fact, the photographer, at least the artist, aims to pose his model in the midst of nature's charms with ease and grace, and perfectly free from all constraint.

The size of the card-picture is a distinct characteristic from all other pictures. The mounts of cardboard for this picture are four inches long by two inches and one third wide; they can be had already prepared, plain or ornamented, with gilt edges, or with a gilt border, at any of the photographic wholesale establishments in the city. The prints are smaller than the mounts, leaving a margin of about one tenth of an inch on either side and on the top; the margin at the bottom is larger, being about a quarter of an inch. The paper on which such pictures are printed is of the finest quality, and very uniformly and highly albumenized. It is impossible to obtain the fine, sharp definition on plain paper as on albumen, because of the difference of homogeneity in the two surfaces. Tinted albumen paper, too, is now sometimes used to meet the wishes of the fanciful, or the cravings after novelty.

Lenses for the Card-Picture.

Lenses for the card-picture are prepared with great care, so as to produce as little distortion as possible in the complete figure. On this account a long-focussed tube is preferred to one that is shorter; but of two tubes, if they both produce irreproachable pictures in a given room, the one, which is the result of the short-focussed instrument, will exhibit more roundness, a finer stereoscopic effect than the other. Choose therefore the shortest tube that will perform all that is required in a card-picture, and at the distance which your glass-house will admit of. Where the business in this department is extensive, two tubes, or even four tubes are mounted at the requisite distance apart for the taking of two or four photographs at the same time. Furthermore, by an arrangement of the plate-holder in the camera, by which it is caused to slide either horizontally or vertically, or in both directions, as many as eight or sixteen photographs can be taken at the same sitting. It would be a waste of time to get up such cameras one's self; they are manufactured very neatly and accurately by city artisans, and are fitted up with the number of tubes ordered or required. Each tube is focussed separately upon the sitter, and then by a shutter the tubes are opened and shut cosentaneously at will. After a proper number of seconds have expired, the shutter is closed, and the plate-holder is moved a fixed distance, so as to expose another portion of the collodion plate. In the mean while the model remains quite still. The shutter is again opened and the plate exposed as before.

Development.

This operation scarcely needs any elucidation; the proper negative effect has to be attained by means of the reducing agent and the intensifier as before minutely described. The image is by far softer, and in other respects more agreeable, if the negative can receive its requisite amount of density by the primary development, or nearly so, so that, when intensified, but little more has to be accomplished, and this little can be effected by a weak intensifier. When the strengthening solution is very strong, it is apt to engender a pulverulent deposit on the surface of the collodion which detracts from softness and sharpness, communicating to the photograph an appearance of measles or small-pox. In this respect it is indifferent whatever may be the size of the negative, where there is a tendency to this powdery phenomenon, whether it arise from the collodion, or, as I have just re-

marked, from a deposit of the silver, it is always advisable to *intensify slowly*.

One point in the taking of negatives I have not yet adverted to. In the wet process, if the sensitized plate has to wait long between the time of its removal from the silver bath and its development, the silver solution evaporates rapidly, and the plate becomes dry, or nearly so; the consequence of this is *supposed to be*, that, as the solution thus becomes stronger, it dissolves the iodide of silver in the film, and gives rise to the phenomenon of minute apertures. Without attaching much credit to this rationale of a trouble which is very annoying, we *do* know that if the silvered plate becomes dry the development is very irregular. Another cause of the minute apertures alluded to is a quantity of insoluble bromide in the collodion. It is a recommendation, therefore, to dissolve the iodides and bromides in the preparation of collodion, first in alcohol, and to filter the solution, after standing several hours, before it is added to the plain collodion. Another reason, and probably a very frequent one, is to be traced to the minute insoluble particles in the silver bath, which settle upon the tender collodion film, and become as it were imbedded in it. These in the subsequent operations of developing and fixing produce either opaque pulverulent black points, or transparent ones, just as they retain a fixed position in or on the film, or are washed or dissolved off. Both these phenomena are exceedingly annoying. Such a cause can be removed by filtration, or by a sort of coagulation, (if I may use the word here instead of precipitation,) by means of a small quantity of a solution of salt, and then by filtration. This operation certainly weakens the bath, but it makes it at the same time a better solvent of certain impurities that tend to cause the trouble in question. The tendency to these horrid *pin-holes* is greater when the bath is strong than when it is weak; it would appear, however, that the insoluble iodide of silver in the film can scarcely be a cause of the trouble; for being present everywhere in the film, it would be uniformly dissolved as the silver solution gradually increased in strength, and would thus present a condition for actinism the very best that could be desired. There is certainly no doubt that these apertures are caused in the majority of cases by an insoluble pulverulent substance, loosely attached to the *surface* of the collodion, and either sensitive to the actinic rays or not, (which is quite immaterial to the argument;) these, imbedded on the surface of the collodion and opaque, prevent the rays from penetrating to the true

film beneath, and being afterward brushed off or dissolved off by the acids in the developer or by the fixing solution, expose parts in which the iodides and bromides have not undergone the luminous influence, and are hence made transparent by the hyposulphite of soda, like any other protected part.

In fine, no *general rule* is known by which *à priori* these pin-holes can *always be avoided* and *accounted for*.

The card-negative, next to that which is prepared for the solar camera, must be bright and transparent, free from the slightest trace of mistiness or fogging, and of such a depth of shade as to preserve the whites, whilst at the same time the operation of printing is performed quickly. That the negative must be *sharp* is a *sine quâ non ;* and in order that the negative be sharp and well-defined to the very edge, and from top to toe, spare no expense, no trouble in securing a reliable lens. With this, and a moderate share of intelligence, an operator may run his career without impediment to success; whilst his neghbors, with poor lenses, whatever their amount of education, will roll down the hill to perdition. The *lens* leads to *success* or to *ruin*.

Fixing.

There is no difference in this department from that which will be found in reference to the melainotype, or the ordinary negative. Either cyanide of potassium or hyposulphite of soda is used. The new fixing agent, sulphocyanide of ammonium, it appears has no claims of superiority over its predecessors; it has, however, a decided disadvantage, and that is its expense; this will always exist comparatively, because cyanide of potassium can more easily be manufactured. Like the cyanide, too, it has toxical properties. In order to avoid all the poisonous effects that might arise from contact of such substances with the broken skin or wounds, as well as the discoloration of the skin from the silver salts during development, I would recommend a plan which I generally adopt. I do not hold the negative in the hand when I intensify; it is placed on a piece of glass cut out in the form of the porcelain dipper for the silver bath. At one end a small piece of thick glass, one inch in width, and as long as the dipper is wide, is cemented by melted lac; over this is cemented a second piece, projecting above the first one, so as to form a ledge beneath which the negative is kept in its place. At the upper end the negative is secured in its place by means of a clothes-pin. In this way the

negative can be intensified without obscuring the light that passes through it from below, and the hand at the same time is protected from contact with the pyrogallic acid and silver. Stains from nitrate of silver, or from the pyrogallate can be removed, it is true, as long as they have not been exposed much to light, by washing with cyanide of potassium; but this would entail upon the operator the trouble of washing after each negative, and might entail upon him incurable ulcers. If he does not wash his hands after each negative has been taken, there is no alternative, they must inevitably become black. The glass dipper will obviate this trouble. Another trouble, but not quite so alarming, arises from the mode we practise of turning the prints round with the hands in the toning and fixing baths. The health of operators is much impaired, and especially in those large printing establishments, where a number of females are employed in this department, who, by this continual manipulation in the two fluids, are frequently in a suffering condition Now all this can be avoided by a dexterous use of a glass rod, well rounded off at either end, and held in either hand. The hands *have no business in these fluids;* and all parties concerned, that is, *hands, fluids, and prints,* will be benefited by following the precaution recommended. With a little ingenuity a pair of porcelain or glass forceps might be constructed for this special purpose, consisting of porcelain or glass legs fastened into a steel spring arch, which would hold them an inch or so asunder. Such forceps may be used, too, in holding the negative either during development or intensifying. The health of the photographer has to be looked to, and means adopted for its preservation.

Printing of Card-Pictures.

There is nothing peculiar in the printing of card-pictures, photographically speaking, as distinct from that in other pictures on paper, except it be the number of photographs on the same plate; for, as was to be inferred from the manner prescribed to take the negative, this plate may contain as many as sixteen distinct pictures; it seldom, however, contains as many. Condensing reflectors find their application here to great advantage when the light is dull. Such an arrangement of reflectors might be constructed on a movable platform, or turn-table, capable of rotating horizontally, whilst the frustum itself, lined by the reflectors, and supported on vertical pillars, has a vertical motion. By the two motions combined, the frustrum can be easily brought

in front of the direct rays of the sun, whereby a great condensation of light can be effected on any given surface. It is immaterial how large a surface may be occupied by the negative, or the sum of the negatives on the same plate, reflectors can be made in accordance, possessing the advantage of the direct rays that strike the plate, as in ordinary printing, together with the extra advantage of the condensed light from the rays after one reflection, as well as from those after two reflections. The size of each of the reflectors alluded to will be proportionate to that given in a preceding chapter. If the negative plate be sixteen inches square, then it will be four times as large in its linear dimensions, as in the example given; consequently, multiplying $14\frac{7}{10}\frac{8}{0}$ and $21\frac{5}{10}\frac{6}{0}$ by this ratio, that is 4, we obtain $59\frac{1}{10}\frac{2}{0}$ and $85\frac{2}{10}\frac{4}{0}$ inches for the length of the upper or larger base, and $86\frac{2}{10}\frac{4}{0}$ inches for the length of the side of each plate of glass in the frustum. Such a machine, of course, will be expensive, but like a wind-mill where no water exists, it will soon pay for its construction by economizing time. By such a condensation of the sun's rays, a negative will print well in from *thirty to sixty seconds.*

Vignette Printing.

A vignette is a picture of a portrait, consisting of the head and part of the bust, of an oval shape, in the middle of the card, surrounded by a sort of halo, or shading off gradually into the white background.

For this sort of printing the operator has to be furnished with *vignette glasses*, which are manufactured specially for such operations, and to be had of all respectable dealers. The vignette aperture can be had of any size required; it is formed of a piece of glass, stained on one or on either side with a metallic oxide, which is burnt into the glass. This stain, however, is a mere film, and can easily be ground away of the requisite shape and size by the lapidary, and then polished. The external parts being of a red orange color, intercept or absorb those rays of light which would act upon the sensitized collodion film, whilst through the vignette opening all the rays can act almost with their primitive vigor. Such a glass, or an appendage of such glasses, is placed first on the glass of the printing-frame; upon this comes the negative, and then the paper, as in ordinary printing arrangements.

Vignette glasses can be made by the photographer himself in the following manner: Take a piece of glass of the proper size, and paint either with water or oil colors the vignette

opening in orange or black, shading off toward the edges; fill up the remaining part with white paint, shading the edges bordering on the vignette gradually deeper and deeper, until the layer becomes uniformly white to the edges of the glass. This is the matrix from which an indefinite number of negatives can be copied, which will be, when varnished, the vignettes required.

Toning, Fixing, and Mounting.

No further observations are requisite. Instructions on these matters are given in detail in a preceding chapter of this work, and on the coloring of the card-picture, of the stereograph and the photograph in a chapter specially devoted to the subject.

On the Tinting and Coloring of Photographs.

The colors required to tint or color photographs are the same as those employed in miniature painting, and the same amount of artistic skill is required in the one as in the other, where excellence and perfection are the aim of the photographer. Where very large photographs are to be colored, the fineness of miniature painting for hatching or stippling is not essential, in fact it would be out of place; in such a case a knowledge of crayon-drawing is brought to bear on the subject. Colors for such artistic purposes exist in three forms: in cakes, in powders, in liquids, in oil, and in crayons.

For touching up daguerreotypes, ambrotypes, melainotypes, and ferrotypes, colors in very fine powder are employed. These are laid on the appropriate parts, shaded off so that no sharp edges exist, and afterward the excess is blown off with an India-rubber blower, either before the application of the varnish or afterward, or both before and afterward, as in the alabastrine process, where the color is laid on sometimes three or four times, until it shows through to the other side.

Liquid colors, that is, the new Aniline colors, are specially adapted for the tinting and coloring of albumen pictures; these colors flow very easily, and the albumen surface requires no preparation. For the ordinary photographic practitioner in card-pictures they are to be highly recommended.

Where the card-picture or photograph is to be colored, hatched and stippled to perfection in the form of a miniature painting, the artist requires a complete outfit of Newman's photographic colors, etc. It is remarkable, however, to see

with how few colors the *real artist* can execute the most finished work.

The Colors used most frequently.

Chinese white, Naples yellow, raw sienna, burnt sienna, yellow ochre, yellow lake, ivory black, bistre, gamboge, cobalt blue, Prussian blue, indigo, Chinese vermilion, scarlet lake, neutral tint, sap green, carmine, rose madder, purple lake, Venetian red, pink madder, and sepia. These are in the form of cakes. To these may be added a few bottles of liquid colors, as of silver white, chrome yellows, greens, etc.

Other Indispensable Articles.

Sable, fitch, and camel's hair pencils, prepared ox-gall, brushes, shells, stumps, slabs, palettes, varnish, gum-arabic, gelatine, penetrating varnish, eraser, basin, tumbler, and sponge.

Coloring of a Portrait.

In regard to coloring as to photography, I shall treat the subject of shading as divisible into three parts: lights, middle tones, and shades. An irregular surface has always these three gradations, not separated by distinct lines of demarkation, but flowing gradually or irregularly into one another, according as the undulations of the surface are gradual or irregular. Difference of distance in a plain surface effects what irregularity effects on an undulating surface, whose parts are nearly all at the same distance. Supposing then a surface of one and the same uniform color gradually retires from the eye, it is evident that the nearest parts are the most brilliant and light, the middle parts less so, and the most distant parts are the darkest and least brilliant. So it is also with undulating surfaces, the most prominent parts are the lights or the bright parts; the depressions or cavities, the shades or darkest parts; and the retiring or intermediate parts are the middle tones. This is the effect of light and distance, and we have to imitate this only in color on a plane surface, for the gradations of shade are already impressed in the photograph. The question to be solved then is simply this: there are three different degrees of the same color in a given space—which is the most appropriate manner of obtaining this collocation or rather gradation of these shades of color? Without the slightest pretension to dictate artistically on a subject that takes much genius and incessant labor to attain to perfection, I recommend to the photographer, who aims to ameliorate his photographs somewhat respectably with color, to lay on the middle tint first over the whole

surface, and then the lights and shades afterward, in their proper places, when the first is dry. To be enabled to do this, select three gradations of the color in question. It sometimes happens that the white of the paper forms the lights; in this case the dark parts may be laid on and shaded off into the lights.

Coloring the Face.

Paste the photograph on a piece of cardboard in the first place, varnish the surface with Newman's preparation, and then proceed as follows: Lay on cobalt blue in small quantity in all the shades and depressions of the face with a light hand and small pencil, as, for instance, along where the roots of the hair commence, about the temples, about the chin, beneath the eyebrows, and around the eyelashes, etc. With another pencil dipped in water, so as simply to moisten it, spread the color so as to dilute it and shade it off, so that it becomes more and more transparent, until it finally reaches the bright lights and merges into them. You proceed in like manner with the interior of the eyes, that is, on the visible parts of the sclerotic or white of the eye. The object of this operation with cobalt blue is to give more softness to the dark shades afterward. The veins of the hand, the borders of the coat, waiscoat, etc., and the cuffs of the sleeves where they terminate on the linen, have to be treated in like manner, beginning with the darkest part and shading off into the lightest. Allow this color to dry, and in the mean while prepare the colors for the face, neck, hands, etc.

For a person of fresh complexion mix up a little yellow ochre, with one third the quantity of vermilion and pink lake in water on the palette or slab, and cover the face, (with the exception of the eyes,) the arms, the hands, etc., with a thin and uniform layer of this mixture; then tint immediately the cheek-bones and other prominences with a very thin mixture of rose madder and vermilion, in order to give more animation to these parts above the rest. If the person has a red complexion, these colors are heightened still more; and where the complexion is very pale, less vermilion is used, and no color on the cheeks. The upper lip, being in shade, must be tinted with a mixture of cobalt blue and lake, whilst vermilion is employed for the lower.

For a sun-burnt complexion, add to the colors indicated a small quantity of bistre, and proceed with the general wash as before; follow up with lake and vermilion for cheeks, where they are colored, and use nothing where they are pale. Where yellow prevails in the complexion, increase the ochre.

Where a simply tinted picture is required, the operation may stop here; but where a higher finish is desired, you may proceed and stipple in a light tint of lake and vermilion on the bright parts of the cheeks, lips, etc., by using a very fine-pointed pencil, and filling up the parts with contiguous fine dots or points of color; and by hatching over the shadows on the forehead and the retiring parts, the temples and the chin with a bluish-gray color, that is, fill up these parts with contiguous short lines, and then cross them in a similar manner, so as to produce a greater depth of shade. Use a little pink madder in the corner of the eye next the nose; stipple the lips too, and mix a little Chinese white with the lake and vermilion for the high lights. The edge of the eyelids have to be treated in a similar way. Stippling and hatching are more especially required where the colors have not been neatly laid on in the first operations. We now proceed to the hair.

Blonde Hair.

Wash the entire surface of the hair with a mixture of yellow ochre and bistre in small quantity; then soften the colors down where they border on the temples and the forehead with a pencil dipped in water. As soon as this wash is dry, take a very fine long pencil and proceed to introduce the dark parts with a mixture of ochre containing more bistre. The lights are produced by adding either a little white or Naples yellow to the original mixture of yellow ochre and bistre. Both the lights and shades are introduced by streaks of color in the direction of the hair, taking care to avoid the wiry effect produced by making each hair separately. Soften down those parts that border on the background, and stipple up those parts along the roots of the hair with cobalt blue or gray, lest the boundary of the hair should be too marked, and give it the appearance of being inlaid.

Chestnut-Colored Hair.

Cover the whole with a layer of bistre; then finish up the shades with a mixture of ivory black and bistre, the lights with Naples yellow and bistre, and the high lights with a little white mixed with cobalt.

Black Hair.

The general wash for such hair is ivory black diluted with water; the dark shades are put in with ivory black of greater consistency, and the lights with the same color, mixed with white and cobalt if the hair is blue-black, and with white and a little pink madder if the hair is of a pure black.

Gray Hair.

Cover the whole with a mixture of equal quantities of bistre and white; the dark parts with bistre and a less quantity of white; the lights with bistre and more white than in the general wash, and the high lights with cobalt, white, and pink madder.

Red Hair.

Take yellow ochre and burnt sienna for the general tint; the same and a little bistre for the shades; white, yellow ochre and burnt sienna for the intermediate lights; white, cobalt and lake for the high lights.

White Hair.

The general tint is that of the photograph itself; the shades are put in with a little black, and a very small portion of yellow ochre and cobalt, and the lights with Chinese white.

The head and face may now be considered nearly finished; all that remains to be done is to put in the deep touches about the eyes with sepia and pink madder, worked up with a little gum-arabic; those about the nose are put in with sepia and gum-water. Put in the light in the pupil of the eye with Chinese white. All these final touches require great care and skill.

The hand, the neck, the shoulders, etc., are retouched with the final stipplings or hatchings in the same way, in order to give animation to the picture, observing to put in greys or cobalt blue in the shades, and pink madder in the bright lights.

Drapery.

The handsomest drapery is black. The general wash is ivory black of the consistency of ink. This is laid on uniformly with a full pencil, beginning at the top and proceeding downward to the lowest edge, the picture being inclined during this operation. All excess is removed with a dry pencil, and the layer is allowed to dry. When dry, the dark shades are put in with ivory black, of greater consistency, and the lights with ivory black, mixed with Chinese white and pink madder.

In all cases of tinting or coloring with any degree of refinement, it is indispensable for the beginner to be provided with two photographs of the model, one to receive the color, and the other to serve as guide for the introduction of the shades, in case they become obliterated in the general wash.

Blue Drapery.

The general tint consists of Prussian blue, or indigo, as the case may require, mixed with a little black and pink madder; the dark parts are put in with the same mixture, containing more black, and the lights with the same, containing an admixture of white. For light blues, cobalt blue may be used; and the lights may be obtained by proceeding with a pencil dipped in water over the parts, so as to remove a portion of the color.

Green Drapery.

Cover the dress with a mixture of yellow lake and Prussian blue; and throw in the shades with the same color, mixed with a little black and pink madder. The lights are put in with emerald green, and the high lights with this color, mixed with a little white.

Red Drapery.

The general wash consists of vermilion, mixed with a little pink madder diluted with water. Add to this a little bistre or black for the dark shades, and Naples yellow or white in place of bistre for the lights.

Rose-Colored Drapery.

Rub up pink madder with the requisite quantity of water for the general wash; to this add a little black for the shades, and a little white for the lights.

Brown Drapery.

Use burnt sienna, with a small portion of black bistre for the general tint; for the shades add a little black, and for the lights a little white.

Pink Drapery.

Cover the dress with a dilute solution of pink madder; then put in the shades with a mixture of pink madder, black and cobalt; and the lights with pink madder and Chinese white.

White Drapery.

The general tint is cobalt, much diluted; yellow ochre, cobalt and a little black form the shades, and Chinese white is used for the lights.

Yellow Drapery.

Any of the yellows, as yellow ochre, yellow lake, gamboge, or chrome yellow, diluted with water, may be used for the ground color; a little bistre added to the yellow forms the

dark parts; and a little white to the yellow is used to pro duce the lights.

Pearl Gray.

Mix a little cobalt, black and pink madder for the ground color; add to this Chinese white for the lights; for the shades use a mixture of ivory black and cobalt.

Violet.

Take equal quantities of Prussian blue and pink madder for the general wash; white and this mixture produce the lights; and neutral tint is used for the shades.

Background.

The background must be secondary in effect to the real object in the picture; as a general rule, it must be lighter than the shades of this object, and darker than the lights. Avoid the appearance of inlaying the object or portrait in the background. This can be done by the appropriate use of shadow, which can be made to throw the background far into the distance behind.

A similar uniform flat tint is laid on as already described for the drapery. Where defects exist in the photograph, a general wash is first laid on and then pulverized crayon of the proper color is rubbed on this, when dry, by means of the finger, and in those parts in contiguity with the figure with a fine stump. Curtains, pillars, tables, etc., are put in precisely in the same way as drapery; only be *very cautious* not to make these the principal objects of the picture by extreme definition and brilliancy of color. They must be thrown into the background by less intensity of color, and by a general feebleness of outline.

How to Imitate Metals, etc., with Color.

The artist does not use the metals themselves in miniature painting; it would be an insult to art to request their use. They can all be imitated by color as follows:

Gold.—Take an equal quantity of yellow lake and yellow ochre, and a very small quantity of burnt sienna, and mix them together on the slab, and cover the part desired with this mixture. As soon as this foundation color is dry, use burnt sienna alone for the shades. The lights are formed of chrome yellow, and are completed in the high lights with a little Chinese yellow.

Silver.—Mix yellow ochre and cobalt in equal quantities together with a small portion of ivory black; this forms the

ground-work. The shades are made with a little neutral tint or ivory black; and the lights with Chinese white laid on with a firm touch.

Iron.—The ground-work consists of cobalt blue, with small portions of black and yellow ochre. The shades are made with neutral tint and a small quantity of ochre; the lights consisting of white, tinted slightly with black.

Mother of Pearl.—This substance takes light in the photograph; there is no ground-tone; put in a very light tint of cobalt blue, as also of very light pink madder in two or three places, taking care they do not come in contact; the shades are then formed of black ochre and cobalt; and the lights with Chinese white.

Lace, etc.—Lay on a general tint of ivory black somewhat deeper than that of the dress; the meshes are then introduced with white mixed with a little blue and black. The design is finished by indicating it with Chinese white.

Precious Stones.—Rubies, sapphires, emeralds, etc., receive a foundation of neutral tint of considerable consistency; Chinese white is put on the luminous part; whereas the reflection, which is on the opposite side to the luminous part, receives the color of the stone. The diamond alone, owing to its nature, has a reflection of a more dead white.

As soon as the portrait is finished, pass over the eyes, the hair, the eye-lashes, the nose, and the mouth, lightly with a solution of gum; do the same also with satin stuffs, such as collars, waistcoats, and robes. Used in moderation, this solution communicates a vigor and freshness to the picture which are quite satisfactory.

(The preceding article on tinting and coloring is extracted almost entirely from the small work on this subject by Hilaire David.)

CHAPTER XXXVI.

DRY COLLODION PROCESS—DRY PROCESSES.

My instructions hitherto have been limited strictly to the chemical and mechanical manipulations that occur in that department of photography denominated the *Wet Collodion Process*. This process will ever remain the predominant mode of conducting photographic operations in the room; it is preferred, too, by many tourists in the field. The inconvenience, however, of dragging along over mountain and valley, or of stowing away on steamer or on the cars, a complete miniature operating gallery, has suggested the idea of superseding all this trouble by the discovery of a *dry process*. Several processes *have been discovered* which are more or less successful, and all very practical; but it must be confessed that the same degree of sensitiveness in the dry process has not yet been attained as in the wet process—instantaneous pictures are the result only of the latter. It appears natural for us to expect such a result; chemical combinations and reductions are effected most easily when the molecules of matter are in such a condition as to have freedom of locomotion, by which new molecular arrangements can be formed, in accordance with the new electro-chemical attractions and repulsions superinduced by the contact of dissimilar bodies.

For landscape and especially for architectural photography, for copying, as well as for every case of photography in still life, where the time of exposure is not important, dry plates are decidedly superior to wet ones because of the uniformity of their condition during the time of their exposure; wet plates, on the contrary, by desiccation are continually changing; and one of these changes — the concentration of the nitrate of silver during evaporation — is *supposed* to be one of the causes that produce minute apertures in the film, and is certainly the cause of an irregularity in the reduction-process during development. The aim of a dry plate is to

attain to a maximum of preservation of the sensitiveness for an indefinite time. It has happened hitherto that the ratio of this preservation is inversely as the time of exposure, or, probably in plainer terms, that the better the plate is preserved so as to retain sensitiveness, the longer the time required to be exposed to the actinic influence to produce a given effect. The theory, that is, the rational elucidation of the action of reduction in a dry plate is still a problem; if the wet plate, after sensitization, be thoroughly washed and then exposed, no picture is developed by the reducing agent; but in the dry plate the film is very carefully washed and then coated with some preservative agent, as it is called, such as albumen, tannic acid, gelatine, honey, syrup, infusion of malt, glucose, etc., and then when otherwise properly prepared and dry, it will yield, when exposed and afterward subjected to the action of a reducing agent, an intense picture. I say the rationale of this phenomenon is still a problem. Some suppose that the albuminous, collodio-albuminous, gelatinous, etc., film becomes permeable to the developer in the dry process; whilst the collodion film in its simple unpreserved condition is not so. Such a supposition is, however, the mere admission of our inability to render any satisfactory explanation; it is the admission of little more than the fact itself.

As yet, also, it is difficult to say which of the dry processes in vogue is *absolutely the best;* although perhaps the majority would throw the weight of their opinion into the scale of the *Tannin Process* of Major Russell. The dry processes most conspicuously on the carpet are: the *Albumen Process;* the *Collodio-Albumen* or *Taupenot Process;* the *Gelatine* or *Dr. Hill Norris's Process;* the *Tannin Process of Major Russell;* and the *Resin Process.*

The Albumen Process.

This process was in use several years before that of collodion; Niepce de St. Victor first produced negatives with it. It is still employed by some of the most distinguished artists in Europe in the production of stereographs, both negative and positive, also of photographs of interiors, and in general of pictures of still life. Its theory is very simple; but its manipulation demands great care and skill.

Formula for Iodized Albumen.

The white of egg, ... 10 ounces.
Iodide of ammonium, ... 44 grains.
Distilled water, (sufficient to dissolve the iodide.)

Dissolve the iodide in the water, then add the solution by degrees to the white of egg, entirely freed from the germ and yolk, and beat the egg up well with a wooden spatula until it is completely converted into froth. This operation must be performed in a place as perfectly free from dust as possible; and then the albuminous mixture is covered with a clean sheet of paper and put aside to settle for a number of hours. After standing the required time, the surface becomes covered with a sort of incrustation, through which an aperture is made to allow the iodized albumen to flow out. In some formulas for iodizing the albumen, a bromide is used and a small quantity of free iodine.

Formula No. 2.

The white of egg,	10 ounces.
Iodide of potassium,	44 grains.
Bromide of potassium,	15 grains.
Free iodine,	2 grains.
Distilled water, (sufficient to dissolve the salts.)	

Beat up the white of egg as before. The operation is best performed when the temperature of the room is low. A few hours previous to the operation of coating the plates, mop the floor and wipe all the shelves with a damp cloth — the great difficulty in this process is the deposition of dust or fibers on the glasses during the time they are drying. Another trouble (and these are about all the difficulties the operator has to contend against) is the flowing of the plate with an *even* and uniform film, and its uniform retention on the plate until dry. The plates, of course, must be *perfectly clean* in this process, as in every other for negative purposes.

Several methods have been proposed by which the plate can be covered with albumen, most of which, no doubt, have deterred photographers from undertaking this branch. I believe the best method is to flow the plate exactly as you would cover it with collodion; and if the albumen ceases to flow in certain parts, to use a glass triangle and thus scrape it as it were over those parts. It is necessary in all cases to pour upon the plate much more albumen than you would collodion, in order to cover the plates easily and effectually; most of the superfluous quantity is poured off at the right nearest corner; whilst the residual surplus is made to traverse the plate diagonally to the farthest left corner and then flow off into the receiving vessel. If any surplus still remains it is flowed gently toward the middle of the plate

and equalized as much as possible over the whole surface. The next operation is the

Drying Process.

This operation, in general, has been rendered very tedious and inefficient; the plates were allowed to dry spontaneously, which occupied several hours, and in the mean while the albumen film became contaminated with the deposition of dust, which completely spoiled the plates. By the following method they may be dried in a few minutes. Prepare a metallic table, that is, a plate of iron or other metal supported on three legs, sufficiently capacious for the purpose. Beneath this an alcohol lamp is kept burning, by which the plate is maintained at any given temperature by the adjustment of the wick, or its distance from the plate. Next, supposing that stereoscopic negatives are the objects of manipulation, prepare a piece of brass or iron longer and wider than the stereoscopic plate by a quarter of an inch; cut out from this a piece of the same shape as the negative plate, but shorter in its two dimensions by a quarter of an inch. On one end rivet a metallic handle, which may be fixed into a wooden one. Turn up a ledge on either side, as also on either end, (as far as practicable on the nearer end by reason of the handle,) about one tenth of an inch high. It is evident that so constructed, the negative can lie on this skeleton plate and within the ledges. Place the plate, albumenized as above, on this metallic plate, and, taking hold of the handle with the right hand, bring it into a horizontal position over the heated plate at a proper distance above it; equalize the albumen by inclining the hand as required; and, keeping the hand in continual motion, the film will soon dry uniformly, and the plate can then be put away for future use. So prepared it will keep for an indefinite time.

Sensitizing the Film.

An oblong flat porcelain or glass dish is preferred to the vertical bath for the purpose of sensitizing the film; and if the dish be made twice as long as required, it will answer the purpose best.

Formula for the Sensitizing Solution.

Nitrate of silver,	1 ounce.
Acetic acid,	5 ounces.
Distilled water,	10 ounces.
Iodide of potassium,	2 grains.

Lay the albumen plate along one side of the glass dish; then raising this side, pour into the inclined side a sufficient quantity of the bath; with a dexterous move raise the inclined side so that the fluid may flow over the albumen film in one quick continuous layer. By this contrivance all lines or marks of stoppage are avoided. This is a very necessary provision here; for the slightest hesitation or stoppage will infallibly show its effect on the negative. About half a minute will be sufficient to *coagulate the albumen*, and to *sensitize the film*. This operation is performed in the dark-room; whereas that of albumenizing takes place in diffused light. After sensitization — which occupies from thirty to fifty seconds—the plate is removed from the bath by raising it first with a bent silver hook, and then seizing it by one corner with the hand. It is then washed under the tap and left to soak in a dish of distilled water until the next plate is prepared. Finally, when it is supposed the free nitrate of silver has been thoroughly removed, it is used immediately or dried for future use. The quantity of acetic acid in the above formula may be diminished in many instances; its object is to prevent fogging, but it diminishes sensitiveness at the same time. If with half the quantity no fogginess supervenes, this quantity will be quite enough; by thus beginning with a small amount of acetic acid, and gradually increasing until fogging ceases, more rapid effects may be obtained in the exposure. When the plates are kept long they undergo a species of decomposition which induces fogginess; the fresh plates, therefore, are in the best condition for producing normal results with the greatest rapidity, because the sensitizing bath requires the least amount of acid.

Blisters are apt to arise in the film by immersion in the sensitizing bath, or during the subsequent operations. These are frequently owing to the imperfect cleaning of the plates or in the clumsy flowing of the albumen. Gummy substances are sometimes added to the albumen in order to render it more adherent or less contractile.

Exposure in the Camera.

The amount of exposure will depend on the conditions of the light, the focal length of the lens, and the sensitiveness of the albumen. In the bright light of spring an exposure of two or three minutes with a pair of stereoscopic lenses will in general be amply sufficient. Experience alone can determine the amount of time required in a given case.

Development of the Image.

The plate is placed in a glass dish, or in one of gutta-percha, and the developer is poured upon it by the same mode of manipulation as just described to be used in the sensitizing operation.

Formula for the Developing Solution.

Gallic acid, ... 8 grains.
Distilled water, (warm, 90°,) . . . . . 2 ounces.

Previous to immersion in the above solution the plates are subjected to the softening action of a warm dilute solution of gallic acid (one grain to the ounce of distilled water) for half an hour. After this the plate is flowed with a sufficient quantity of the above solution containing five or six drops of a solution of nitrate of silver two per cent strong. The image will soon begin to appear, and will proceed until the vigor of the print is satisfactory. The development is not so soon complete as in collodion operations, the time required varying from a few minutes to forty minutes or an hour. Any amount of exposure almost can be made to yield a good picture by adapting the developing solution in accordance with the exposure. If the plate has been *under-exposed* more silver will have to be used; if *over-exposed*, less will be found to be all that is necessary. Silver from the sensitizing bath might be used, but in this case it must contain more acetic acid. The weak solution above described is to be preferred; and if there is a tendency to fogging, add a few drops of acetic acid to counteract the effect. As soon as the shades are sufficiently dense, the plate is removed from the bath, well washed in many waters, and then the image is fixed in a solution of hyposulphite of soda. No varnishing is required, because the albumen film is quite hard of itself.

Taupenot Process—Collodio-Albumen Process.

This process was originally proposed by Taupenot. His design was to combine the advantages of these two ingredients, albumen and collodion. The collodion film on the glass is a much better receptacle of the albumen than the glass itself; but the operation is somewhat circuitous, inasmuch as the plate is sensitized twice. Other methods have since been devised, in which the collodio-albuminous film requires but one sensitization. Some of these are found to be very effectual dry processes.

Preparation of the Glass Plates.

These are first immersed for a number of hours in the following solution:

Salts of tartar,	1 ounce.
Rain-water,	16 ounces.

If the plates have been already employed before, soak them in water and remove the collodion film with a piece of rag. The alkaline solution can be used several times. As soon as the plates are removed from this solution, pass them through water several times, and then clean and polish them in the vice, by means of alcohol and rotten stone, as previously directed. Immediately before the collodion is flowed upon the plate, it is dusted with a silk cloth, and then with the broad camel's hair pencil. A collodion that flows well and one that adheres forcibly to the glass is to be preferred.

Formula for the Collodion.

Ether, (concentrated,)	12 ounces.
Alcohol, "	3 ounces.
Pyroxyline,	1 drachm.
Iodide of ammonium,	1 drachm.
Bromide of ammonium,	15 grains.

This collodion, containing quite an excess of ether, which is very volatile, has to be poured over the plate with great dexterity. It is very fluid and admits of this dexterity. The plate is then, as soon as the film has sufficiently congealed, immersed in the ordinary nitrate of silver bath, containing about 35 grains of the nitrate to the ounce of distilled water. It is left in this bath for four or five minutes and then taken out and allowed to drain. After this proceeding, the plate is immersed in a dish of rain-water and well washed by agitation, or it may be washed at the tap in the ordinary method, and then flowed with distilled water several times, and again allowed to drain. It is next flowed, while still moist, with the following albuminous preparation:

The white of egg, (free from germs and yolk,)	12 ounces.
Distilled water,	2 ounces.
Iodide of ammonium,	44 grains.
Bromide of ammonium,	16 grains.
Ammonia,	1 ounce.
White sugar,	2 drachms.

These ingredients are intimately mixed by an egg-beater until the mass is reduced to froth. They are then allowed to subside for a day or two. The clear part is separated by decantation or by a syringe from the residue below, and from

the indurated scum on its surface above. With this clear solution flow the still moist plate as you would with collodion almost. Holding the plate by the left-hand nearer corner, between the thumb and the first finger, pour the albumen on the right-hand further corner, then inclining the plate, let the albumen flow to the left-hand further corner. Now allow the whole body of the albumen to flow down in one mass, driving the water before it until it arrives at the nearest edge. Inclining the right-hand nearest corner, allow the water to flow off together with the excess or surplus of the albumen into a separate receiver. Now raise the nearest edge of the plate and let the surplus proceed back again to its place of starting, and once more to the nearest right-hand corner, when all excess is allowed to flow off. The plates are then reared away on one corner to dry. In this state the film is not sensitive, and consequently the plates so far can be prepared beforehand and preserved until wanted.

Sensitizing of the Taupenot Plates.

Nitrate of silver,	1 ounce.
Acetic acid,	1 ounce.
Nitrate of silver,	12 ounces.

The plates are immersed in this bath with great care and dexterity, in order to avoid all lines of stoppage, etc. In thirty seconds the film will be sufficiently sensitized. The plate is then taken out and plunged into a dish of water, moved about in this, then transferred to another, allowed to drain, finally flowed two or three times with distilled water, and put away to dry in a perfectly dark place.

In this condition the film is much more sensitive to light than albumen alone, although it is less so than collodion. The plates can be preserved sensitive for several months, but the sensitiveness gradually deteriorates by age.

Exposure.

With a portrait combination an exposure of two or three seconds will be found to be sufficient to receive a good impression of an object well illumined by the sun, and as many minutes will suffice with a single lense.

Development of the Image.

The developing solution is composed as follows :

Distilled water,	12 ounces.
Gallic acid,	18 grains.
Pyrogallic acid,	6 grains.
Alcohol,	2 drachms.
Acetic acid,	½ drachm.

To every three ounces of this solution add a solution of one grain of nitrate of silver, when about to use it. A larger proportion of pyrogallic acid and nitrate of silver will increase the intensity of the blacks; and where the time of exposure has been too long, the gallic acid may be diminished and the acetic acid increased. The horizontal bath is preferable for this sort of development. The plate, first dipped in water, is then lowered dexterously with the collodio-albumen surface downward into the solution, and the upper end is allowed to rest on a piece of glass or porcelain, to prevent the film from coming in contact with the bottom of the vessel. The plate is raised from time to time to watch the progress of the development, which may occupy from ten minutes to twenty-four hours. When the shades are intense enough, the plate is taken out, well washed, and then immersed in the fixing solution.

Fixation of the Taupenot Plates.

Hyposulphite of soda,	1 ounce.
Water,	20 ounces.

Even a weaker solution will frequently be all that is required. The soluble iodides being removed, the plates are taken out and thoroughly washed as usual.

Modified Albumen Process. (*By James Larpey.*)

Let the plates be coated with any collodion, iodized or non-iodized, and afterward well washed.

Flow them with the albumenizing solution, which is made as follows:

Formula for Iodized Albumen.

Albumen,	10 ounces.
Iodide of ammonium,	50 grains.
Bromide of potassium,	12 grains.
Water,	2½ ounces.

The mode of flowing is the same as already described for the Taupenot process. After draining, dry as before indicated.

Sensitizing Solution.

Nitrate of silver,	60 grains.
Acetic acid,	60 minims.
Water,	1 ounce.

The time required will be thirty seconds or thereabouts; remove from the bath and wash thoroughly.

Exposure.

This preparation requires about twice as long an exposure as wet collodion.

Developer.

Saturated solution of gallic acid and a few drops of a solution of nitrate of silver, (fifty grains to the ounce of water.) By varying the quantity of nitrate, any kind of tone can be got. A small quantity yields brown tones; a larger quantity black tones.

Fixing.

Wash thoroughly and then fix in the ordinary solution of hyposulphite of soda; finally wash and dry.

The collodion film in this process facilitates the flowing of the albumen, which besides dries much quicker. Its keeping properties are very good.

Modified Collodio-Albumen Process. (*By James Mudd.*)

Coat the plates with collodion, as usual. As soon as the film is sufficiently adhesive, immerse in the ordinary bath of nitrate of silver. Dilute the collodion with ether if it gives a very thick and creamy film. After sensitizing, wash the plates thoroughly, and then immerse them in a weak solution of iodide of potassium, (one grain to the ounce of water,) for two or three minutes, moving them gently all the while. Wash again and allow to drain for one minute.

Formula for Iodized Albumen.

Albumen,	10 ounces.
Iodide of potassium,	50 grains.
Bromide of potassium,	10 grains.
Ammonia,	100 minims.
Water,	2½ ounces.

First dissolve the iodide and bromide in the water, then add the ammonia; mix this solution with the albumen, and beat the whole into a froth, and then allow it to settle for at least twenty-four hours. Decant, as previously directed, before use. While the plate is still wet, pour on the albumen. Pour it on and off twice. Allow the plate to drain for a few minutes; then dry it rapidly before a clear fire, and make it quite hot.

Sensitizing Solution.

Nitrate of silver,	40 grains.
Glacial acetic acid,	½ drachm.
Distilled water,	1 ounce.

Warm the plate slightly, and then immerse it in this solution; drain for a moment, and wash in different dishes of pure water, and finally under the tap. Dry the plates by artificial heat, or let them dry spontaneously.

Plates so treated are very sensitive, and possess tolerable keeping properties. In summer, however, it is advisable to prepare fresh ones every two weeks or so.

Development.

The plate, first moistened and supported on a horizontal stand, pour upon it a fresh solution of pyrogallic acid, (three grains to the ounce of water.) The image will soon appear, but it requires intensity.

Intensifying.

Pyrogallic acid, ...	2 grains.
Citric acid, ...	2 grains.
Nitrate of silver solution, (20 gr. strong,)	2 or 3 drops.

Pour a sufficient quantity of the above upon the plate and keep it in motion. If the shades do not assume sufficient intensity, use more silver. The solution may be warm in cold weather, or when the picture has been under-exposed.

Fixing Solution.

Hyposulphite of soda, ...	6 ounces.
Water, ...	16 ounces.

Wash the plates well before immersion; fix as usual, and again wash. Cyanide of potassium must not be used for this purpose.

Fothergill Process.

This process, like the two preceding, is a mere modification of the Taupenot process, the principal difference between this and the Taupenot being that the plate is sensitized only once. The plate is first flowed as usual with any *ripe* bromo-iodized collodion, and then as usual sensitized in the common nitrate of silver bath; after removal from the bath, soak the plates in distilled or rain-water, so as to remove all but a mere trace of nitrate of silver. This part of the operation is probably the most important and characteristic of the operation. Some pursue the plan of soaking the plates, as just directed, in a dish of distilled water, keeping the water moving over their surface until all apparent oily streaks or greasiness have disappeared. Others recommend a more definite plan. They use a measured quantity of distilled or rain-water for a certain number of square inches of surface. For a stereoscopic plate half an ounce of water is

poured carefully on one corner of the plate, and is made to cover the whole quickly, as in the developing process. The water is then kept in motion by tilting the plate slightly up and down, until the greasiness disappears; it is then poured off, and the plate is allowed to drain for a moment, and covered with the following preservative solution:

Albumen,	2 ounces.
Ammonia,	20 minims.
Water,	6 ounces.

Mix well by agitation in a large bottle, and filter through a sponge immediately before use.

This solution is poured upon each plate whilst still moist, in the same manner as plates are covered with collodion; the residual quantity is poured off at one of the near corners. Another quantity of the albumen is now poured upon the plate and allowed to remain one minute, after which it is poured off, and the plate is properly washed, drained, and dried either spontaneously or by the application of heat.

Developing Solution.

After exposure, the plates are first moistened in distilled water, and then covered with the following developer:

Pyrogallic acid,	3 grains.
Citric acid,	1 grain.
Water,	2 ounces.
Alcohol,	10 minims.

Add to each ounce of the above solution half a drachm of a solution of nitrate of silver, containing fifteen grains to the ounce of water. Wash thoroughly when the image is perfect.

Fixing Solution.

Fix the impressions in a bath of hyposulphite of soda; wash, dry, and varnish.

CHAPTER XXXVII.

DR. HILL NORRIS'S PROCESS—GELATINE PROCESS.

Make use of a non-contractile bromo-iodized collodion, and after the film has been sensitized in the ordinary nitrate of silver bath, and allowed to drain, pour upon it a solution of honey, containing one ounce of honey to two ounces of distilled water. The solution must be warmed and filtered through filtering paper, previous to its application. This solution may be kept in vials, *completely filled*, for a considerable time. As soon as the plate has been thoroughly covered with the syrup, it is very carefully washed beneath the tap, until the washings no longer taste either of honey or silver. The plate is next flowed with the following solution:

Preservative Solution.

Gelatine, ...	1 drachm.
Water, (distilled,)	20 ounces.
Alcohol, ...	4 drachms.

Soak the gelatine in the water until it has swelled, then apply heat to dissolve it. After it is cool, mix with the solution the white of an egg very intimately, then boil the mixture, so as to coagulate the albumen. Let it stand for a few moments, and then filter whilst still hot through a flannel bag before a fire. The first portions of the filtrate, not being clear, are poured back again into the funnel and again filtered. The alcohol is next added to the clear solution, in order to communicate to it keeping properties.

When about to use the gelatine, place the bottle that contains it in a dish of hot water, in order that the gelatine may melt; a separate vessel used for flowing the mixture is nearly filled with the melted gelatine, and rendered still more hot and fluid in a hot-water bath. The plate is first heated and then flowed with this hot solution, which is allowed to rest upon the surface a moment; fresh gelatine is then poured upon the plate, and off again at one corner, until the film is quite uniform. Drain the plate and dry.

The exposure, developing, and fixing are the same as in the preceding processes.

Dr. Hill Norris's theory of this process is as follows: The collodion film, as long as it is moist, is a porous material, and when it is once dried, it ceases to be porous. Now, by the use of honey, gelatine, etc., on the moist surface, it is supposed that these substances penetrate the pores, and thus prevent the pyroxyline, during induration and drying, from closing up apertures which allow the developing solution to permeate the film. The special function of the honey, however, seems to be the removal of every trace of nitrate of silver.

Tannin Process of Major Russell.

This process promises to supersede most of the preceding dry methods. The collodion is apt to wrinkle or slide entirely from the plate, when prepared according to the original mode. There are, therefore, two methods of preparing the glass for the reception of the collodion film.

In the first place, and in all cases, file the edges on both sides of each plate. Then, if the plate is not first to be covered with a solution of gelatine, place it upon a flat surface, as on the corner of a table, and laying a flat ruler along either side, leaving one eighth of an inch between the edge of the glass and the edge of the ruler, abrade the surface of the glass along this narrow strip by means of a wet emery or corundum grindstone, such as is used by dentists. In this way a rough border will be made all round, to which the collodion will adhere with great tenacity.

The plates must be exceedingly well cleaned and free from all sorts of reduction from previous use. So prepared, they may be manipulated without much risk of undergoing the troubles alluded to. But it is the opinion of many good amateurs in this department, that the plates work much better when previously covered with a coating of gelatine, which acts not alone as a preventive to wrinkles, etc., in the collodion film, but is supposed in some way to ameliorate the photographic results during development, with all sorts of collodion. Small plates need scarcely to be covered with gelatine.

Gelatine Operation.

To prepare a clear solution of gelatine, proceed as follows:

Formula.

Gelatine,	30 grains.
Acetic acid, (glacial,)	6 minims.
Water distilled,	10 ounces.

Immerse the gelatine in the cold water, and let it swell for two or three hours in a warm room; after which add the acetic acid, and apply a gentle heat until the gelatine is dissolved. To this add the following solution:

Alcohol,	6 drachms.
Iodide of cadmium,	12 grains.
Bromide of cadmium,	3 grains.

Filter the solution two or three times through paper in a warm place. So prepared, it will keep a long time, is limpid, and has, when warm, about the same consistency as collodion, but it does not flow over the plate with the same facility.

Warm the plates and the gelatine solution; then pour the latter upon the surface of the former, and cause it to spread, either by breathing forcibly upon it or by means of a glass triangle. The surplus quantity is poured off at one corner into a separate vessel, and after dripping, the plates are reared away against the wall on the same corner, upon bibulous paper, until they are dry. Spontaneous drying in a warm room is preferable to drying quickly by artificial heat. The plates so prepared can be preserved when dry in grooved boxes for an indefinite time.

Collodion for the Tannin Process.

A good bromo-iodized collodion, already ripe, and of a powdry nature is the best for this process.

Formula for Collodion.

Iodide of ammonium,	16 grains.
Iodide of cadmium,	8 grains.
Bromide of cadmium,	16 grains.
Pyroxyline,	48 grains.
Alcohol, spec. grav., .805,	4 ounces.
Ether, concentrated,	4 ounces.

After the plates have been carefully flowed with this collodion, they are sensitized in a bath of nitrate of silver, made slightly acid with acetic acid, that is, with one drop of the ordinary acetic acid to each ounce of the neutral nitrate of silver bath. For instantaneous work, or, properly speaking here, for very short exposures, a neutral bath would be the most appropriately calculated to succeed. When the color of the collodion film indicates a sufficiency of sensitization, which will be in four or five minutes under ordinary circumstances, the plate is taken out and immersed in a dish of distilled water, moved about for a short time, and then left collodion-film upward in the dish, until a second plate is

collodionized and sensitized. It is then thoroughly washed under the tap with common water, and finally flowed with distilled water.

Preservative Solution of Tannin.

This solution may vary in strength from ten to thirty grains of tannin to one ounce of water, depending upon the light and the nature of the collodion.

Tannin, ...	15 grains.
Distilled water, ...	1 ounce.

Dissolve and filter through paper before use, and then add four or five minims of alcohol to the ounce of water, but always after filtration. Of this solution pour first a small quantity upon the plate, so as to remove before it all superfluous water; pour it on and off two or three times, and afterward commence with a fresh solution. Allow the plate to drain for a minute or two, then rear it up on end upon a piece of blotting paper, and afterward dry spontaneously or by artificial heat, remote from all light. When perfectly dry, the plates will keep in the dark for a long time.

When the contrasts of the landscape are very marked, and the light brilliant, a less quantity of tannin may be used; the greater the quantity of tannin, the greater the density of the shades. When the plates are dry, the film, if in a right condition, will be bright and highly polished in its appearance.

If the tannin plates have not first been covered with a solution of gelatine, this is the time, before they are put away, to proceed round the edges of the film with varnish. This operation can be performed best by dipping the quill end of a strong feather from a hen's wing into the varnish, and then, inclining the feather, begin at one corner of the plate in contact with the edge and proceed to the other end slowly, so that a small quantity of the varnish is attracted by the collodion film as you advance. The side of the quill is in contact with the edge, and not the end. As soon as the varnish is *thoroughly* dry, the plates are stored away. It is best to use the plates as soon after preparation as possible.

The time of exposure is three or four times as long as with the wet process, but this may be shortened by following the plan of development recommended by Dr. Draper.

Development.

No. 1.	Pyrogallic acid, ...	72 grains.
	Alcohol, ...	1 fluid ounce.

Filter if there is any turbidity, otherwise not.

No. 2. { Nitrate of silver, ... 20 grains.
Citric acid, ... 20 grains.
Distilled water, ... 1 ounce.

Filter if there is a white precipitate, otherwise not. With No. 1 and No. 2 as stock bottles, proceed as follows:

Dilute solution of No. 1. { Solution No. 1, . . . 1 drachm.
Distilled water, . . . 6 ounces. } For present use.

Of this dilute solution of No. 1, take out four drachms for a stereoscopic slide, and add to it from fifteen to twenty-five minims of No. 2. This mixture is made immediately before the plate is to be developed.

Immerse the dry plate for a few seconds in distilled water; then pour on the developer and keep it in motion until the image appears. If the picture is slow in making its appearance, although the sky develops quickly, the time of exposure was too short, and the developer must be increased in strength, by adding ten or fifteen drops of No. 1. On the contrary, where the time has been too long, the development on all parts will be simultaneous, and the proper equilibrium of action will have to be maintained by adding a few drops of No. 2, otherwise the sky will not be opaque enough.

Dr. Draper's modification consists in immersing the plates after exposure in a vessel of hot distilled water, and then proceeding as above. The development is very rapid. In consequence of this the time of exposure can be reduced almost to instantaneity.

It is advisable not to postpone the development long after the exposure; during the evening of the day on which the pictures were taken is in all respects an appropriate time for the development, and although in many instances this operation can be put off, it is not advisable. The color of the image by the tannin process is rich and warm; its tone is very agreeable. Plates prepared either by this process or by the albumen are well adapted for taking transparent positives, by direct contact printing, for the magic lantern, or for the stereoscope.

The developed plates are well washed and fixed in a bath of hyposulphite of soda, but not of the cyanide, because it is apt to loosen the film. They are then carefully washed, so as not to disturb the film, dried and varnished.

The Tannin and Honey Process.

Several modifications of the Tannin process have been proposed, more or less successful; the honey process of Mr. England being one which seems to possess considerable advan-

tages in sensitiveness. Mr. England's formula for collodion is as follows:

To five parts of ether and three of alcohol, add sufficient pyroxyline to give a tolerably thick film. As soon as it has well settled, decant the clear supernatant part into another bottle, and measure off two portions of ten drachms each; to one add forty grains of bromide of cadmium, and to the other thirty grains of iodide of ammonium; shake till dissolved, and put by to settle. When thoroughly settled, add one drachm of each to six parts of plain collodion.

Sensitize in a neutral bath of nitrate of silver, containing forty grains of nitrate of silver to the ounce of water, and wash afterward in a dish of distilled water, rendered acid by acetic acid. The plate is left in this dish until a second one is prepared; it is then taken out and washed thoroughly beneath the tap, flowed with distilled water, and coated with the following solution:

Tannin,	15 grains.
Honey,	15 grains.
Distilled water,	1 ounce.

Coat as before directed, wash and dry. Protect the edges of the film with varnish.

After exposure, immerse the plate in a bath of nitrate of silver, ten grains to the ounce, as follows:

Nitrate of silver,	2 drachms.
Distilled water,	12 ounces.
Acetic acid,	1 drachm.

Keep the plate in this bath for one minute, and then develop with the pyrogallic acid developer as usual, or according to the method in the Tannin process just described.

Mr. Anthony, of New-York, finds it advantageous to fume the Tannin plates for a few seconds with the vapor of ammonia, for instance, the evening before their exposure, the time of which is said to be shortened by this process.

Resin Process.

This is the simplest of all dry processes, the discovery of Despratz. It consists simply in dissolving in the collodion about two and a half grains of powdered resin for every ounce of collodion. After sensitization the plate is well washed and dried. The development and all other manipulations are the same as in the wet collodion process. Dubosq makes use of amber, and Hardwich of Glycirrhizine for the same purpose.

Sutton's Rapid Dry Process.

The operations in this process, as furnished by Sutton, are as follows:

1. Clean the glass plate, dry it thoroughly, and apply to it a solution composed of one grain of India-rubber, dissolved in an ounce of keroselene.

2. Coat the plate thus prepared with bromo-iodized collodion, containing an equal number of atoms of iodine and bromine, added in combination with cadmium. There should be about five grains of mixed iodide and bromide of cadmium to the ounce of collodion.

3. Excite the film in a bath composed of thirty grains of pure recrystallized nitrate of silver, slightly acidified with nitric acid.

4. Wash off all the free nitrate of silver, and pour over the film a preservative composed of twenty-five grains of gum-arabic freshly dissolved in an ounce of water. Let it dry spontaneously, and, before putting the plate into the dark-slide, dry it again thoroughly before a hot flat-iron.

5. Give the same exposure as for wet collodion.

6. Develop the picture by first wetting it with distilled water, and then pouring over it a developer, consisting of one ounce of distilled water, two grains of pyrogallic acid, two scruples of glacial acetic acid, and a few drops of a weak solution of nitrate of silver. The image appears immediately, and very soon acquires the necessary intensity.

7. Fix the negative in the usual way, with a saturated solution of the hyposulphite soda or lime, and when dry, varnish it with spirit varnish.

Keene's Rapid Dry Process.

This is a modification of the Tannin Process, or Tannin and Honey Process. The characteristic difference is this: After the plate is sensitized, it is *not washed*, but flowed immediately with equal parts of a filtered, fifteen grain per ounce solution of tannin and gum, the latter consisting of four ounces of picked gum-arabic, dissolved in eight ounces of rain-water. The collodion plate requires twice the time in the nitrate bath of an ordinary collodion plate. When removed from the bath, drain a few moments and flow it with the preservative mixture bountifully, as with collodion, tilting the plate, so that the tannin solution flows from the right upper corner to the left upper corner, then to the left lower corner, and finally to the right lower corner, and then along

with the excess of water off at this corner. Repeat the operation once or twice. The last lot can be used for the first of the next plate. The plate is then drained, washed and dried. It is said to be almost as sensitive as a wet collodion plate. It is soaked in distilled or rain-water before it is developed. It is fixed and developed like any other tannin plate.

CHAPTER XXXVIII.

PRINTING OF TRANSPARENT POSITIVES BY THE DRY PROCESS.

Positives on glass, whether for the stereoscope or the magic lantern, that is, such as are to be regarded by transmitted light, are prepared most easily, most quickly, and most effectually by the Dry Process. The first part of the operation consists in obtaining a correct negative of the object, either by the wet or the dry process, the latter being preferable, because the negative so obtained is less liable to be damaged in the subsequent manipulations than the ordinary unvarnished collodion negative. The negative in question is required to be very sharp in all its parts, moderately dense in the deepest shades, though not so much so as for the ordinary printing on paper, and transparent in the lights. The film must be thin, bright, and free from all deposit of dust arising from reduction or impurities. The negative best adapted for the printing of glass transparencies is incontestably that with albumen; for it requires no varnish, and is endowed with all the requisites above mentioned. The albumenized glass, too, is the best for the reception of the transparent image. Dry plates by the Tannin Process are the next best; it is a good plan in this instance also to have the negative an albumen print, and the transparencies on tannin plates.

Provided with such a negative, place it in the shield of the plate-holder with the image toward you; on this place a sensitized tannin or albumen plate, the film being from you, so that the two films lie in intimate juxtaposition; close the door, whose spring retains the plates firmly in contact. Introduce the plate-holder into the grooved receptacle at one end of the cylinder, as described in a previous chapter of this work, expose the other end to the light of a cloud, etc., and draw the slide. An exposure of a few seconds will be all-sufficient. The precise time can not be accurately given, but is easily ascertained with given materials. Begin with an exposure of one second, and proceed until you find the time best adapted for the circumstances. With dry plates, it is

not absolutely necessary to use the cylinder; the cylinder, however, yields superior results.

The development of the plate depends upon the nature of its constitution; if an albumen plate, develop it accordingly; if a tannin plate, in like manner. These different modes are given in detail in the preceding chapters on the subjects in question; as well as every other information referring to the completion of the picture after development, such as washing, fixing, drying, and varnishing.

The color of an albumen print is not sufficiently agreeable for stereoscopic purposes. This color is improved by immersing the plate in the first place in a dilute solution of bichloride of mercury, and after it has been washed, in a solution of sel d'or, (the double hyposulphite of gold and of soda,) when the color will be an agreeable sepia tone.

Chloride of gold alone, in dilute solution, communicates to the fixed positive an agreeable purple tone; naturally the prints have to be washed always after such operations.

To take Copies of any given size.

Where the required transparency must be of a given size, as is the case in the preparation of slides for the magic lantern, and for other similar exhibitions, or for church windows, the printing has to be performed in the camera and by means of the lens. This process is described in a preceding chapter of this work.

Theoretically a picture can be made as many times larger or smaller than the original by an analysis of the well-known formula for the conjugate foci of a double convex lens. This formula is as follows:

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$

where the thickness of the lens is not taken into consideration; but with this consideration, the formula will be:

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}+\frac{t}{p}\left(\frac{p-1}{r}-\frac{1}{u}\right)^2$$

when any two of the preceding terms v, f, and u, are known, the third can be found; f signifies the principal focal distance; u the distance of the object from the nearest surface of the lens; v is the distance of the picture on the ground glass from the same surface; t is the thickness of the lens; r the radius of curvature of the first surface; and p is the index of refraction of the transparent medium of which the lens is formed.

Without going into a minute optical discussion, I will analyze the first formula so as to be enabled with a lens of a given power, and with a given sized object to show what must be the respective distances of the object and image from the lens.

In the first place I will explain a few technical terms, such as the *axis* of a lens, the *optical center* of a lens, the *principal focus* of a lens, the *conjugate foci* of a lens, the *equivalent focus* of a combination.

The axis of a lens is a line perpendicular to all the diameters drawn from edge to edge.

The optical center of a lens is the point where a line (joining an impingent and an emergent ray that are parallel to each other) crosses the axis; this center is sometimes within the lens, sometimes on its surface, and sometimes external to it.

The principal focus of a lens is the point where parallel impingent rays converge and cross after refraction and emergence; it is the burning point of the sun's rays. The distance of this point to the optical center is called the *principal focal distance.*

The conjugate foci are any point on an object and its corresponding point on the image. The distances of these two points to the optic center are denominated *conjugate focal distances;* these distances, however, are generally reckoned from the *vertex* or surface of the lens next to the object.

The *vertex* is that point where the axis touches the surface of the lens nearest the object.

The *equivalent focus* is a term that refers to compound lenses, such as those used by the photographer; it is the *principal focus* or the *focus of parallel rays* of the combination. It is called equivalent from being compared with a single lens that will produce the same sized picture at the same distance of the object. If rays from an object impinge upon a lens and on emerging converge, they will cross each other, and where they cross they will form a picture of the object.

The axis of a radiant point, that is, of any point on an object, does not mean the same thing as the axis of the lens; it is a line that is broken at the two surfaces of the lens, passing through the optic center, of which the impingent and emergent parts are parallel. On this axis the image of the object is found. If rays emerge parallel, they will never cross, and therefore produce no picture; if they diverge

after emergence, the image will be on the same side of the lens with the object, and is denominated a *virtual image.*

Equidistant conjugate focus refers to an object and its image on the ground glass when they are equidistant from the optical center, or more intelligibly speaking for the photographer, when the image and the object are of the same size. The distance of the equidistant conjugate focus can be derived from the principal focal distance, or *vice versâ.* Thus in the equation:

$$\frac{1}{v}=\frac{1}{f}-\frac{1}{u}$$

let $f=12$ inches, required the value of v and u when they are equal, or when the picture and object with the lens in question are of the same magnitude? By transposition

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{v}=\frac{2}{v} \text{ or } \frac{1}{12}=\frac{2}{v} \text{ or } v=24 \text{ inches.}$$

Therefore if a given single lens has a principal focus of 12 inches, the ground glass as well as the object will have to be placed respectively at a distance of 24 inches from the lens in order to obtain a picture of the same size as the object.

The principal focal distance of a single lens can be found with sufficient accuracy for all practical purposes by measuring the distance of the lens from the burning point, and by adding to this distance half the thickness of the lens.

The principal focal distance of a combination can be found with the same degree of accuracy by adjusting the camera before a given line so that the image of the line on the ground glass is exactly of the same size. One fourth of the distance between the object and the image is the principal focus required. For instance, let this distance be 48 inches, then v is 24 and u is 24 inches; by substitution

$$\frac{1}{f}=\frac{1}{24}+\frac{1}{24}=\frac{2}{24}=\frac{1}{12}, \text{ or } f=12 \text{ inches.}$$

The distance of either the image or the object from the optical center bears a direct ratio with the size of the image or the object, whether the lens be single or compound. Thus then, if we know the respective linear magnitudes of the image of the same object as obtained by two single lenses or by a single lens and a combination, as well as the principal focal length of the former, (which can always be easily obtained by the sun's rays,) we can by the legitimate

proportion derive the *principal focus* of the other single lens or the *equivalent focus* of the compound lens. For instance, let the principal focal length of a single lens be 3 inches, and the linear magnitude of an image of a given object be 2 inches as obtained by this lens; let also 5 inches be the linear magnitude of the image of the same object at the same distance when taken by another lens; required the principal focal length of the other lens, (if single,) or the equivalent focal length of the combination?

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By proportion as $2 : 3 :: 5 : 7\frac{1}{2}$ the principal focal length required.

In the proportion $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$, let u be n times larger than v; required the proportion that f bears to u?

$$\frac{1}{f}=\frac{1}{v}+\frac{1}{nv}=\frac{nv+v}{nv^2}=\frac{n+1}{nv} \text{ or}$$

$$nv=f\,(n+1), \text{ but } u=nv$$

$$\therefore u=f\,(n+1) \text{ and}$$

$$v=\frac{f\,(n+1)}{n}$$

Hence if we multiply the principal focal length of any lens by one more than the times the image is linearly greater than the object, we shall obtain the distance the screen is to be placed from the lens; and if we divide this latter product by the number of times the image is linearly greater than the object, we obtain the distance of the object from the lens. In these analytical conclusions we suppose the lens to be single and very thin. The deductions thus derived have to be regarded in reference to the center of the combination. The following table has been constructed in accordance with the preceding principles, and it exhibits the distances between the object and the lens, the image and the lens, and the object and the image. Any degree of reduction and enlargement with a given lens or combination, whose equivalent focus is known, can be effectuated with great ease by adjusting the object and the ground glass at the distances indicated.

O in the following table stands for the distance between the object and the center of the combination.

I stands for the distance between the image and the center of the combination.

S stands for the distance between the object and the image, or the sum of the two preceding.

TABLE *of the distances between the Object and the center of the Lens, the Image and the center of the Lens; and of the Sum of these distances.*

TIMES OF REDUCTION OR ENLARGEMENT

Focus of Lens	Reduction Distance	1	2	3	4	5	6	7	8	9	Enlargmt Distances
Inches		Inches.	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches.	
	O	2	3	4	5	6	7	8	9	10	I
1	I.	2	$1\frac{1}{2}$	$1\frac{1}{3}$	$1\frac{1}{4}$	$1\frac{1}{5}$	$1\frac{1}{6}$	$1\frac{1}{7}$	$1\frac{1}{8}$	$1\frac{1}{9}$	O.
	S	4	$4\frac{1}{2}$	$5\frac{1}{3}$	$6\frac{1}{4}$	$7\frac{1}{5}$	$8\frac{1}{6}$	$9\frac{1}{7}$	$10\frac{1}{8}$	$11\frac{1}{9}$	S
	O	3	$4\frac{1}{2}$	6	$7\frac{1}{2}$	9	$10\frac{1}{2}$	12	$13\frac{1}{2}$	15	I
$1\frac{1}{2}$	I	3	$2\frac{1}{2}$	2	$1\frac{7}{8}$	$1\frac{4}{5}$	$1\frac{3}{4}$	$1\frac{5}{7}$	$1\frac{7}{8}$	$1\frac{8}{9}$	O
	S	6	$6\frac{3}{4}$	8	$9\frac{3}{8}$	$10\frac{4}{5}$	$12\frac{1}{4}$	$13\frac{5}{7}$	$15\frac{7}{8}$	$16\frac{2}{9}$	S
	O	4	6	8	10	12	14	16	18	20	I
2	I.	4	3	$2\frac{2}{3}$	$2\frac{1}{2}$	$2\frac{2}{5}$	$2\frac{1}{3}$	$2\frac{2}{7}$	$2\frac{1}{4}$	$2\frac{2}{9}$	O
	S	8	9	$10\frac{2}{3}$	$12\frac{1}{2}$	$14\frac{2}{5}$	$16\frac{1}{3}$	$18\frac{2}{7}$	$20\frac{1}{4}$	$22\frac{2}{9}$	S
	O	5	$7\frac{1}{2}$	10	$12\frac{1}{2}$	15	$17\frac{1}{2}$	20	$22\frac{1}{2}$	25	I
$2\frac{1}{2}$	I	5	$3\frac{3}{4}$	$3\frac{1}{3}$	$3\frac{1}{2}$	3	$2\frac{11}{12}$	$2\frac{6}{7}$	$2\frac{13}{16}$	$2\frac{7}{9}$	O
	S	10	$11\frac{1}{4}$	$13\frac{1}{3}$	$15\frac{1}{2}$	18	$20\frac{5}{12}$	$22\frac{6}{7}$	$25\frac{5}{16}$	$27\frac{7}{9}$	S
	O	6	9	12	15	18	21	24	27	30	I
3	I.	6	$4\frac{1}{2}$	4	$3\frac{3}{4}$	$3\frac{3}{5}$	$3\frac{1}{2}$	$3\frac{3}{7}$	$3\frac{3}{8}$	$3\frac{1}{3}$	O
	S	12	$13\frac{1}{2}$	16	$18\frac{3}{4}$	$21\frac{3}{5}$	$24\frac{1}{2}$	$27\frac{3}{7}$	$30\frac{3}{8}$	$33\frac{1}{3}$	S
	O	7	$10\frac{1}{2}$	14	$17\frac{1}{2}$	21	$24\frac{1}{2}$	28	$31\frac{1}{2}$	35	I.
$3\frac{1}{2}$	I.	7	$5\frac{1}{4}$	$4\frac{2}{3}$	$4\frac{3}{8}$	$4\frac{1}{5}$	$4\frac{1}{12}$	4	$3\frac{15}{16}$	$3\frac{17}{18}$	O
	S.	14	$15\frac{3}{4}$	$16\frac{2}{3}$	$22\frac{3}{8}$	$25\frac{1}{5}$	$28\frac{1}{12}$	32	$35\frac{1}{16}$	$38\frac{1}{18}$	S
	O.	8	12	16	20	24	28	32	36	40	I.
4	I	8	6	$5\frac{1}{3}$	5	$4\frac{4}{5}$	$4\frac{2}{3}$	$4\frac{4}{7}$	$4\frac{1}{2}$	$4\frac{4}{9}$	O.
	S	16	18	$21\frac{1}{3}$	25	$28\frac{4}{5}$	$32\frac{2}{3}$	$36\frac{4}{7}$	$40\frac{1}{2}$	$44\frac{4}{9}$	S.
	O	9	$13\frac{1}{2}$	18	$22\frac{1}{2}$	27	$31\frac{1}{2}$	36	$40\frac{1}{2}$	45	I.
$4\frac{1}{2}$	I.	9	$6\frac{3}{4}$	6	$5\frac{5}{8}$	$5\frac{2}{5}$	$5\frac{1}{4}$	$5\frac{1}{7}$	$5\frac{1}{16}$	5	O.
	S	18	$20\frac{1}{4}$	24	$28\frac{1}{2}$	$32\frac{2}{5}$	$36\frac{1}{4}$	$41\frac{1}{7}$	$45\frac{9}{16}$	50	S
	O	10	15	20	25	30	35	40	45	50	I
5	I	10	$7\frac{1}{2}$	$6\frac{2}{3}$	$6\frac{1}{4}$	6	$5\frac{5}{6}$	$5\frac{5}{7}$	$5\frac{5}{8}$	$5\frac{5}{9}$	O
	S	20	$22\frac{1}{2}$	$26\frac{2}{3}$	$31\frac{1}{4}$	36	$40\frac{5}{6}$	$45\frac{5}{7}$	$50\frac{5}{8}$	$55\frac{5}{9}$	S
	O	11	$16\frac{1}{2}$	22	$27\frac{1}{2}$	33	$38\frac{1}{2}$	44	$49\frac{1}{2}$	55	I
$5\frac{1}{2}$	I.	11	$8\frac{1}{4}$	$7\frac{1}{3}$	$6\frac{7}{8}$	$6\frac{1}{2}$	$6\frac{5}{12}$	$6\frac{2}{7}$	$6\frac{1}{16}$	$6\frac{1}{18}$	O
	S.	22	$24\frac{3}{4}$	$29\frac{1}{3}$	$34\frac{3}{8}$	$39\frac{1}{2}$	$44\frac{11}{12}$	$50\frac{2}{7}$	$55\frac{1}{16}$	$61\frac{1}{18}$	S
	O	12	18	24	30	36	42	48	54	60	I
6	I.	12	9	8	$7\frac{1}{2}$	$7\frac{1}{5}$	7	$6\frac{6}{7}$	$6\frac{3}{4}$	$6\frac{2}{3}$	O
	S	24	27	32	$37\frac{1}{2}$	$43\frac{1}{5}$	49	$54\frac{6}{7}$	$60\frac{3}{4}$	$66\frac{2}{3}$	S
	O	13	$19\frac{1}{2}$	26	$32\frac{1}{2}$	39	$45\frac{1}{2}$	52	$58\frac{1}{2}$	65	I
$6\frac{1}{2}$	I.	13	$9\frac{3}{4}$	$8\frac{2}{3}$	$8\frac{1}{8}$	$7\frac{4}{5}$	$7\frac{7}{12}$	$7\frac{3}{7}$	$7\frac{5}{16}$	$7\frac{2}{9}$	O
	S.	26	$29\frac{1}{4}$	$34\frac{2}{3}$	$40\frac{5}{8}$	$46\frac{1}{5}$	$53\frac{1}{12}$	$59\frac{3}{7}$	$65\frac{13}{16}$	$72\frac{1}{9}$	S
	O	14	21	28	35	42	49	56	63	70	I
7	I	14	$10\frac{1}{2}$	$9\frac{1}{3}$	$8\frac{3}{4}$	$8\frac{2}{5}$	$8\frac{1}{6}$	8	$7\frac{7}{8}$	$7\frac{7}{9}$	O
	S.	28	$31\frac{1}{2}$	$37\frac{1}{3}$	$43\frac{3}{4}$	$50\frac{2}{5}$	$57\frac{1}{6}$	64	$70\frac{7}{8}$	$77\frac{7}{9}$	S
	O	15	$22\frac{1}{2}$	30	$37\frac{1}{2}$	45	$52\frac{1}{2}$	60	$67\frac{1}{2}$	75	I
$7\frac{1}{2}$	I	15	$11\frac{1}{4}$	10	$9\frac{3}{4}$	9	$8\frac{1}{4}$	$8\frac{4}{7}$	$8\frac{7}{16}$	$8\frac{1}{3}$	O
	S	30	$33\frac{3}{4}$	40	$46\frac{3}{4}$	54	$61\frac{1}{4}$	$68\frac{4}{7}$	$75\frac{9}{16}$	$83\frac{1}{3}$	S
	O.	16	24	32	40	48	56	64	72	80	I
8	I	16	12	$10\frac{2}{3}$	10	$9\frac{3}{5}$	$9\frac{1}{3}$	$9\frac{1}{7}$	9	$8\frac{8}{9}$	O
	S	32	36	42.	50	$57\frac{3}{5}$	$65\frac{1}{3}$	$73\frac{1}{7}$	81	$88\frac{8}{9}$	S
	O	17	$25\frac{1}{2}$	34	$42\frac{1}{2}$	51	$59\frac{1}{2}$	68	$76\frac{1}{2}$	85	I
$8\frac{1}{2}$	I	17	$12\frac{3}{4}$	$11\frac{1}{3}$	$10\frac{5}{8}$	$10\frac{1}{5}$	$9\frac{11}{12}$	$9\frac{5}{7}$	$9\frac{9}{16}$	$9\frac{5}{9}$	O
	S	34	$38\frac{1}{4}$	$45\frac{1}{3}$	$53\frac{1}{8}$	$61\frac{1}{5}$	$69\frac{1}{12}$	$77\frac{5}{7}$	$86\frac{1}{16}$	$94\frac{1}{18}$	S
	O.	18	27	36	45	54	63	72	81	90	I
9	I	18	$13\frac{1}{2}$	12	$11\frac{1}{4}$	$10\frac{4}{5}$	$10\frac{1}{2}$	$10\frac{2}{7}$	$10\frac{1}{8}$	10	O.
	S	36	$40\frac{1}{2}$	48	$56\frac{1}{4}$	$64\frac{4}{5}$	$73\frac{1}{2}$	$82\frac{2}{7}$	$91\frac{1}{8}$	100	S
	O	19	$28\frac{1}{2}$	38	$47\frac{1}{2}$	57	$66\frac{1}{2}$	76	$85\frac{1}{2}$	95	I
$9\frac{1}{2}$	I	19	$14\frac{1}{4}$	$12\frac{2}{3}$	$11\frac{7}{8}$	$11\frac{2}{5}$	$11\frac{1}{12}$	$10\frac{5}{7}$	$10\frac{11}{16}$	$10\frac{1}{2}$	O
	S.	38	$42\frac{3}{4}$	$50\frac{2}{3}$	$59\frac{3}{8}$	$68\frac{2}{5}$	$77\frac{1}{12}$	$86\frac{5}{7}$	$96\frac{11}{16}$	$106\frac{1}{2}$	S

Application of the Preceding Table.

If the equivalent focus or principal focal length of a combination be known, it is very easy to arrange the object to be photographed, the camera and the screen, so as to produce a picture so many times larger or smaller than the object, as may be required; for instance, let the focal length of the combination be $4\frac{1}{2}$ inches, what must be the conditions of the three things, object, combination, and ground glass, so as to obtain an image eight times larger than the object?

Look for $4\frac{1}{2}$ in the first vertical column, and for 8 on the first horizontal line; where these two columns meet will be found all that is required. In the first place the object and the ground glass must be $45\frac{9}{16}$ inches apart, the ground glass is $40\frac{1}{2}$ inches from the middle of the combination, and the object is consequently $5\frac{1}{16}$ inches from the same point.

If we wish to diminish the size of the picture eight times, then the two latter of the above terms are inverted, the object being $45\frac{9}{16}$ from the center of the combination, and the image only $5\frac{1}{16}$ inches from the same point.

The table can be extended as far as desired, by using the multiples of the numbers already given. If we required the conditions for 15 inches focus, multiply those along column 5 by 3, the results will be the conditions required.

Microphotography and Macrophotography.

This branch comprehends the mode of taking photographs of microscopic or almost invisible objects, as also of amplification by means of the *solar camera*. In either case means are resorted to by which light can be concentrated or condensed on the object or collodion positive to be copied, and enlarged or diminished. These means are combinations of plane reflectors, concave reflectors, double convex or plano-convex lenses. The appendages to the *solar camera* and to the *solar microscope* are fac-similes of each other; but the solar microscope existed before photography had been elicited from chaos; the solar camera, therefore, is a mere imitation of its antecedent; the patentees of the latter instrument, then, can make no claim to originality of design; their *only claim* can be the application of the instrument to photography.

Solar Microscope.

The appendages to the solar microscope, that is, the condensing part of the apparatus, consist in the first place of a plane mirror in the form of a rectangle, whose width is at least equal to the diameter of the plano-convex or double

convex lens, which condenses the light received from the mirror. The length of the mirror must be about four times its width. At one end there is a hinge-joint, which allows the mirror to swing on the same like a door. The hinge is fixed to a circle of brass or other metal, which, by means of a dentated periphery, admits of a circular motion. By this contrivance it will be seen that the mirror has two motions at right angles to each other; for instance, supposing the back of the mirror faced the sun at noon, and were perpendicular to the horizon, then one of the motions mentioned would cause the mirror to incline toward the sun, until finally it would be flat on the horizon. The other motion permits the mirror to move either toward the East or the West; so that, as it now stands, if moved toward the West, the silvered surface would face the setting sun. By combining these two motions consentaneously, the mirror can always be so inclined as to reflect the rays of the sun from rising to setting into the axis of the condenser. The two motions in question are effected by means of screws and pinion-wheels, etcetera.

The part just described might be a concave mirror admitting of the same motions; this would act as a reflector and condenser at the same time. The condenser is fixed in the brass plate which is attached to the window-shutter, and around the condenser the metallic ring moves, to which the hinge of the mirror is attached. The object of this part of the apparatus is, by refraction, to cause the large bundle of parallel rays that impinge upon its surface, to be condensed from a cylindrical into a conical form, so that at a given distance this converging and condensed light will arrive at its apex or focus.

Now, at this focus, *all the light* that has passed through the lens will be concentrated; and at a variable distance, before it arrives at this focus, it will cover a variable space, varying from a point or zero upward to an amount equal to the surface of the lens.

The amount of condensation will be the ratio between the squares of the distances from the focal point; thus, suppose the focal distance be twelve inches, and that we intercept the cone of light at three inches from the focus; then by dividing the square of twelve by the square of three we obtain the ratio, which is sixteen, and this indicates that the light at this distance is sixteen times more intense than it was when it first immerged from the lens.

The object of the refracting lens, therefore, is to illumine

the object with light. This is the primary view of the matter, but it does more than this; each ray from the condenser not only illumines each point on the transparent object upon which it impinges, but on emergence after refraction it passes on modified by the medium through which it has penetrated, and carries, so to say, this part of the picture with it; the cone of modified light is in fact the picture set in motion, and so directed as to strike the surface of the camera-lens which is next to it. These rays are convergent, and are each the axis of an independent cone of divergent rays from each illumined point of the transparent negative. Some photographers maintain that the axes alone (that is, the rays that constitute the cone of light from the condenser) are available, and that the divergent rays around each axis are of no avail. This, however, is a mistake, and is equivalent to saying that, if an opaque object were illumined by a condenser or reflector, the picture could be taken only by focussing the cone or the beam of reflected light; whereas we know full well in copying that the rays that enter the camera through the lens, and that go to the formation of the picture, can not be any of the reflected rays, because these are perpendicular to the surface of the copy, and would indicate that the impingent rays were also perpendicular, which is an impossibility, owing to the opacity of the camera and its tube, which occlude all perpendicular rays. On the contrary, each illumined point becomes a new radiant, from which proceeds a divergent pencil of rays, of which many around the axis are refracted by the lens and brought to a focus on the other side.

If the condensing lens be achromatic, the light will be white; if not achromatic, it will produce spectral colors, of which some are useless in photography, whilst others are exactly those which are needed. Now the scientific optician can arrange his non-achromatic condenser in such a manner, in reference to the lens and the negative, as to make use only of the violet light, or the actinic part of the spectrum, for the formation of the picture. The focus of the violet or actinic light is shorter than that of the luminous or yellow part.

The next appendage to the solar microscope is the *object-holder*, which has a sliding motion to or from the condenser, in the neighborhood of the focus, by which means the object can be placed in a condensed part of the cone of light, which is just sufficient to cover it and no more, a contrivance by which light is economized.

The remaining part of the instrument is the microscope

proper, which contains the corrected objective for magnifying the object.

Now the above description is precisely the same as that of the condensing part of the solar camera. With such an arrangement of mirrors and refractors, the camera and screen may remain fixed during the whole time of the operation.

Another arrangement for concentrating light is accomplished by means of reflectors fixed in the form of a frustum of a pyramid. But in the application of this contrivance the camera and screens must all move together on a universal joint, like a heliostat, by which means the silvered surfaces of the reflectors can always be preserved in front of the sun, so as to catch his rays, (as described in a previous chapter of this work.)

The mode of using the solar microscope and the solar camera is in no wise different, excepting that in the former a transparent object is substituted in the holder for the transparent collodion negative in the latter. Each is placed in the cone of condensed light, in order to be brilliantly illumined, and in such a position, in reference to the objective or photographic lens, as to bring the *focus of the actinic rays* immediately on the optical center of the last or front lens of the combination. It is by this means alone that the best enlarged picture can be obtained.

How to find the point where the Lens is to be placed.

It appears then that the lens may not be placed in any position for maximum effect; the true position depends upon the power of the condenser, in combination with the power of the posterior lens of the tube, where such is used. There must be a relative connection between these two powers; but this is not maintained in any of the solar cameras in the market, from the fact that tubes are not considered as parts of the solar camera; operators are consequently left to apply whatever combination they may have on hand; we must therefore avail ourselves of what is next best, and fix the combination where the maximum effect can be obtained with given materials.

Knowing the length of the principal focus of the condenser and its diameter, as well as that of the compound lens from the posterior lens, the mathematician can easily calculate how much the former focus will be shortened by the interposition of the tube. Supposing, for instance, the diameter of the condenser be eight inches, and its focal length be twelve inches, then the angle which the side of the cone of

condensed light makes with the diameter will be 71° '.23 Moreover, let the diameter of the posterior lens be two inches, and the focal length from the back lens two inches, then the angle formed between the side of its cone and the diameter will be 63° 45′. That is, if the rays entered the combination parallel, they would form a cone, of which the outside ray would have this angle with the diameter of the back lens. But, being interposed in the cone of condensed light, of which the rays are convergent, the tendency of the combination is to shorten the focal length, by reducing the angle 63° 45′ to 56° 00′, the difference between these two angles being the same difference that exists between 71° 32′ and 63° 45′. As the angle diminishes, so will the focal length of the cone of condensed light be diminished, and in the present instance to the amount of half an inch.

Besides this, we have to reduce this distance still more, in order to find the actinic focus, which the mathematical optician can easily find.

But the generality of photographers are not supposed to be in a condition to deduce the requisite corrections in this way; we must therefore show by practical means how we can approximate to the same results.

Ascertain the focal length of the condenser by finding the distance of its burning point from the glass; then, when the tube is screwed out to the extent of its play, measure the distance from the face-plate, in which the tube is fastened, to the front lens; subtract this distance from the focal length of the condenser, the difference will give the distance of the condenser to the outside of the camera nearly, or to the part upon which the face-plate of the tube is to be screwed. More accurately the same result can be obtained by interposing the tube in the condensed light, and by moving it backward and forward, until the focal or burning point is just on the outside of the front lens; let an assistant measure this distance from the outside of the camera, and at this distance fix the tube permanently. Whilst doing this the greatest care is required to make the axis of the condenser coïncide with the axis of the tube.

This is the first rude adjustment. The second adjustment consists in bringing the actinic focus so as to coïncide with the optic center of the front lens. Screw back the sliding part of the tube and turn on the sun; the luminous focus will be quite visible in the dark space behind the camera. Now insert a piece of deep violet-colored glass between the condenser and the objective, so as to intercept all the colors of

the luminous cone, excepting the violet, and ascertain where the violet cone comes to a focus; screw the tube out until this focus is just in front of the anterior glass; then, knowing the thickness of the front lens, advance the tube until the blue focus is in the middle of the front lens, and let this be the final and permanent adjustment of the tube in reference to the condenser. Mark this position by a line on the brass work, in order that the tube can be adjusted at a moment's notice when required to be used.

The negative-holder is movable by means of a screw, so that it can be brought into focus upon any screen on the other side of the tube. Whenever this operation of focussing is to be performed, insert the violet-colored glass, so as to focus in reference to actinism, and not to luminosity. By this means the luminous picture on the screen (that is, when the violet-colored glass is removed) may not be quite sharp, but the printed picture on the paper will be sharp and beautifully defined. The same mode of proceeding may be followed with the ordinary camera, where there is any doubt of the correction of the tube for actinism. Place in front of the tube a piece of violet-colored glass every time you focus.

Macrophotography, or the Art of Taking Enlarged Photographs.

The Negative for Enlargement.

The size of the negative will have to depend on the diameter of the condenser; if this be nine inches, a one-sixth plate will be large enough, the object being to get the negative as near the apex of the cone of concentrated light as possible, and in such a position as to be totally covered by the cone.

The Quality of the Negative.

The negative suitable for the solar camera must be very bright, well defined and quite clear. The glass must be thin, perfectly flat, or in the same plane and homogeneous. The negative effect need not, in fact, *must not* be carried on to the same extent as for positive printing; it is but a trifle in advance of the ambrotype; if there should happen to be the slightest quantity of fogging, that is, reduction on the transparent parts, it will be necessary either to take another negative or to clear off the fogginess. This is effected by flowing the plate with a dilute solution of iodine in iodide of potassium, until the picture turns slightly cream-colored; the plate is then washed and flowed with a solution of cyanide of potassium, which dissolves the newly formed iodide

of silver and thus clarifies the picture. As soon as the latter is satisfactory, as to brightness, cleanness, and fine definition, wash and dry the plate, but apply no varnish.

As soon as the negative is in its place, and accurately focussed actinically, fix the prepared paper on the screen in its place. In order to preserve the paper perfectly flat and smooth, sponge the back with a wet sponge, and after it has thoroughly expanded, and lies uniformly, and without undulations, go round the edge to the amount of half an inch on the same surface which has been sponged with a thick solution of gum-arabic; attach the paper so prepared to an even plate of glass or drawing-board, of somewhat smaller dimensions than the paper, and allow it to dry. When dry, all the corrugations and undulations will have disappeared; the paper will be smooth and flat, and ready to receive the image, supposing naturally it has already been sensitized in the silver bath. If this operation has been neglected or omitted, the silver solution can be very expeditiously poured upon the surface and spread with a pad or tuft of cotton wool, until the film is uniform. The excess of silver is then removed, and the plate is reared on one corner over a wine-glass to receive the drippings.

When dry it is placed in the focus of the negative, and the sun is turned on. By means of the two screws on the solar camera, the sun's light is maintained in its position during the whole operation. Printing on albumenized paper by the solar camera is a tedious operation, requiring sometimes several hours before it is complete, and sometimes even a day or two by reason of the cloudiness of the sky. Where this sort of printing is practicable, as is the case generally in our own country, the results are the best. Printing by development, however, is more reliable, because it is altogether independent of the condition of the sky, whether cloudy or cloudless.

Several processes for printing by development will be found in the chapter in which this subject has been discussed. I will insert another in this place, from its applicability and reliability. It is the process of Blanquart-Evrard, whose prints have been so much admired.

Bromo-iodizing Bath for Paper.

Water,	12 ounces.
Gelatine,	1 drachm.
Iodide of potassium,	1 drachm.
Bromide of potassium,	15 grains.

Immerse the papers in this bath, as many at a time as it will contain, and keep them there for two or three hours. The bath can be used over and over again until exhausted. The papers are then taken out and hung up to dry. As soon as they are dry they may be preserved in a portfolio for use.

Previous to being sensitized they are exposed for a quarter of an hour to the vapor of hydrochloric acid. This operation is easily effected by fixing the paper along the sides and under the lid of a large nearly air-tight box, by means of varnished pins. At the bottom of the box place a saucer containing a handful of salt, an ounce or two of sulphuric acid, and half as much boiling water. Vapors of hydrochloric acid will be generated in abundance, and will thus saturate the paper.

Sensitizing Bath.

Nitrate of silver, ... 1 ounce.
Distilled water, ... 14 ounces.
Nitric acid to give it an acid reäction.

Let the paper float in this bath for ten minutes. By decomposition they will now contain the iodide, bromide, and chloride of silver. After sensitization they are allowed to drain, and then dried either by pressure between folds of bibulous paper or by suspension in the dark-room.

The exposure required will vary from a couple of seconds to half a minute beneath a negative, and longer than this on the screen of the solar camera. When the image is just visible, the printing has been carried on long enough.

Development.

The picture is brought out by immersing it in the ordinary gallic acid bath, at a temperature of 80 degrees, and by keeping it there for a quarter of an hour or more as circumstances require. The bath must be large enough for many pictures at a time; these are kept in motion all the while. They assume a disagreeable color, and become covered with spots which are removed by the operations afterward. As soon as the depth of shade is sufficiently intense, the prints are taken out, laid one by one on a glass plate, and sponged on both sides and then immersed in a bath of hyposulphite of soda for five minutes, in which they are toned.

Hyposulphite of soda, ... 1 ounce.
Rain-water, ... 20 ounces.

After this they are removed direct into a second bath of hyposulphite of soda of the same strength, and are allowed

to remain for twenty minutes, in which they are completely fixed.

The prints are then carefully washed in several waters and finally immersed in a bath of dilute hydrochloric acid, which removes a yellow deposit and the spots above mentioned. A second washing completes the operation, with the exception of drying and exposing to the action of light for several weeks, which improves the reddish tone by changing it gradually into purple.

These prints will keep for an indefinite time, although toned with sulphur.

Microphotography, or the Art of taking Diminished Copies of Photographs, or Photographs of Microscopic Objects.

Diminished Photographs.—It is a much easier operation to diminish the size of a photograph or object by photographic means than to amplify one; and the result in general is more satisfactory, because all the errors of the original are diminished in the same ratio as the whole picture is diminished. In order to take portraits so invisibly small as not to be seen without the aid of a magnifier, we require a small camera specially arranged for the purpose. Such cameras, furnished with the necessary objective, are manufactured by *Bertsch* in Paris. The tube requires no focussing; the only condition to be observed is to place the photograph, object, or print to be copied at or beyond a given distance. All lenses have this property of requiring but one adjustment, which is permanent when once found, for objects beyond a given distance, which varies directly as the focal distance or power of the lens. Lenses for the diminutive pictures in question are in focus for all distances beyond three feet or so. Objectives, such as are sold for microscopic purposes, whose focal distances are one inch, half an inch, or a quarter of an inch, may easily be arranged in a very small camera to take these diminutive portraits. But very little ingenuity will suffice to make such a camera out of a small telescope, where one tube slides into another. In the end of the inner tube the objective is fixed; in the end of the outer, the ground glass and the plate-holder. This compound tube is fixed permanently upon a solid support six inches high, on a piece of board four or five feet in length or even more. On the opposite end of the board a plane is erected at right angles to the former and also to the axis of the camera. Find the point on this vertical board where the axis cuts the same, and mark it as the center of the pic-

ture to be copied. The picture is fixed upon this plane by means of tacks or pins in an inverted position and so that its center coïncides as near as possible with the mark just made.

The next proceeding is to focus the lens. Take the long board and place it so as to receive the sun's rays upon the picture. Now move the inner tube of the camera in and out until the image is seen on the ground glass by means of a powerful magnifier. Focus with the greatest sharpness. This operation is very refined and requires a great deal of patience. When the utmost definition is thus obtained, place before the opening of the tube a piece of very thin violet-colored glass and see if the image is still sharp; if it be, fix the two tubes permanently so that their relative position can not be changed. In future this operation of focussing is no longer required. If, however, the picture is not sharp when the violet-colored glass is interposed, focus until you get perfect definition, and then fix as just directed.

The glass to receive the picture is thin and homogeneous; it is flowed also with a very thin collodion and sensitized as usual. All the operations are precisely the same as those already described in the preparation of the ambrotype. Of course a pair of spectacles of very high magnifying power is required while developing, fixing, and mounting. With a pair of pliers or forceps the small piece of glass can be broken down so as to fit into the ring, etc., which is to receive the picture.

The objectives manufactured by Grunow in New-York for microscropes have succeeded quite well with me in the production of almost invisible pictures; and I have no doubt he will be able to fit up a microscopic camera for such as require one from the indications here given. Such a camera, requiring great refinement of workmanship, will of course be more likely to be better made by those who are accustomed to the refined adjustments of a microscope than by the photographer himself. The objectives of Grunow are not only unexceptionable, but are endowed with qualities superior to those in many of foreign origin.

Microscopic Objects. — The objectives just alluded to are very well suited for taking enlarged photographs of microscopic objects, such as the porous structure of wood, the siliceous deposit in guano, blood corpuscles, starch granules, itch insects, etc. Such an objective is fixed to an ordinary bellows camera, so arranged on a sliding platform that the axis of the objective coïncides with

the axis of the cone of concentrated light from the condenser of the solar microscope. The latter instrument has a special opening between the condenser and the objective to receive the transparent object whose photograph is to be taken of an enlarged size. If the objective is not quite achromatic, insert a piece of thin violet-colored glass over the object while focussing, and fix the objective so that the violet cone of light terminates in the optic center of the objective as before described. Focus by means of a pair of very powerful spectacles or a compound microscope. In the first place make the camera firm on the platform, when the objective is once in its place; then draw out the ground glass nearly as far as it will go, and afterward move the microscopic object nearer or farther off, as the case may be, by means of the thumb-screw, until the picture is visible on the ground glass; finally focus with accuracy so as to get perfect sharpness. The violet-colored glass may now be withdrawn. The prepared collodion plate is inserted in the place of the ground glass; the slide is drawn out, and the sun's light turned on for a fraction of a second. It is in many instances an advantage to keep the violet-colored glass in its place, because it moderates the light; and the result is even better with it than without it.

Finish the plate for a positive or negative according to rules already prescribed in ordinary photography.

CHAPTER XXXIX.

THE DAGUERREOTYPE.

A PHOTOGRAPH on a silver or silvered plate is superior in definition and beauty to all other photographs taken on other materials. It has, however, its disadvantages; amongst these may be reckoned the lateral inversion of the picture, the inability of regarding the image at all angles of reflection, and of producing reproductions of the original by some quick printing process.

The Daguerreotype process is divided into six different operations.

First Operation, or the Cleaning and Polishing of the Silvered Plates.

Copper plates can be purchased already silvered with a pure frosted silver surface, of the proper size and ready for the polishing. In the first place, with a pair of shears, clip off the four corners of the plate, about a quarter of an inch from the apex of each angle; next with the machine for this purpose make a ledge all round the plate of one tenth of an inch in width from the silver side toward the copper side, so as to form a groove such as the tinman makes when grooving two edges of tin together. The plate is then fixed on a patent plate-holder, which in its turn is next screwed tight in the plate-vice. In this condition the silvered surface can easily be cleaned. This is effected by means of rotten stone, alcohol and Canton flannel, which are used in the same manner exactly as in the cleaning of glass plates. As soon as the plate is perfectly smooth and free from scratches, it is polished with what is called the buff, which consists of a piece of wood, about fifteen or eighteen inches long, four or five wide, and about three quarters of an inch thick; this piece is slightly curved longitudinally like the rocker of a chair, though to a less extent. It is well padded on the convex surface and finally covered with chamois leather. On the surface scatter a small quantity of jewel-

er's rouge, (sesquioxide of iron,) and then holding the buff by either end in the right and left hand move it backward and forward over the smooth silver plate, first in one direction and then at right angles to it, until the surface has a very uniform rich polish, devoid of lines. The plate is then ready for being sensitized. The buffing is more easily and uniformly executed on what is denominated the buffing-wheel.

Second Operation, or the Sensitizing of the Silver Plate.

For this purpose two coating-boxes are required, one containing the vapor of iodine, and the other that of bromine. They are so arranged as to allow the introduction of the polished plate without any loss of vapor. These boxes must be kept at a warm temperature so as to evolve the vapors from the materials; in winter artificial heat is used. One coating-box contains at the bottom first a piece of Canton flannel, and then about half an ounce or more of iodine in crystals; the other contains a mixture of hydrated lime and bromine, well pulverized and mixed. The operation is performed in the dark-room near the orange-colored pane of glass. The polished plate is first inserted in the holder of the iodine coating-box, and the lid is then closed. The surface, if examined closely, assumes various shades of color, beginning with light yellow, then deep yellow, reddish, copper-red, violet, blue, and green. As soon as the plate passes from the yellow to the red, it is placed over the bromine vapor, and kept there until the reddish color changes into a violet or steel color; it is then put back again over the iodine for one third of the time of the first exposure. By this means the film receives a very high degree of sensibility. The times of these three exposures, as soon as determined by practice, are counted in seconds. A more sensitive film may be obtained by iodizing simply to the light yellow, by bromizing to the dark yellow, and then again over the iodine for one third of the first exposure. This film, however, is very thin and not suitable for portraits, although well adapted for views. The plate is now ready for the

Third Operation, or the Exposure to Light.

It has been observed that the sensitized plates are more sensitive to the actinic impression if not exposed for a quarter of an hour after sensitization; in general, however, the plate is transferred directly from this operation to the plate-holder of the camera, and exposed right away. The time of

exposure is very short; it is naturally various, as in all other and similar cases depending upon the brilliancy of the light, the season of the year, the time of the day, and other minor circumstances. A few seconds, even in the room, are mostly quite sufficient. The exact number is easily learned from the conditions of the case; and then the exposure afterward can be regulated by counting. The plate is next withdrawn from the plate-holder in the dark-room; it contains no visible image; this is made to appear by proceeding to the

Fourth Operation, or Developing by the Vapor of Mercury.

A cast-iron box is prepared for this purpose, capable of being well closed after the plate is introduced. It contains mercury at the bottom, which is kept at the temperature of from 120° to 150° Fahrenheit, by means of a lamp with a small flame capable of graduation, and a thermometer attached to the box with the bulb in the mercury. A couple of ounces of mercury will be sufficient at once for ordinary portraiture. In two or three minutes the development will be complete. At intervals the plate may be examined to see the progress of development; but this examination must be made with great care, for the film is easily fogged by exposure to diffused light. If the time of exposure has been too long, the whole image will be fogged and indistinct; whereas if it has been too short, the high lights alone will be developed, while the rest will undergo no change whatever. Supposing the picture to possess the proper gradation of light and shade, it is then ready for the

Fifth Operation, or the Fixing of the Developed Image.

The film is still very sensitive, and the picture in a few minutes would be irremediably spoiled, unless the sensitive character of the film be annihilated. This is effected by plunging the plate immediately into the fixing solution, which must be preserved in a very clean condition by continual filtration after each operation. The fixing solution consists of:

Hyposulphite of soda, ...	2 drachms.
Distilled or rain-water, ...	2½ ounces.

Agitate the plate in this solution for a few seconds, until the iodizing is entirely removed, and then wash the plate in distilled water. In all operations of washing and fixing, use only filtered materials, for small particles of dust are very visible on the dried plates; use, especially, very pure water, because ordinary water contains salts, which are left as a

deposit on the plates when dried. After the fixed plate is well washed proceed to the final or

Sixth Operation, or the Toning with Gold.

In the first place make a ledge round the plate in the opposite direction, so as to form a miniature dish with the picture at the bottom; or cut off the former ledges entirely, and holding the plate by one of its corners with a pair of pliers, pour upon the surface of the picture, held horizontally, as much of the following gold solution as it will hold without flowing over the edges:

Toning Solution.

No. 1.	Chloride of gold, ...	1 grain.
	Distilled water, ...	1 ounce.
No. 2.	Hyposulphite of soda, ...	4 grains.
	Distilled water, ...	1 ounce.

Dissolve and pour the gold solution into the hyposulphite of soda, and mix well together. Next light a spirit-lamp with a large wick, and holding the pliers and plate in the left hand, play beneath the plate containing the toning solution with the flame of the lamp held in the right hand. Do not allow the flame to play upon the same spot; move it about, bubbles will soon begin to arise, and the picture will soon begin to assume a much more agreeable tone. Take care to have an excess of gold solution all the time upon the plate, otherwise, if it fails on a certain part during the operation of gilding, a stain will be produced that can not be removed by any subsequent treatment. Use also a large flame, to produce rapid action; prolonged action fogs the picture. When the tone of the picture is satisfactory, immerse the plate at once in a basin of water, and wash well at the top; afterward pour over the plate two or three times, distilled water, and then dry the plate; beginning at the upper edge with the application of the flame of the lamp, proceed downward, as the film dries, blowing off the excess of water as you proceed, or absorbing it with a sponge from the pendent edge and corners, until the whole surface is dry.

Daguerreotypes may be touched up with color like any other photographs, where desired. It must be confessed, however, that a well-toned daguerreotype picture looks best unadorned with either color or tinsel.

CHAPTER XL.

PRINTING WITHOUT THE SALTS OF SILVER.

These processes comprehend several operations with the persalts of iron, chromium, the salts of uranium, and the carbon process. They are very interesting, but have not as yet been applied to any useful purpose. The carbon process has not arrived at that degree of perfection which is expected in such operations.* This expression of its merits is limited to direct printing on paper by carbon or other colored media in connection with chrome salts, etc. Photo-lithography and its congeners, that require the application of carbonaceous ink, are properly classified as photo-engraving, and will be treated as such.

Process with the Salts of Iron.

Sir John Herschel discovered, several years ago, that certain of the persalts of iron, when exposed to light in connection with organic matter, undergo decomposition, and are reduced to the state of proto-salts; and we are indebted to Poitevin for numerous interesting developments in this department. For instance, the perchloride, so exposed, becomes reduced to the proto-chloride, or, as Van Monckhoven more appropriately remarks, to the state of oxy-chloride. For this purpose the sesquichloride must be quite neutral. The ammonio-tartrate, potassa-tartrate, and the ammonio-citrate of iron are much more sensitive to light than the sesquichloride, and the latter salt the most of all.

The image formed by means of these salts is much fainter than that with the chloride of silver; but it can be intensified by the application of other metallic salts. The mode of operation consists in floating the paper on the solutions in question, in the dark-room, in allowing them to dry and then exposing them afterward beneath a negative, as usual, with paper prepared with chloride of silver.

* Pouncy's New Carbon Process seems to give great promise of being usefully applied.

Cyanotype.—Float on a solution of the sesquichloride of iron, dry and expose; afterward wash the prints, and then immerse them in a bath of ferridcyanide of potassium. The picture will appear of a blue color in all those places where the sun has acted. Ferridcyanide of potassium has no action upon the persalts of iron; on the protosalts, however, it produces prussian blue.

Crysotype.—If the papers containing the faint image, produced on the ammonio-citrate of iron, be floated on a bath of a dilute and neutral solution of chloride of gold, the image assumes a purple tone, which becomes gradually darker the longer it is exposed to the solution.

Solutions of the other metals, such as those of silver, mercury, and platinum, also produce images which are of a grayish color. Bichromate of potash yields a picture by a similar decomposition.

Process with the Salts of Uranium.

The discovery of this process owes its origin to Niepce de St. Victor and to Burnett. The nitrate of the sesquioxide of uranium undergoes in connection with organic matter, when exposed to the sun, a decomposition analogous to that of the sesquichloride of iron.

The paper, without having undergone any preceding preparation, excepting that of having been excluded from the light for several days, is floated on a bath of the nitrate of uranium, as follows:

Distilled water, ...	10 drachms.
Nitrate of uranium, ...	2 drachms.

The paper is left on the bath for four or five minutes; it is then removed, hung up and dried in the dark-room. So prepared, it can be kept for a considerable time.

The exposure beneath a negative varies from one minute to several minutes in the rays of the sun, and from a quarter of an hour to an hour in diffused light. The image, which is thus produced, is not very distinct, but comes out in strong contrast when developed by one of the following developers:

Nitrate of Silver Developer.

Distilled or rain-water, ...	2 drachms.
Nitrate of silver, ...	7 grains.
Acetic acid, a mere trace.	

The development is very rapid in this solution; in about half a minute it is complete. As soon as the picture appears in perfect contrast, the print is taken out and fixed by immersion in water, in which it is thoroughly washed.

Chloride of Gold Developer.

Distilled water,	2 drachms.
Chloride of gold,	2½ grains.
Hydrochloric acid,	½ a drop.

This is a more rapid developer than the preceding. This print is fixed in like manner by water, in which it must be well washed, and afterward dried. When dried by artificial heat the vigor of the print is increased. Prints that have been developed by the solution of nitrate of silver may be immersed in the gold bath, which improves their tone.

The picture may be developed, also, by first immersing the prints in a saturated solution of bichloride of mercury, and afterward in one of nitrate of silver. In this case, however, the time of exposure is increased.

Pictures may be obtained also by floating the papers on a mixture of equal quantities of nitrate of silver and nitrate of uranium, in about six times their weight of water. When dry, they are exposed beneath a negative. In this case the image appears as in the positive printing process with chloride of silver, being effected by the decomposition of the nitrate of uranium, which, reäcting on the nitrate of silver, decomposes this salt, and reduces the silver. These prints require fixing in the ordinary fixing bath of hyposulphite of soda, and then washing as usual.

Process for Red Pictures.

Float the papers for four minutes in the preceding bath of nitrate of uranium, drain and dry. Next expose beneath a negative for eight or ten minutes, then wash and immerse in the following bath:

Ferridcyanide of potassium,	30 grains.
Rain-water,	3 ounces.

In a few minutes the picture will appear of a red color, which is fixed by a thorough washing in water.

Process for Green Pictures.

Immerse the red picture, before it is dry, in the following solution:

Sesquichloride of iron,	30 grains.
Distilled water,	3 ounces.

The tone will soon change to a green. Fix in water, and dry before the fire.

Process for Violet Pictures.

Float the papers in the following bath for three or four minutes:

Water,	2 ounces.
Nitrate of uranium,	2 drachms.
Chloride of gold,	2 grains.

Afterward take them out and dry. An exposure of ten or fifteen minutes will produce the necessary reduction. The picture has a beautiful violet color, consisting of metallic gold. Wash and dry, as usual.

Process for Blue Pictures.

Float the papers for a minute on the following solution:

Distilled water,	5 ounces.
Ferridcyanide of potassium,	1 ounce.

Dry in the dark-room, and then expose beneath a negative until the dark shades have assumed a deep blue color; then immerse the print in a solution of:

Rain-water,	2 ounces.
Bichloride of mercury,	1 grain.

Wash the print, and then immerse it in a hot solution of:

Water,	4 ounces.
Oxalic acid,	4 drachms.

Again wash and dry.

Carbon Process.

This process aims to produce a picture on paper either with lampblack or some other fine, impalpable powder. I shall discuss this subject as distinct from photo-engraving or photo-lithographic operations, although the two processes are based upon the same principle, that of the decomposition of the bichromates or the persalts of iron when exposed in connection with organic matter to the rays of the sun. The chloride of chromium and the other salts of chrome, as well as the sesqui-salts of iron, are subject to this mode of decomposition. The rationale of the operation appears to be this: the chromic acid of the chromate, or the sesquioxide in the case of iron is reduced by light into the sesquioxide of chromium, or a protosalt of iron, and thus parts with oxygen which is communicated to the organic substance with which the salts were mixed, such as gelatine, gum-arabic, etc., which in their turn become changed in properties as to solubility or insolubility, etc.

Various authors have experimented in this direction; Mungo Ponton first indicated the principle. We are indebted for the most interesting results in carbon printing to Poitevin, Garnier and Salmon, Pouncy and Fargier. In the first experiments of Poitevin, a chromate was employed in

connection with gum, gelatine or albumen. His mode of operation, as described in the *Traité de l'Impression Photographique sans sels d'Argent* is as follows:

"I apply different colors either liquid or solid to the paper, fabric, glass or other surfaces, by mixing these colors with the solution above mentioned, (bichromate of potassa and organic matter, etc.)

"The photographic impression, on this prepared surface, is produced by the action of light passing through a photographic negative, engraving or suitable object, or finally by means of the camera. It is then washed by means of a sponge and an abundance of water. The albumen or the organic matter becomes insoluble in the parts where the lights have acted, and the picture is produced by the color employed."

A second method is described as follows:

"In the preparation of the papers I cover them with a concentrated solution of one of the substances above mentioned (gum, gelatine and the like) in connection with a chromate; after drying I submit them to the direct rays of the sun or to diffused light beneath a negative of the object to be copied. After an exposure, which varies according to circumstances, I apply by means of a pad or a roller a uniform film, either of typographic or lithographic ink, previously diluted, and then I immerse the sheets in water. It is now that all the parts, which have not been impressed by light, give up the greasy substance, while the others retain it in proportion to the quantity of light that has passed through the negative."

The principle involved in these two operations is quite different, although the result is the same. In one the film of gelatine, etc., where it has been exposed to the sun, has become insoluble in water, and consequently retains the coloring matter from being carried away in the washing. In the other case the film that has received the impression of light, has received a new power, that of adhering to the greasy ink applied uniformly to the whole surface, whilst the other parts, having no attraction for this ink, allow it to be dissolved off when floated on water.

All the other carbon processes, as for instance, that of Testud de Beauregard, of Pouncy, Chardon, Salmon and Garnier, Lafon de Camarsac, and of Fargier, are mere modifications of Poitevin's process, with but little amelioration.

Testud de Beauregard took out a patent for his process in November, 1858. It will be unnecessary to describe this

process, because it is essentially analogous to Poitevin's where he makes use of printing ink.

Pouncy's Process.

Take a drachm of lampblack, reduce it to an impalpable powder and pass it through a muslin sieve; mix it intimately with half an ounce of a concentrated solution of gum-arabic and the same quantity of a similar solution of bichromate of potassa. Lay on a uniform layer of this mixture upon a piece of a paper fixed on a stretcher, by means of a camel's hair pencil; as soon as it is dry, it may be exposed beneath a negative to the sun's rays for a number of minutes, (from four to eight.) The print is then immersed in water, impression side downward, and left for five or six hours in this fluid. Finally it is washed beneath the tap. The gum and the coloring matter are retained in those parts that have been impressed; whilst on the others they are dissolved or washed off.

Pouncy's New Carbon Process.

Take a sheet of tracing paper, made transparent by varnish or oil, and coat it on one side with a solution of gelatine. When dry it is ready to receive a coating of printing ink of the consistence of cream. This ink, as far as I have been informed, consists of a mixture of lampblack, or some similar material, together with asphaltum or bichromate of potassa, or with both. The quantity of the latter is very small by reason of its insolubility in the other ingredients. This ink is brushed over the surface that has been covered with gelatine, and is then hung up to dry. This part of the operation has to be performed in the dark-room. The paper, when dry, may be preserved for months unchanged, if not exposed to the light.

The next operation is to expose the prepared paper beneath a negative to light. Pouncy has availed himself of a method of exposure first suggested and used by Fargier, as will be seen in one of the following pages. The negative is laid in the printing-frame as in the ordinary printing of positives; upon this place the prepared paper, but with the white surface upon the film of the negative, and the surface covered with gelatine and sensitive ink away from it or on the opposite side.

The light, therefore, has to pass both through the negative and the transparent paper before it arrives at the sensitive film. The time of exposure is about half an hour.

Wherever the light impinges upon this film, it indurates the ink and renders it insoluble in turpentine or benzine. In this process the middle tones are produced with great accuracy and beauty.

After exposure there is no apparent change in the film; but when the paper is dipped in turpentine the soluble parts are all dissolved off. The paper is next placed in a second bath of turpentine where the lights are thoroughly cleansed of ink.

The paper is then taken out and dried. The paper being transparent, the picture is seen through it, and then regarded as a true picture, free from inversion. These prints can be used as transparencies, or can be transferred to cardboard or stone. In the former case they look like wood-cuts or engravings, combining at the same time all the beauty of the photograph.

This discovery of Pouncy's has been published without the necessary details, just as these sheets are passing through the press; but if the results are as stated by good authorities, it may be regarded as the great discovery, not only of the year, but of the age. Neither silver nor gold is required in the process—the prints appear in *printing ink* after developing, fixing, and washing in turpentine.

Processes of Salmon and Garnier.

For one of these processes a part of the Luynes second prize was assigned to the authors in 1858. Their other process was not brought into competition, although it was patented. (Poitevin took the first gold prize.) In both processes a transparent positive is employed instead of a negative.

No. 1. — Dissolve thirty drachms of loaf-sugar in thirty drachms of water, then add seven drachms and a half of neutral bichromate of ammonia, pulverized and dissolved in a mortar. To this mixture add ten drachms of the white of egg previously well beaten up together with a few grains of the bichromate. As soon as all these ingredients have been very intimately mixed, the solution is passed through a linen filter for use. In the mean while the paper is fixed on a board by means of tacks, and then brushed over with the above mixture. Take care to use of the mixture only just enough to cover the surface in order thus to obviate streaks and other similar imperfections. The paper is then removed and dried before the fire, taking care not to bring it too near, and to present the

posterior side to the heat. This part of the operation is soon finished. It is then exposed beneath a positive to the rays of the sun for fifteen or twenty minutes. After the expiration of this time the image is quite visible; the paper is again heated before the fire, which appears to continue the action of light, and thus becomes the means of modifying the intensity of the shades. It is now fixed a second time upon the board, and fine ivory black is brushed over the surface with a flat, moderately soft and flexible camel's hair brush. The film of ivory black is afterward uniformly spread by means of a soft pad of cotton all over the surface, after which the paper is detached from the board and presented for a few seconds to the fire. This being done, the paper is cautiously immersed in water, picture-side upward, and left there for a quarter of an hour, moving it about gently at intervals. As soon as it is supposed that the soluble portions of the bichromate have been removed by the water, the paper is withdrawn. Finally, in order to improve the whites, the paper is immersed in a bath containing ten ounces of water and half an ounce of concentrated sulphurous acid. This operation has to be performed, in like manner with the preceding, with great care, otherwise the coloring matter is liable to be carried off from the parts which are insoluble, for the film does not adhere with much tenacity. The object of this final immersion is to remove a number of yellow and gray patches in the lights; with the greatest care, however, it is very difficult to get rid of numerous small particles of charcoal imbedded as it were in the porous structure of the paper. After this operation the paper is taken and dried.

Sulphurous acid may be prepared for the preceding operation, by heating a mixture of sulphuric acid and small fragments of wood, such as chips or matches, in a retort. The vapor thus produced is sulphurous acid, which can be condensed in cold rain-water to saturation.

No. 2.—In the second process a thick solution of citrate of iron is spread evenly with a soft linen pad over the surface of a sheet of satin paper. The paper is then dried in the dark-room. It is next exposed beneath a transparent positive from ten to thirty minutes to the rays of the sun, by which an image is made apparent. This is intensified or made more vigorous by the following application. Fix the paper on a board with tacks and then with a cotton pad dab the surface over uniformly with an impalpable powder of carbon or any other color. At first no change is apparent, but by breathing upon the surface, those parts that have not

been impressed by light, being more or less hygrometric in proportion to the actinic action, attract the humidity and at the same time the coloring material, which exhibits the image. The parts through which light has penetrated, being no longer deliquescent, or at least only partially so, reject the carbonaceous materials, and these are swept away together with the unaltered citrate in the process of washing and fixing. The prints are afterward dried and varnished if thought necessary. The addition of sugar to the citrate in this process is recommended by Poitevin.

All these processes are more or less defective, producing prints devoid of the middle tones. This arises from the circumstance that the image is in general a mere surface picture, and especially as regards the middle tints. In the washing, therefore, these are apt to be annihilated together with the soluble film beneath them. This defect had been noticed and the cause assigned by Laborde as well as by Poitevin ; and it is probable that Fargier eliminated his process on the hints thus published. The difference in his mode of manipulating consists essentially in separating the film containing the image from the glass upon which it was formed, and in fixing it on a piece of gelatinized paper the other side up. The chemical and actinic part of the operation remains the same as in Poitevin's.

Fargier's Process.

Make a mixture of two drachms of white gelatine dissolved in two ounces and a half of water, and fifteen grains of lampblack, (previously washed with carbonate of soda, and afterward with hydrochloric acid, in order to remove all fatty or resinous matter;) to this mixture add a few drops of ammonia in order to decompose the alum contained in the gelatine and finally fifteen grains of bichromate of potassa. The mixture, when the ingredients are thoroughly dissolved, is filtered through a linen cloth, and after it is made hot, it is poured upon a properly cleaned glass, and the films dried by a gentle heat.

The glass, thus prepared, is exposed for a few seconds to the light, and then beneath a negative to the rays of the sun.

The first exposition to light for a few seconds is to render the whole surface of the gelatine slightly insoluble. The second exposure beneath a negative produces an insolubility more or less deep according to the luminous intensity and its duration. It will be easily conceived that the two surfaces of the gelatine film, that is, the upper surface and the

one adhering to the glass, are in very different conditions, the former being almost totally soluble, excepting here and there where the intensity of the rays has penetrated the whole substance; whereas the exterior surface, as before remarked, is insoluble. The parts between these surfaces are more or less soluble according to the quantity and intensity of the light that has passed through the negative. It will be seen, therefore, from these conditions of things, that the operation if washing, in order to be effectual, ought to be performed on the under surface. The film consequently is removed from the glass and transferred in the following manner:

Flow the film on the glass plate with two coats of collodion, and then immerse it in a dish of lukewarm water. The collodion will soon be detached together with the gelatine film, which will float in the water. The film is allowed to remain until all the soluble parts are dissolved off, together with the coloring matter which they contain. By this mode of proceeding the most delicate half-tones remain attached to the collodion, and the image is brought out very perfectly. Whilst in this condition in the water a piece of paper already prepared with gelatine is brought carefully beneath the floating film and then lifted out of the water and stretched upon a board. The film, carefully adjusted on the gelatinized surface of the paper, soon adheres to it, and may thus be dried.

Carbon Processes with the Salts of Iron.

Without recapitulating all the various processes arising out of the use of the salts of iron, I may here mention that Poitevin has employed the gallate of iron and the sesquichloride; and that others, following in his steps, have been more or less successful in the same domain of experimentation. I will give two examples only, and refer the reader for more ample information to Poitevin's interesting treatise.

No. 1.—*Process with Sesquichloride of Iron and Tartaric Acid.*

Make two solutions as follows:

No. 1.	Sesqui chloride of iron, ...	5½ drachms.
	Water, ...	15 drachms.
No. 2.	Tartaric acid, ...	2 drachms.
	Water, ...	15 drachms.

Filter each solution separately, then mix and add two ounces and a half more water. Keep the solution in the dark, and use it until exhausted.

The image with carbon or any other colored and inert

powder is formed on glass. For this purpose Poitevin recommends such glass as is used for stereoscopic slides, being ground on one side. If the glasses have been used before, they are cleaned by the ordinary means recommended. Each glass is then flowed with the sensitizing solution just prepared, in the same way as with collodion or albumen, and the excess is poured off at each corner. They are then reared on one corner on pieces of bibulous paper, inclining at an angle of 60°, with the sensitized surface downward. It is better to dry the plates by rearing them up near some heated surface, otherwise the operation of desiccation will be very tedious. This operation must be performed in the dark-room. The property of the dry plates is this: by the influence of light they become *hydroscopic*. The plates so prepared will keep for months in boxes, as was to be expected, inasmuch as the persalts of iron have a tendency in the dark rather to peroxidize than to be reduced to protosalts.

A plate is exposed beneath an ordinary negative varnished with copal dissolved in alcohol; all other varnishes, such as those prepared with benzine, gum, gelatine, etc., would be injurious. The film of the prepared glass and of the negative are in juxtaposition, and are placed together with great care. The time of exposure is about the same as in the common printing process. This has to be learned by practice; it is better to give too much time than too little, because the development can be stopped as soon as the image has sufficiently appeared. When taken from the printing frame the picture is already visible, white upon a yellow ground. It is exposed in the dark-room to the influence of the air, when it will be found that all those parts that have received the luminous action will become moist. In a few minutes the filmwill be ready to receive the first application of the carbonaceous or other inert colored material.—By putting away the plates when taken from the printing frame in well-closed boxes, the development may be postponed.—The development is effectuated by dipping a very soft camel's hair pencil in the fine impalpable powder and then dabbing or rubbing it gently over the surface of the impressed plates; the image will soon begin to appear, the coloring material adhering only to those parts that have become hydroscopic by the action of the light, and consequently in proportion to the luminous impression. In general the half-tones do not appear by the first application of the powder, and it is better when this is so; for if the plate took up the color too quickly, it would

be a sign that the exposure had been too long. A second application of the powder is made, and then a third, and so on, until the image is brought out in perfect harmony of light and shade. The operation may be stopped midway without any injury to the final development, which may be completed at any convenient time. It is very easy to follow the progress of development by placing the plate image side downward on a sheet of paper, or by regarding it by transmitted light; but seen so, it is always more feeble than by reflected light. It is also easy to accelerate certain portions which are slow in appearing; all that is required is to moisten them with the breath, and then go over the parts with the pencil dipped in the carbonaceous powder. As soon as the image is perfect, it may be retained on the plate by means of a coat of varnish, and thus be used as a transparent positive, without any washing or fixing. If instead of lampblack or vegetable colors, metallic oxides or enamel powders were to be applied to the sensitized glass plate, these coloring substances may be melted in a muffle, which communicates to the surface of the glass plate a perfectly unalterable picture, similar to glass-painting; the same mode of operation may be applied to plates of porcelain. In case, however, it is required to transfer the print to paper, the operation may be performed either immediately or a long time afterward.

To transfer the Carbon Print from Glass to Paper.

This operation is extremely simple, and presents no difficulty. Coat the film, containing the picture, with common plain collodion, of a consistence suitable for photographic purposes, then immerse the plate in water until the oily aspect of the film has disappeared. Next pour upon the collodion surface water acidulated with hydrochloric acid; repeat the operation two or three times. The film immediately in contact with the glass is rendered soluble in water by means of the acid, and the adherence of the collodion to the glass is at the same time destroyed. The acid is then thoroughly removed by washing in several waters, and then a piece of paper, covered with a layer of gelatine on one side and previously moistened, is placed upon the collodion and brought into contact with it by means of a large, broad and soft pencil, which is moved over it in all directions. As soon as the contact is complete and all bubbles of air have been removed, the whole is left to dry spontaneously. In the act of drying the gelatinized paper separates from the glass of itself, carrying with it the film of collodion in firm adhesion

to the picture. All that now remains to be done is to varnish the surface. Copal varnish is suitable for this purpose, because it lies upon the surface of the image without penetrating the film of collodion or gelatine, and consequently never arrives at the paper beneath. The prints, thus obtained, have a very delicate and velvety appearance, the only drawback being that of lateral inversion like the negative, unless the latter has been specially prepared beforehand. But the picture can be produced without any lateral inversion, not only by having a negative in the right conditions, but by the following somewhat complicated manipulation, although equally as easy as the preceding. In this case, the collodion is applied as before, the immersion in water and the flowing with acidulated water are performed, and then a piece of moistened paper, smaller in size than the plate, is brought into contact with the collodion film, in the same way as the gelatinized paper was made to adhere. The border of film all round the paper is now raised and folded over the edges of the paper, which when raised with caution carries the whole detached film from the glass. A piece of paper covered with gelatine and larger than the plate is now moistened, upon this the detached print is brought into contact, pressed into perfect adhesion by means of the soft brush, and then the borders of the film around the edges of the first paper are folded back, when, seizing an angle of the first paper, it is easily raised from the collodion film. The picture now is no longer inverted, and is besides fixed, the coloring matter or image proper lying protected between two films, one of collodion and the other of gelatine. With a tenacious collodion this operation of double transfer is always successful; it takes in fact longer to describe it than to perform it; as to the simple transfer, it always succeeds, whatever may be the quality of the collodion.

This process, after all, is very simple and almost always certain; besides this, it entails but little expense and requires less delicacy of manipulation than other photographic processes.

For vitrification or enamel operations, it possesses a great advantage arising from the facility of folding the collodion film, retaining the picture upon curved as well as upon plain surfaces.

Another property of the surfaces prepared with the sesquichloride of iron and tartaric acid is this: fatty substances, such as printing inks, applied after the luminous impression

through a negative, adhere only to those parts that have not been modified by light.

Almost all vegetable colors may be used in this process; it will be evident therefore that pictures resisting all change from the atmosphere or from time, may be obtained of any color that may please the fancy.

Printing directly on Paper by means of the Sesquichloride of Iron and Tartaric Acid.

This is a new process of Poitevin's. Five or six parts of gelatine are dissolved in a hundred parts of water; this solution is colored with a sufficient quantity of lampblack or any other inert color. Each sheet of paper is floated on this solution, which is kept lukewarm on a water-bath. By this means a very uniform film of color is communicated to one side of the paper, which is afterward placed flat on a horizontal surface with the colored side uppermost, and allowed to dry spontaneously. In this way a large number of sheets may be prepared beforehand.

In order to sensitize them they are immersed in a bath containing a solution of sesquichloride of iron and tartaric acid in the proportion of ten parts of the sesquichloride or iron, one hundred parts of water and three parts of tartaric acid. The papers are then allowed to dry in the dark. By this treatment the film of gelatine has become completely insoluble, even in boiling water.

These films receive the actinic impressions through a transparent positive; and in the parts where the light acts, the film becomes soluble in hot water proceeding from the surface of the film in contact with the transparent positive.

After the paper has been in this way exposed to the sun, if the positive is not very intense, (which is preferable in this kind of print,) it is immersed in hot water; then all the parts that have undergone the solar influence are dissolved in proportion to the quantity of light that has permeated the glass positive. In the places which correspond with the lights of the positive, the blackened or colored surface is dissolved to the surface of the paper, and will leave perfect whites; whereas in the half-tints, only a certain portion of the film will disappear, proceeding from the surface, and these half-tones will be reproduced by the greater or less thickness of the film of gelatine remaining insoluble. Now as this part is in immediate contact with the surface of the paper, it can not be carried away in washing. As to those parts of the positive which are completely black, they will

be produced by the total thickness of the primitive film. All that is required to finish the print is to allow it to dry, and then to wash it in acidulated water in order to get rid of the salts of iron, afterward to pass it through several waters, and finally to allow it to dry spontaneously.

Photographic Engraving.

It is a curious fact that experiments in photographic engraving gave rise to photography itself. The idea, the most prominent in the mind of Nicéphore Niepce, when he commenced his indefatigable researches in 1813, was not only to fix the image obtained by the camera obscura on a plate of metal, but to convert this plate into an engraving from which to receive prints by the press. After the partnership concluded between Niepce and Daguerre, this idea appears to have been abandoned; and an early death removed the former, the real originator of much that is valuable in photography, before he perfected the process which he left us. This process, together with a great deal that is interesting in photographic engraving, will be found at length in a small pamphlet published by his indefatigable nephew, Niepce de Saint-Victor, the *Traité Pratique de Gravure Heliographique*, in 1856.

The various ways that have been taken to come to one and the same result, that of obtaining a metallic plate, resembling an engraved plate, from which to receive prints exactly in the same way as with the engraved plate, take their origin either from the Iodo-mercurio-type or plated copper of Donné, the bichromotype of Talbot, or the asphaltotype of Nicéphore Niepce, if I may thus be allowed to create new names to represent these three classes. Without adhering to historical dates, I will simply recount what has been accomplished in each class.

Engraving on the Daguerreotype Plate.

The first attempts that were made to convert the daguerreotype into an engraved plate by an etching liquid, were those of Dr. Donné. He first went round the edge of the plate with a varnish or wax, making a ledge so as to retain the etching fluid. This fluid consisted of aquafortis diluted with four parts of water, which, when poured upon the plate immediately after the image was fixed, but not gilt, attacked the silver parts, without injuring or altering the whites. As soon as the etching was supposed to have advanced far enough, the plate was well washed, and the varnish or wax removed from the edges. It was then ready to print from.

The specimens obtained by the engraver's press from such plates were not very satisfactory; and the softness of the silver film precluded the possibility of printing more than a few dozen from the same plate.

Process of Fizeau.

This process is similar to that of Donné, but it proceeds further, and thus overcomes two very great imperfections in Donné's plates: the want of depth in the parts etched, and the extreme softness of the silver film. I will give the process as described by the originator:

"A mixed acid, composed of nitric, nitrous and hydrochloric, (the last two may be replaced by nitrite of potassa and common salt,) is endowed with the requisite properties, which is common to a solution of bichloride of copper, but in a manner less perfect.

"If a daguerreotype, whose surface is very pure, be submitted to the action of this acid, especially when hot, the white parts are not altered, while the blacks are attacked with the formation of chloride of silver, which adheres to the surface and prevents any further action of the acid by reason of its insolubility.

"Ammonia is then poured upon the plate, which removes the film of chloride, and thus presents a fresh surface to the action of the acid. By this means the depth of the shades can be increased.

"By operating in this way for several times, the daguerreotype becomes converted into an engraved plate of great perfection, but in general not possessed of sufficient depth, so that the prints on paper are not vigorous enough. It has been found necessary, therefore, to adopt other means of increasing the depth of the shades. This operation consists in gilding the prominent parts or the lights of the engraving, and to leave the silver in the etched parts intact; by which means the depth of the etching can be increased afterward by a simple solvent of silver.

"In order to obtain this result, the plate engraved as just described is rubbed over with a drying oil, as for instance linseed oil, then wiped in the manner of copper-plate printers. In this way the oil remains in the cavities alone and forms a varnish which soon dries.

"Gold is next deposited by galvanism upon all the parts of the plate excepting those filled with the linseed varnish, which is afterward removed by caustic potassa. The result of this is that all the prominent parts of the plate are protected

by a film of gold; whereas the excavated parts present denuded silver.

"It is now easy by means of nitric acid to act upon these hollow parts alone, and thus increase the depth *ad libitum*. Previous to this treatment, however, the plate is covered by what is denominated by engravers the *resin-grain*, which produces in the metal those numerous inequalities denominated *aqua-tinta* granulations.

"From the result of these two operations the daguerreotype plate is transferred into an engraved plate resembling the *aqua-tinta* plates, which like these is in a condition by impression to furnish a number of prints.

"But since silver is a very soft metal, the number of impressions would be very limited, if some very simple means were not devised to remedy the speedy destruction of the photographic plate when submitted to the operations of the press.

"This end is attained, previous to handing the plate over to the printer, by covering its surface with a film of copper by the electrolitic process. In this way it is evident that the film of copper alone bears the wear and tear produced by the labor of the pressman. If this film should happen to be damaged to any considerable degree, it may be entirely dissolved off by means of a dilute acid, without injuring the silver on which it is deposited, when the plate may again be covered with copper, and rendered as good as new."

Process of Talbot.

Plates of copper, steel or zinc are employed in this process. These are first washed over with a dilute solution of sulphuric acid in order to remove the film of oxide, then well rubbed with a mixture of carbonate of soda, and well dried. A solution of bichromate of potassa and gelatine is then flowed over the surface, and dried by the application of heat until the film assumes a beautiful yellow color. This operation is performed in the dark-room.

No. 1.	Gelatine,	1 drachm.
	Water,	2½ ounces.
No. 2.	Saturated solution of bichromate of potassa,	4 drachms.

Mix the two solutions and filter. The mixture will keep for some time. In summer it is sufficiently fluid; but in winter it requires to be warmed before it is flowed upon the plates. It must be preserved in a dark place. The proportions above given are found to work well, but they may be

changed, however, without altering the result. The color of the film is pale yellow and generally bordered with narrow fringes of prismatic colors. If the whole surface is covered with this prismatic appearance, it indicates that the film is very thin, perhaps, if any thing, too much so for successful manipulation.

The transparent positive or other object is now placed in the printing frame and the prepared plate upon it. An albumen photograph is the best adapted for such operations, because the film is the least liable to be damaged. The two films are in juxtaposition. An exposure of two or three minutes to the rays of the sun will produce a picture which will appear yellow on a brownish background. A longer exposure is required in diffused light; the amount of which will have to be modified by experience.

The next operation consists in covering the film of the plate when removed from the printing-frame with *very fine* copal or resin powder. This part of the work has to be performed with great care and uniformity. It is frequently effected by placing a heap of the finely pulverized material on the bottom of the box and then with a pair of bellows to make a cloud of the dust in which the plate is placed. The object of this operation is to communicate to the plate the *aqua-tinta* granulation. If the film of copal or resin be too thick, the etching fluid will not be able to penetrate to the metallic plate beneath. The plate thus covered with the powder is heated over an alcohol lamp in order to melt the copal. The fusion is known to be effected by a change in the color. The plate is then allowed to cool. The ordinary way of producing an aqua-tinta foundation is to project the resinous powder on the denuded surface of the metal; in this case it is on the surface of the gum itself, and it is found to act well.

The etching fluid is prepared as follows: Saturate hydrochloric acid with sesquioxide of iron by means of heat. The solution is filtered and evaporated until when cooled it becomes a concrete mass, which is preserved in well-stoppered bottles. It is a very deliquescent salt. With this salt prepare three solutions in the following manner:

No. 1. Saturated solution of sesquichloride of iron in water.

No. 2. Contains five or six parts of No. 1 to one of water.

No. 3. Contains equal portions of No. 1 and water.

The stronger the solution, the less effective in etching; the right strength can be learned only by experience. Make

a trial as follows: Pour a small quantity of No. 2 upon the plate and spread it with a camel's hair pencil. It is not necessary to have an elevated border of wax around the plate, because but a very small quantity of fluid is used, and there is no danger of its flowing over the edges of the plate. The etching fluid penetrates the gelatine where the light has not acted, and this penetration is in proportion to the deficiency of the luminous action. On this remarkable property is founded, in a great measure, the art of photographic engraving. After a minute or so, the engraving begins to show itself by turning dark, brown or black; and soon the effect extends over the whole plate. The details of the picture appear with great rapidity in each part. This rapidity must not be too great, and, where there is a tendency in this direction, the progress of the etching must be impeded before it has acquired a sufficient depth, (which requires an action of a few minutes' duration.) If in these preliminary experiments it be found that this tendency prevails, the solution No. 2 has to be modified by the addition of a portion of the saturated solution No. 1, before No. 2 can be employed in the etching of a fresh plate; but if, on the contrary, the engraving fails to appear after the lapse of a minute, or if it commences but proceeds too slowly, it is a sign that the liquid No. 2 is too strong or too near its saturation. This deficiency is corrected by adding a little water before it is employed for a second plate. In making this correction the operator must not forget that a small quantity of water often produces a great difference and causes the etching to proceed very quickly. As soon as the strength of No. 2 has been appropriately graduated, which in general requires three or four experimental trials, it may afterward be employed with safety. In this case the plate is flowed as before indicated, and the operation proceeds until all the details appear and present a satisfactory aspect to the eyes of the operator, which takes place generally in two or three minutes, the etching liquid being kept moving over the surface all the time by a camel's hair pencil. As soon as it appears probable that the engraving will not be any better, the operation is stopped, by wiping off the fluid with a pad of cotton or of wool and afterward flowing the plate with a sheet of cold water. The plate is then wiped with a clean linen cloth, and afterward rubbed with soft Spanish white and water in order to remove the gelatine. The engraving is now complete.

Another method by the same author is the following:

When the plate is ready for etching pour upon it a small quantity of No. 1, the saturated solution. This may be left on the plate for a minute or two. No apparent effect is produced by this operation, but it acts beneficially by hardening the gelatine. After this it is poured off and a sufficient quantity of No. 2 takes its place and produces the etching already described, which, on its appearing satisfactory, requires nothing more to be done.

But it frequently happens that a few patches of the engraving, such as distant mountains or vessels in a landscape, refuse to appear, and as without these the engraving would be incomplete, it is recommended to apply, by means of a camel's hair pencil, a little of No. 3 to those parts, without pouring off No. 2. This simple means is frequently effective in bringing out the details of the picture, and sometimes with great rapidity, so that the operator has to be very cautious lest this fluid might corrode parts that are to remain white. With proper skill this mode of strengthening certain parts will be found of great advantage in bringing out portions which probably would remain invisible.

Asphaltotype of Nicéphore Niepce.

The substance used to produce the image on the plate under the influence of light is *asphaltum* or the *bitumen of Judea*. The process of Nicéphore Niepce has undergone various modifications by his nephew Niepce de Saint Victor. The solution of asphaltum was formerly applied by means of a roller covered with leather, or of a pad of cloth or leather; it is now applied like collodion.

Varnish of Niepce de Saint Victor.

Anhydrous benzine, ...	90 parts.
Essence of citron-peel, ...	10 parts.
Pure bitumen of Judea, ...	2 parts.

In order to render the benzine more anhydrous, place a quantity of freshly prepared chloride of calcium in the vial which contains it, and shake the mixture frequently. In twenty-four hours it may be used.

Asphaltum or the bitumen above mentioned dissolves very easily in benzine; it is necessary, however, to shake the mixture, and then to allow it to settle for a day or two, after which the more liquid part is decanted and filtered in order to remove all insoluble particles. The varnish is then very fluid, and produces a very thin film. The thinner the film, the more sensitive it is to light. If a thicker film be

required, it is obtained by removing the stopper of the vial for a while, and allowing the varnish to evaporate, or by adding three or four parts of asphaltum instead of two. But a thick film presents more resistance to the etching fluid, and there is a limit to its application, otherwise the half-tones will be entirely wanting. The bottle containing the varnish must be kept filled and well closed, and be preserved in a dark room, if it is to be kept some time. It is better, however, to prepare only a small quantity at a time for present use.

Preparation of the Plate.

Plates of steel, copper, zinc or of glass may be used in this process. The first conditions, naturally, for all such operations of contact-printing, are, that they be perfectly plane and well-polished. Whether direct from the planing-machine or from previous use where it has failed to succeed, the plate of steel, for instance, is cleaned with benzine in order to remove all greasy material, then rubbed with a pad of cotton dipped in alcohol ninety-five per cent strong, and very fine emery powder. By this means the steel can be polished as bright as a daguerreotype plate. Copper and zinc plates as also those of glass are polished with rotten-stone. Immediately before use it is well to cover the steel, etc., plate, with a coating of rotten-stone and alcohol, allow the film to dry and then to rub it off; afterward use the broad camel's hair pencil, as in the wet collodion process, in order to remove all particles of dust.

Flowing of the Varnish.

This operation is similar to many others already briefly described. Be careful not to shake the varnish before it is poured upon the plate, otherwise it will give rise to an infinite number of small bubbles in the film. Pour the varnish either on the middle or the upper right-hand corner of the plate, as you would collodion, and as you are accustomed to do so with success; and allow the excess to flow off at the lower right-hand corner. Invert the plate and let it lean against the wall on the opposite corner to that from which the excess was poured and with the film toward the wall. This operation may be performed in a weak diffused light; let the plate, however, dry in the dark-room, which will take place very rapidly, and use it as soon as dry; for its sensibility is now the greatest. The more uniform and thin (to a certain extent) the film may be, the greater the probability of a successful issue.

Exposure of the Plate.

The printing operation is performed in the printing frame, only a transparent positive is used instead of a negative. A paper print may be substituted for the glass positive, first making the paper transparent by a solution of wax in turpentine or otherwise. The glass positive is placed upon the glass plate of the printing frame; and then the prepared asphaltum plate lies upon the positive, their two films being in contact. In this the frame is exposed to the direct rays of the sun or to diffused light. The time of exposure will seldom exceed a quarter of an hour in the sun or an hour in diffused light; the right time has to be learned by experience.

Development of the Image.

This operation consists in dissolving the parts that have not been acted upon by light and thus removing them and exposing the plate beneath.

Solvent.

Rectified oil of naphtha, ...	4 parts.
Ordinary benzine, ...	1 part.

This solvent is poured upon small plates in the same way as collodion, or the developer, etc.; but when the plates are large, it is necessary to have a porcelain or glass dish, at the bottom and the left end of which the plate is placed. The solvent is poured upon the inclined right end, and by elevating this end the liquid flows uniformly over the whole plate. This operation of flowing the plate must be performed immediately after the exposure, whether in the camera or by contact.

If the action of the light has been too long, a stronger solvent is needed; the strength of this solution is increased either by increasing the quantity of the benzine or diminishing that of the naphtha. If the whole of the film of asphaltum is dissolved off, the action of the light has not been either sufficiently intense or prolonged; if, on the contrary, but little has been dissolved, either the luminous action has been too long, or the asphaltum was very sensitive, in which case the image is always foggy.

If the asphaltum peels off in certain parts of the plate, it is an evident sign the plate was moist. It sometimes happens, however, that when the film is too thick, the same inconvenience takes place.

The solvent may be used several times in succession, taking care to filter it when it becomes too colored.

Washing of the Plate.

The picture in general appears very quickly, so that the action of the solvent has to be stopped almost immediately after its application. If the exposure has been too long, the solvent action of the varnish is not so rapid. In order to prevent all further action, the plate is plunged into a vessel of water and afterward well washed beneath the tap until every trace of the solvent and all particles of dust are removed. The plate is then allowed to dry spontaneously, or is dried by artificial heat.

Fumigation of the Plates.

The film of asphaltum, unfortunately, is not quite impermeable to the action of the etching fluid used afterward. Various means have been resorted to so as to obviate this difficulty. Wax is sometimes added in small proportions to the varnish to remedy this evil. The best result is obtained by subjecting the plates after development to the vapors of the essence of lavender or spikenard. For this purpose an arrangement is required similar to those used for iodizing the silver plate in the daguerreotype process. At the bottom of this vessel a small porcelain capsule is placed containing the pure essential oil not distilled or rectified, which is heated from below by means of a spirit-lamp to the temperature of about from 150° Fahrenheit to 170° at the most, lest the oil should be volatilized in too large a quantity. In the first place let the fumigator be filled with vapor, then introduce the plate and keep it there for two or three minutes. The same essence may be used a second time, but no more.

The color of the film after fumigation, when successful, must be the same as before it has been acted upon by the light, bronzed and iridescent.

The plate is then dried by exposing it a moment to the air before the etching fluid is applied, and if the operation of fumigation has been properly timed and conducted, the film has become quite impermeable. It is necessary to guard against carrying the deposition of the essential oil too far, otherwise the acids will have no action whatever upon the metallic plate.

Application of the Aqua-Tinta Granulation.

This operation is indispensable for plates obtained direct either by contact or in the camera from a photograph, a landscape or portrait, etc.; if the plate be copied from an

engraving, it is not necessary. Without this expedient the plate will not retain the ink.

The grain is applied in the following manner: Resin reduced to an impalpable powder is placed at the bottom of a box made for this purpose, which, by means of a pair of bellows, is raised into a cloud, and thus, when it settles on the plate, communicates to the latter the granular condition denominated *aqua-tinta*. The plate is then heated, whereby the resin becomes melted and forms a sort of network over the whole surface. This operation gives the shades a grain more or less fine, (according to the impalpability of the powder,) which retains the printing ink, and thus permits numerous impressions to be taken of the plate as soon as the varnish and the resin have been removed by the aid of fatty bodies and essential oils or benzine.

Etching of the Plate.

It would be useless to attempt to etch a plate where the conditions are not appropriate. The film must have a brilliant and iridescent appearance, be sufficiently impermeable to the acid employed, free from fogginess, (that is, the metallic plate must be completely denuded in the deep shadows and partially so in the half-tones,) and the *aqua-tinta* grain must have been communicated to it. This being the case, proceed as follows:

Raise a border of mastic all round the edge of the plate, and varnish those parts that are intended to be quite white in the print, as is practised in ordinary etching. Next pour upon the film a dilute solution of nitric acid, beginning with one per cent of acid, and strengthening it to as high as twelve per cent, according to the resistance of the varnish and the depth of etching required. The etching fluid has to be changed, without increasing the per centage of acid; for it frequently happens that the plate resists the action of the fluid for some time, and especially if the film has been fumigated with the essential oil of spikenard. Very good results may be obtained by pouring hot water over the plate before the acid is applied; but in this case be sure to remove every bubble of water from the interstices by blowing before you pour on the etching fluid.

As soon as the etching is supposed to have advanced far enough, all further action is suppressed by dipping the plate in cold water; this must be done in time, otherwise the varnish would be attacked in those parts that ought to be preserved, a circumstance that sometimes happens, for which

unfortunately no definite cause can be ascribed. To obviate this difficulty a saturated solution of iodine in water at 60° is used as an etching fluid, instead of the aqua-fortis. The fumigation is omitted; and the iodine solution is poured upon the plate and kept there for ten or fifteen minutes, until it becomes nearly colorless; this operation is repeated two or three times, until the etching is regarded as deep enough or nearly so; it is then terminated by employing a dilute solution of aqua-fortis, which completes the etching without attacking the varnish.

Copper requires a much stronger etching fluid than either steel or zinc, and iodine can not be used in this case; it has therefore been recommended to etch the parts by galvanism.

The plates in general require touching up with the graver, especially if copied from photographs; whereas distinct pen and ink drawings or plans or maps may be engraved in the way prescribed, without requiring the aid of the graver's tool.

Etching on Glass.

Etching on glass is performed, when the plates are prepared, by placing them with the film downward over the fumes of hydrofluoric acid. For this purpose a box is constructed of lead, of the size and shape of the plate, and about two inches deep. At the bottom of this place a small saucer of lead containing pulverized fluor spar and sulphuric acid intimately mixed. Cover the box with the inverted and prepared plate as a lid, and apply heat to the bottom of the leaden box by means of a spirit-lamp; fumes of hydrofluoric acid will be set at liberty, and will corrode those parts of the glass that have been denuded by the solvent.

Nègre's Process for Heliographic Engraving.

The plate, prepared either with asphaltum or the bichromate of potassa and gelatine, is subjected to the luminous impression beneath a *positive* instead of a negative. After exposure and washing, the plate is attached to the negative pole of a battery and immersed in a solution of gold for electrolytic purposes. In this way the lights of the design are protected with a film of gold, the middle tones are partially covered, and the blacks only just sufficient to communicate a sort of reticulated structure which forms the necessary grain.

Copies for the Engraver to work from.

The metallic plate, the wood, stone or glass is first covered on both sides with a varnish quite impermeable to the action

of acids; it is then flowed on the prepared surface with iodized or bromo-iodized collodion, and treated in every respect the same as a glass plate for the reception of an ambrotype; that is, it is sensitized in the bath of nitrate of silver, exposed in the camera, or by contact with an albumen, etc., print on glass to the view, etc., developed, fixed, washed and dried. Finally, the surface of the picture, thus obtained, is covered with a solution of dextrine to preserve it from injury. The plate, etc., is now ready for the draughtsman, and when prepared by him by means of a fine-pointed style, it is submitted to the etching fluid, as before directed.

Photo-lithography and Photo-zincography.

These branches have been brought to a high degree of success within the last two or three years. They are not yet quite perfect; the want of perfection consists in the inability to obtain easily and uniformly the middle tones. Drawings in pen and ink, maps, plans, pages of letter press, etc., in which there is no intermediate tones between the lights and shades, are executed to any amount of reduplication by the photo-lithographic process, and very successfully; but landscape scenery, architecture and portraiture, where there is a regular blending of light into shade, can not *always and at will* be reproduced satisfactorily by any of the known processes of photo-lithography or photo-zincography, although it must be confessed that the specimens published in the work on Photo-zincography by Colonel Sir Henry James indisputably prove the possibility of the accomplishment of this desideratum.

The various processes practised in this department of photography depend upon the properties of asphaltum, the persalts of iron, and of chrome already frequently alluded to; and the object to be attained consists either in preparing surfaces where the shades are etched out as in the copperplate, or in relief, as in common type.

In some processes the designs are taken directly upon stone or zinc; in others on prepared paper, and afterward transferred to stone or zinc. By the latter the picture is obtained in a direct position; whereas by the former, without previous arrangement, the image is inverted.

Asphalto-photolithographic Process.

This process was originally employed by Nicéphore Niepce in the production of heliographic engravings. The first attempts in photo-lithography were made at the suggestion of

Barreswil, in connection with Lemercier, a lithographer, and Lérebours, an optician. Davanne, too, co-editor with Barreswil, of the *Chimie Photographique*, assisted in the preparation of the specimens published as early as 1853.

The properties of asphaltum dissolved in ether or in essential oil, are the following:

First. It is sensitive to light, and becomes changed in proportion to the intensity, whereby parts, not acted upon by the luminous impression, can be removed by a subsequent operation of washing with a solvent.

Second. It is sufficiently adhesive to the stone and impermeable to the etching liquids to prevent the latter from acting upon the stone, excepting on the parts denuded by the solvent.

Third. The parts of asphaltum left on the stone have an attraction for the greasy ink used in photo-lithography.

Now these are the properties required in photo-lithography:

The stone is first prepared as for lithographic purposes, and then placed on a leveling stand and made perfectly horizontal. Next take a quantity of bitumen, reduce it to a powder and dissolve it in ether; filter as much of the solution as may be required to flow the stone. Whilst flowing the stone with this preparation be very careful to avoid agitating the air so as to set the dust in motion, or produce undulations in the film. The excess of bitumen may be allowed to flow off on the sides and corners; and where there is a tendency of the fluid to become stagnant or to flow back again upon the stone, this is prevented by the application of a glass rod to guide the superfluous fluid over the sides. The object is to obtain a thin, uniform film, which beneath a magnifying glass presents a reticulated appearance all over the stone, communicating to it what is denominated by engravers *a grain*. The quantity of asphaltum in ether required to produce such a thin and uniform film has to be ascertained by practice.

As soon as the asphaltum is dry, a negative is placed on its surface, (the two films being in juxtaposition,) and is held down in contact by pressure on the sides and corners by means of a pressure-frame. Any negative may be used. The stone is now exposed to the light of the sun for a time, which has to be learned by experience. This operation being concluded, the stone is taken into a room feebly lighted, the negative is removed and the surface containing the latent image is washed with ether. The parts, on which the light

has acted, have become *insoluble;* these, therefore, are not disturbed by the solvent; whereas all the rest of the bituminous film that has been protected by the shades of the negative, is dissolved and washed off. If the time of exposure has been too short, the image is destitute of all middle tones; it is mere black and white; if, on the contrary, the exposure has been too long, the picture is foggy, that is, the fine lines have become heavy and the stone imperfectly denuded in the lights. In order to be successful, the surface must be well washed with ether, otherwise spots will arise that can not afterward be removed.

The film is then dried, and if the image thus formed is satisfactory, the stone is then treated in the same manner as a drawing with lithographic crayons; that is, it is first flowed with a weak acid solution containing a little gum, so as to preserve the whites and give more transparency to the picture; it is then washed in several waters, and if need be, in oil of turpentine; finally it is inked with lithographic ink. If all succeeds well, the image will take the ink with facility as soon as the roller is passed over it, and will require no touching up. Prints are obtained from stones, prepared in the manner above described, as with any other lithographic stone; they improve gradually after a number of impressions have been taken. The authors, whose process I have copied, assert that they have prepared a number of stones by this process, that have given great satisfaction and have not been worn out quicker than any ordinary lithographic impression.

Bichromo-photo-lithographic Processes of Poitevin.

The mixture proposed by Talbot of bichromate of potassa and organic matter, such as gelatine, albumen, gum, etc., is used by Poitevin in the processes about to be described.

An ordinary lithographic stone is covered with a solution of albumen and bichromate of potassa, and allowed to dry spontaneously. It is then exposed to the light of the sun beneath an albumen, tannin, etc., negative, by which the parts to which the light has not been able to penetrate through the opaque shades of the negative, are preserved in their natural and *soluble* condition, while the parts impressed by the light have become *insoluble.* Thus modified, the latter parts repel water, as if the light had produced some greasy substance in the film. In this condition these parts easily adhere to ordinary lithograpic ink, whilst there is no adherence between the ink and those parts that have undergone no actinic impression. A roller charged with such ink is then passed

over the stone; and the image is made manifest by the adherence of the ink to the parts impressed and in accordance with the intensity of the impression. The excess of ink is removed with a wet sponge. The stone is then covered with a weak acid which acts upon the parts not imbued with ink, and thus presents the image in relief, which is treated afterward like any other ordinary drawing on stone with lithographic crayons.

Photo-typographic Process of Poitevin.

Poitevin has also availed himself of a peculiarity, which gelatine in connection with bichromate of potassa possesses, of swelling when exposed to cold water and before it has been impressed by light. His mode of proceeding is as follows:

A plate of glass is flowed with an even film of a solution of gelatine, which is allowed to dry spontaneously. The plate is then immersed in a concentrated solution of bichromate of potassa; and when the film has become completely permeated with the salt, the plate is quickly washed in order to remove all excess of the solution, and is put away in the dark-room to dry. The plate is then ready for exposure beneath a negative, which must be very clear, transparent, well-defined and vigorous. After exposure it is immersed in cold water, by which the parts that have been protected beneath the dark shades of the negative, swell. In this condition the plate is moulded in plaster. This mould is afterward submitted to the electrolytic action of a galvanic battery, from which a metallic matrix may be obtained for printing from by the typographic press.

The processes above described, whatever the success in manipulation, are defective in one essential point: the pictures are laterally inverted. It is true that negatives may be obtained by copying in a condition to produce the proper effect.

Photo-lithographic Process of Newton.

A lithographic stone or a plate is covered with a solution of one quart of water, four ounces of gum-arabic, one hundred and sixty grains of sugar, and a certain quantity of bichromate of potassa. The stone is then put away to dry in the dark-room. It is next exposed either in the camera or beneath a transparent positive. The gum becomes almost insoluble by the action of the light. The stone is then washed with a solution of soap, which removes the parts that have not been acted upon by light, while the soap is decomposed

in those parts where the luminous impression has been made, "the action of the soap being inversely proportional to the intensity of the light." The stone thus prepared is washed with water, and when it is dry it is covered by means of a roller with a layer of printer's ink, which, combining with the soap, adds new body to the print. When it is desired to obtain gradations of light and shade, the stone is submitted to the graining process above described; but this is not necessary where blacks and whites alone are required.

It is difficult to observe any fundamental difference between this process of Newton and the preceding one of Poitevin; it is apparently a mere copy. The remaining processes to be described are the most important and successful; they are founded upon a discovery of Asser of Amsterdam, the transfer-process, although Sutton had remarked that printer's ink, put on gelatine paper, would come away, if soaked in water, leaving the paper quite clean.

This process consists in first obtaining a picture on paper prepared with bichromate of potassa and organic matter, and then in transferring this direct picture on stone or zinc, which, being laterally inverted, yields a direct print in the press. The process has been much improved in the manipulations both by Osborne in Australia, as well as by Captain Scott and Colonel Sir Henry James, in the Ordnance Office, Southampton. Osborne, it appears, made his discoveries and improvements independently of Asser's publication, and of those from the Government office in Southampton. These processes being then essentially the same, it will not be necessary to describe more than one in this work. Colonel Sir H. James has just published a new edition of his Photo-zincography, accompanied with very neat specimens of prints that can be obtained directly from photographic negatives by this process.

Photo-zincography by Colonel Sir H. James, R.E.; and Photo-lithography by Mr. Osborne.

The negatives in this sort of work require above all things to be very transparent, without the slightest fogginess in the transparent parts; the opaque parts, on the contrary, must be exceedingly dense. Such negatives can be obtained only by redevelopment or intensifying. The exposure of the collodion plate to light is not quite so long as for an ordinary negative, nor is the development carried on to the same extent *in the first instance* as for a negative; it is better to stop the action of the iron solution as soon as the pic-

ture has appeared in full brilliancy as a positive, and then to intensify afterward. For copying engravings, pen and ink drawings, maps, plans, etc., where the delineations are purely black and white, this mode of preparing the negatives is certainly to be recommended. Where there is a gradation of tone, the time of exposure and of development must be increased beyond that of a positive or ambrotype, but yet not to the same extent as for a negative.

To intensify the first sort of negative, that is, the one for copying engravings, etc., proceed as follows, as soon as it has been developed and fixed and is perfectly clear in the transparent parts:

While the plate is still moist, flow it with a part of the following solution:

Pyrogallic acid,	3 grains.
Glacial acetic acid,	48 minims.
Alcohol,	36 minims.
Distilled water,	2 ounces.

After moving the solution backward and forward for a minute or so, pour it off into a wine-glass, and add to it about six drops of a solution of nitrate of silver thirty per cent strong, if the plate is stereoscopic size, and so on, according to the size; shake the mixture well and then flow the plate with it, and keep it in motion, and watch the progress of blackening by the light transmitted from below, as before directed and described in the article on the negative collodion plate. It may be necessary to add more silver, or even to repeat the dose of the intensifier, sometimes two or three times; this, however, is a rare occurrence if the time of exposure has been right. When the shades are *quite opaque*, the operation is so far complete. Wash thoroughly and examine the plate in diffused light. If the lines have become somewhat thickened, or the transparent parts slightly fogged, these evils must be remedied by Osborne's clarifying process.

Dissolve iodine in a solution of iodide of potassium to saturation; of this solution take ten or twelve drops to four drachms of water, (for a stereoscopic plate,) and pour the solution on the moist plate, and keep it in motion until the surface of the negative assumes a uniform film of a cream color. Wash the plate and flow it with a very dilute solution of cyanide of potassium. This will remove the iodide of silver and diminish the thickness of the lines and the fogged appearance of the transparent parts.

Sir H. James intensifies with bichloride of mercury, by

immersing the well-washed plate in a weak solution of this salt; as soon as the surface is whitened by the action of the mercurial salt, it is washed again, and a dilute solution of sulphide of ammonium is poured over it, which changes the color to a brown-yellow. If the negative is allowed to dry, the bichloride is used, there will be less danger of filling up the lines; but the edges of the film must be varnished first, to prevent it from slipping off when it is washed.

After the negative has been intensified and is dry, it is varnished, and is then ready for use.

The following are the formulæ for the various solutions recommended by Sir H. James:

For Cleaning the Glass Plate.

Alcohol,	1 ounce.
Ammonia,	½ drachm.
Water,	8 ounces.

Tripoli powder, sufficient to give it the consistence of cream.

Collodion.

Pyroxyline,	80 grains.
Iodide of cadmium,	15 grains.
Iodide of potassium,	75 grains.
Alcohol, sp. gr., .812,	10 ounces.
Ether, sp. gr., .725,	10 ounces.

Nitrate of Silver Bath.

Nitrate of silver recrystallized or fused,	1 ounce.
Water,	14 ounces.

Dissolve and filter, then coat a plate with iodized collodion, and immerse for twelve hours in order to saturate the bath with iodide. If, on exposing the plate, there should be any sign of fogging, add dilute nitric acid, (one of acid to ten of water,) drop by drop, until a clear picture is obtained. If at any time the bath should be too acid, it can be neutralized by adding a little oxide of silver.

Developing Solutions.

Iron.		*Pyrogallic Acid.*	
Protosulphate of iron,	1 ounce.	Pyrogallic acid,	30 grains.
Glacial acetic acid,	6 drachms.	Glacial acetic acid,	1 ounce.
Alcohol,	6 drachms.	Alcohol,	6 drachms.
Water, distilled,	20 ounces.	Water, distilled,	20 ounces.

Fixing Solution.

Cyanide of potassium,	15 grains.
Water,	1 ounce.

Quality of the Paper used in the Transfer Process.

The paper suitable for this purpose must be *hard*, *thin*, and *tough*, of even texture, free from wooliness, and but slightly sized. Paper made from linen is the best, such as that used for bank post paper. If there is too much size in the structure, it can be remedied by steeping the paper in hot water a short time before coating it with the solution.

Coating of the Paper with the Sensitive Solution.

This solution must be quite fluid at the temperature of 100°.

Dissolve	Bichromate of potassa,	2½ ounces.	No. 1.
	Hot water, rain or distilled,)	10 ounces.	
Dissolve	Gelatine, (the finest,)	3 ounces.	No. 2.
	Hot water, (rain, etc.,)	40 ounces.	

Mix the two solutions and filter while warm. When about to be used let it be poured into a large flat dish, and maintained at a temperature of 100° by placing this dish in another containing warm water.

Float the paper on this solution with the right side downward for three minutes, taking care to break up all bubbles; the operation is performed in the dark-room. Drain the paper and hang it up to dry in the manner already described in the positive printing process. When dry, the paper is floated a second time and hung up to dry by an opposite corner.

The surface is afterward smoothed by passing it through a copperplate press on a hot steel plate—the rolling press with a flat plate is also quite suitable for this purpose.

Exposure under the Negative.

The amount of exposure is regulated by the appearance of the print. When the lines appear distinctly marked, and of a dark brownish-green, the operation is complete. The time will vary with each negative, and with the light, from one minute in the sun to twenty minutes in dull weather. If the printing is incomplete, the lines will break beneath the sponge in the washing; and where the exposure has been too long, the ink (to be afterward applied) will adhere to the ground of the print.

The Inking of the Bichromate Print.

Formula for the Ink.

Chalk lithographic ink,	2 pounds.
Middle linseed oil varnish,	1 pound.
Burgundy pitch,	4 ounces.
Palm oil,	2 ounces.
White wax,	2 ounces.

Melt the three latter in an iron pot until they begin to burn, stirring the ingredients all the time; finally, add the varnish and the ink, and mix intimately.

When about to use this ink, the necessary quantity is melted with a proportion of turpentine, so as to reduce it, when cold, to the consistence of thick molasses. A small quantity is laid on the printing roller, which is then worked on a stone in the usual manner, till the coating is perfectly even.

The closer and finer the lines of the print are, the thinner should be the coating of ink.

A zinc plate is inked with the printing roller, and the bichromate print is laid face downward on it, and passed through a lithographic press; by this means it receives a very even coating of ink.

The Cleaning of the Surface of the Print.

After the operation of inking the print is floated on water at 90°, back downward, for five minutes; it is then placed face upward on a porcelain or marble slab, and the surface is gently rubbed with a new soft sponge dipped in gum-water. If all the previous operations have been well performed, the ink will readily leave the ground of the print remaining on the lines.

The less friction is used the better; if the ink does not easily leave the paper where it ought to do so, the print must be floated once more on the warm water, face downward, for a few minutes.

As soon as the ground of the print is quite cleared of ink, and the whites appear in the closest parts where they show on the original, the paper is thoroughly washed in tepid water to remove all the gum from the surface, so that no trace remains. It is then dried and is ready for transferring to zinc or stone.

Transference of the Print to Zinc or Stone.

The plates of zinc are first scraped until all inequalities are removed. A piece of a saw-blade makes a good scraper. Let it be four inches long and three wide, in the form of a rectangle. Grind the long sides quite flat on a grindstone, so that these surfaces present two sharp edges for scraping. Use the scraper as in veneering. When the surface of the zinc is thus made free from blisters, scratches, etc., grind it down flat with a pumice-stone, and smooth it with snake-stone. Finally it is grained with a disk of zinc four inches in diameter, half an inch thick, and fixed to a handle, by

rubbing the disk with a circular movement over the surface with fine sand and water. The sand is passed through a wire sieve containing from eighty to one hundred and twenty meshes in a square inch. As soon as this operation is complete, the plate is thoroughly washed and dried, and then used immediately.

Old plates are first cleaned with turpentine, then with an alkali, and finally with a mixture of equal parts of sulphuric and hydrochloric acid to twelve parts of water. The graining, too, is repeated.

The bichromate print is first moistened between sheets of damp paper for a few minutes, then placed face downward 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 print 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 the latter 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 from the plate; and nearly the whole of the ink should remain on the zinc.

Etching of the Zinc.

The etching liquid is prepared as follows:

No. 1.

Aleppo galls, ...	4 ounces.
Water, ...	3 quarts.

Bruise the galls in a mortar and steep them in the water for twenty-four hours; after which the mixture is made to boil over the fire, and then filtered.

No. 2.

Gum water of the consistence of cream, .	3 quarts.
Decoction of galls, ...	1 quart.
Phosphoric acid, ...	3 ounces.

The phosphoric acid is prepared in the following manner:

Take a bottle, three quarters full when holding a pint of water, and insert sticks of phosphorus in the water, so that parts of them are exposed to the air above the fluid. An incision is cut in the cork to let in air. The phosphorus thus becomes oxidized, and the phosphoric acid is dissolved by the water below. In a few days the solution is sufficiently strong for use.

The etching liquid is poured on the plate, and spread over

the surface with a sponge or camel's hair brush. For fine work twenty seconds will be sufficient; whereas strong lines would bear the action of a minute without injury. The etching solution is next removed entirely with a cloth dipped in water.

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

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

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

Formula for Zinc Enamel.

No. 1 { Russian glue, ... 4 ounces.
{ Water, ... 3 quarts.

Soak for several hours, and then dissolve by heat:

No. 2. { Zinc white, (oxide of zinc,) . . . . 1½ pounds.

Grind with water on a slab, mix gradually with the solution of glue, and pass through a hair-sieve.

This enamel is communicated to the paper with a broad brush, and the streaks are obliterated with a flat camel's hair pencil. A second coating is applied in a similar manner, when the paper is hung up to dry.

Sir H. James remarks that, since the publication of the first edition of the process above copied from his work, he has discovered that the paper coated with the bichromate of potassa and gelatine, after exposure in the printing frame as already described, can be made to produce *transfers with half tone or gradation of shade* by using the following composition for the ink, and washing with a soft sponge moistened with tepid water without gum, and by using a very gentle hand in the manipulation.

Formula for Transfer Ink.

Lithographic printing ink, ...	8 ounces.
Middle lithographic varnish, ...	4 ounces.
Burgundy pitch, ...	4 ounces.
Palm oil, ...	4 drachms.
White wax, ...	4 drachms.

Photo-papyrography by Colonel Sir H. James, R.E.

This is a method of obtaining a single copy, or a copy or two of some manuscript, plan or document, etc., on paper, without incurring all the trouble of preparing either a stone or a plate of zinc. For this purpose a negative has to be prepared, by copying according to plans already minutely described, in which the parts are not laterally inverted. This can be effected too by simply presenting the glass surface (not the collodion surface) to the view, etc., in the camera.

With such a negative and with paper already prepared with the film of gelatine and bichromate of potassa, a positive picture can be obtained in carbon ink, laterally inverted. The image is brought out precisely as described in the process of photo-zincography. It is then placed face downward on a sheet of paper and passed through a lithographic press. A sharp and clean impression is thus obtained.

Colonel Sir H. James prepares negatives on paper covered or flowed with the wet collodion process. The sensitiveness is superior to that of collodion on glass, and the negatives, when waxed, give excellent results.

On the production of Photographs, etc., on Glass in Enamel Colors by Joubert.

A piece of crown or plate glass is selected for receiving the photograph; this glass must be as free as possible from all flaws. It is cleaned as usual, and flowed with the following solution:

Saturated solution of bichromate of ammonia, .	5 drachms.
Honey, ...	3 drachms.
Albumen, ...	3 drachms.
Distilled water, ...	20 to 30 drachms.

Mix intimately and filter in the dark-room. As soon as the plate is dry by means of artificial heat from a stove or otherwise, it is placed in contact with a *transparent positive* in the printing-frame. An exposure of a few seconds to the sun will show, on removal from the frame, a faintly indicated negative picture. To bring it out, an enamel color, in a very impalpable state, is gently rubbed over with a soft brush until the whole composition or subject appears in a perfect positive form. It is then fixed by alcohol, in which a small quantity of acid, either nitric or acetic, has been mixed. This mixture is poured over the whole surface, and drained off at one corner.

When the alcohol has completely evaporated, the glass is immersed gently and horizontally in a large dish of clean water, and left until the chromic solution is dissolved, and nothing remains but the enamel color on the glass; it is then allowed to dry spontaneously near a heated stove. When dry it is ready for the kiln.

Enamel of any color may be used, so that by a careful registering a variety of colors can be printed one after the other, so as to obtain a perfect imitation of a picture; also the borders of any description can be subsequently added, and the plate again submitted to the fire.

Naturally ceramic productions can be thus coated with the bichromate photograph, and afterward submitted to the fire to vitrify the image.

White enamel is glass rendered milky by fusion with oxide of tin; it forms the basis of many of the colored enamels, which receive their tinge from the metallic oxides. Thus the purple of Cassius (gold) imparts a fine ruby tint. The oxide or phosphate of silver gives a yellow color. The oxides of iron communicate blue, green, yellow and brown, according to quantity or state of oxidizement. The oxides of copper produce a rich green, and, when mixed with tartar, a red color. Antimony yields a rich yellow. The black oxide of manganese in excess forms black glass; in smaller quantities, various shades of purple. The oxide of cobalt imparts beautiful blues of various shades, and with the yellow of antimony or lead it produces green. Chrome yields greens and reds according to the state of oxidizement.

CHAPTER XLI.

STEREOSCOPICITY.

The property of seeing objects in relief has occupied the attention of philosophers from the earliest periods; and various reasons have been given for its existence. I have no hesitation in pronouncing them *all false*, excepting the one which I have published myself. The fact exists: we see objects in relief—what is the meaning of this expression? Simply this: we can see *at long and short distances at the same time.* But the eye is a veritable lens, a corrected lens, and is subject to the ordinary laws of optics; the conjugate foci of objects at different distances are not on the same plane but *at different distances;* the retina, therefore, is *not a surface*, it is a substance having *depth*, and in this depth are found those conjugate foci of the different objects, producing thus in the sensitive and transparent substance a miniature solid picture. This is the simplest means to meet the end in view; and the Almighty makes use of the simplest means, and these means I think I have understood and analyzed. To see long and short distances at the same time, that is, to see objects in relief, requires the possession of a retina of the depth of about $\frac{1}{100}$ of an inch in sensitiveness—now this is all that is required—the action of the ciliary nerve, the motion of the ciliary muscle, the layer-like structure of the crystalline lens, the action of the various straight and oblique muscles of the eye, the effect of the will, of the optic arteries, and numerous other contrivances, all these are not required in the production of this happy effect.

Euclid, it appears, though I know not where, attributes this phenomenon to the simultaneous impression of two dissimilar images of the same object in either eye of the observer.

Arago writes that when we see an entire object, the phenomenon is attributable to the rapidity of the action of the eye passing in quick succession from one part to another.

Pouillet's theory is this: he says that the crystalline lens consists of ellipsoidal layers superposed one over the other,

endowed with the property of acting, that is, of refracting light independently of each other, or simultaneously.

Some authors maintain that the crystalline lens is moved by the ciliary muscle from or toward the retina with great rapidity during the action of the perception of relief.

Some maintain that the cornea is made to change its form by the instrumentality of some muscular action and thus to accommodate itself to different distances, or to compensate for the change.

Others again entertain the hypothesis that the eye-ball is either elongated or compressed by some muscular action, just as the distance is shorter or longer.

As I said, all these hypotheses seem to be false, because the minutest investigations have not yet discovered that the eye is elongated or compressed, that the crystalline lens is advanced or drawn back, that the crystalline lens is endowed with independent optical layers, that the ciliary muscle acts as described, that the cornea is in any way changed during the act of any perception. On the contrary, it is known to be a positive fact, that a *single eye* has a correct perception of relief—that many animals, such as ducks, fish, etc., have their eyes located in such a position as not to allow the *simultaneous* action of either eye on all occasions; it is supposed, however, they see as perfectly as human beings. It is a well-known fact that we can see near and distant objects, as for instance, the moon, a cloud, a church steeple, and the branches of a tree close by, without any change of the eye, and without any effort. It has been furthermore ascertained by microscopical examinations that the retina has thickness, transparency through this thickness, and is constituted of a conical or stick-like juxta-collocation of nervous material from before backward, which we have a right to suppose sensitive to the impressions of light throughout. With such a constitution of nerves the problem of long and short distance, or the problem of seeing in relief, is solved.

The problem of seeing *pictures* in relief, depends primarily upon the property which the eye possesses of seeing *objects* in relief; for if the eye were not endowed with this power, pictures as well as objects would be seen, as it were, projected flat on the ground glass of the camera. This depends secondarily on the combined action of two eyes; for a *single eye* can by no contrivance see any picture optically in relief.

It appears that Leonardo da Vinci has touched upon the subject of binocular vision in one of his manuscripts. This

distinguished painter and scholar was born in 1452. There is nothing positive in any thing he has left us about the power and rationale of seeing pictures in relief.

The same may be said also of Giovanni Battista Della Porta and of Francis Aguillon, who both seem to have had some knowledge of binocular perception.

The first definite and positive acquaintance with this peculiar property is of modern date and is mentioned in 1832 in the third edition of Mayo's *Outlines of Human Physiology*. Wheatstone's reflecting stereoscope appeared in 1838; it appears from the evidence of Newmann, of Regent street, London, that Wheatstone was acquainted with a refracting prism that would produce the same effect. Brewster's refracting stereoscope appeared in 1850. Since its discovery by Brewster and its manufacture originally by the celebrated opticians, Soleil and Dubosc in Paris, stereoscopicity has occupied the attention of philosophers and amused the public as much as photography itself, which has been the means, in its turn, of rendering the stereoscopes so popular. Without photography the stereoscope would be, like the kaleidoscope, a mere philosophical toy.

The way in which photography has extended the influence of stereography is attributable to the facility it gives of obtaining consentaneously two dissimilar pictures of the same object in the exact conditions as they would be depicted by either eye of the spectator; for it is a well-known fact now that these pictures are endowed with differences depending upon the parallax of the object on the base line between the two eyes; the greater the parallactic angle, the greater the angular displacement of either picture in reference to the other.

For example, let a spectator stand before a pane of glass looking upon a church for instance. At the distance of distinct vision from the glass fix a metallic plate containing two small apertures, separated by a distance equal to that between the two eyes. Let the observer now, by means of a style dipped in thick printer's ink, trace the outline of the church on the glass as seen through the aperture of the right eye; in like manner, let him do the same through the aperture of the left eye. He will find that, instead of one church, two sketches will appear on the glass side by side, endowed with the following property as characteristically distinct from two engravings of the same object from the same plate. With a pair of compasses measure the distance between two corresponding points on the church which are nearest

to the observer; measure also the distance between two corresponding points that are the most distant from the observer, it will be found that the latter measurement will exceed in length that of the former; and that this result will always be obtained; that is, the greater the distance of certain parts of the objects comprehended in a picture from the point of observation, the greater the difference of distance between two corresponding points in the foreground and two in the distant background. It will be found, moreover, that the distance between two corresponding points which are very remote from the eyes, or properly speaking at an infinite distance, is equal exactly to the distance between the eyes of the observer.

The parallactic angle is that angle which is comprehended between the axes of the eyes converging to a given point; and the distances between any two corresponding points is equal to twice the versed sine of the parallactic angle; but the versed sine of an angle is complementary to the sine, and the sine varies as the angle; thus, therefore, as the sine decreases, the versed sine increases; and in like manner the distances between corresponding points from anterior to remoter positions in the background will gradually increase. Such are the properties inherent in the two pictures of the same object as depicted on the retina of either eye, or on the ground glass of a binocular camera. Two photographs or pictures taken as thus described, side by side, are the mere interception of rays on a flat surface as they proceed from the object. It is natural therefore to suppose that these pictures, when beheld by the eyes, ought to give an impression of the reality in relief. By a minute investigation of the subject it is ascertained that conditions arise for the effectuation of this result, which at the first sight are not anticipated. One condition is to obtain the same convergence of the axes of the eyes as existed when the pictures were taken. To obtain this convergence is an effort for the eyes; and on this account there are but few persons who possess such perfect command of their eyes as to secure the right convergence for given pictures. It is far from being absolutely necessary that the convergence should be exactly the same as existed originally when the photographs were taken; there are, however, certain limits on either side, that is, it may be a little either greater or less than that of the parallactic angle.

The object of this convergence is a very essential point in binocular perception producing relief; and the rationale of

this perception of relief is not lucid on other grounds than that which admits of the production of a *virtual solid image* in space, either at a distance beyond the pictures or in front of them. Such solid images are formed in space by the intersection of the rays that proceed from the corresponding points in either picture; for these rays, when they pass the optic centers of the eyes, form different parallactic angles, according as the distances apart are different, and thus intersect at variable distances corresponding with the points in the real object from which the pictures were taken.

Some eyes have a very great facility of converging their axes; in which case the rays from corresponding points intersect in front of the pictures and very nearly, if not exactly, at a distance half-way between the pictures and the eyes; in this case, (as may be seen on referring to this subject discussed at large, page 73, etc., Vol. XIV. of *Humphrey's Journal*) the effect of relief is inverted, the most distant points being projected forward, whilst the anterior points are seen in the extreme background. This is the natural consequence of the intersection of lines at angles that depend upon the peculiar distance apart of the corresponding points in the pictures.

Where eyes do not possess this great degree or facility of convergence, the intersections will, with the same degree of geometrical consequence, take place beyond the pictures and at variable distances beyond. The solid picture in this case will not be inverted; but it will vary in magnitude according as the intersections occur nearer to the pictures or farther from them. Persons, therefore, endowed with this less degree of convergence, have the pleasure of beholding a magnified solid picture, of which the magnitude is sometimes very great; whereas, those whose optical axes can easily converge, see a solid image uniformly of half the size of the pictures, but which is on this account very sharp and pleasing.

All eyes can be tutored with very little difficulty to receive this impression of relief from two photographs possessing the conditions required.

In order that the solid picture in the latter case shall be direct, that is, not pseudoscopic, the pictures must be inverted, the left being pasted upon the right side; and the right on the left side. Two photographs, so mounted, I have denominated a *Strabonic* Stereograph, to distinguish it from the ordinary stereograph.

Another condition, in order to see pictures in relief, by

the binocular perception, is the *cosentaneous independent* action of either eye. From this circumstance either eye beholds the two images; but the two interior ones intersect, are therefore superimposed and form thus only one image, which is the solid image; the two outside images are flat, and do not attract the attention to any great extent, by reason of the superior brilliancy of the middle picture. The rationale of this delightful phenomenon, as hitherto given in all our text-books on the subject, is so far erroneous, from the fact that it is asserted that each eye sees its corresponding picture as the object was seen when the pictures were taken. If this were true, we ought to see only the solid image, and not the two outside flat pictures.

All the instruments, called stereoscopes, are mere optical contrivances whereby in the first place the requisite convergence is obtained with facility; secondly, they magnify the image in relief; and thirdly, they shut off the two outside flat pictures. They are not essential at all to the perception of relief furthermore than as accessories. The philosophy of stereoscopicity is very simple, it is founded solely on the production of *intersections* of rays from corresponding points of two pictures, the distance of which points must be endowed with the requisite differences; from these intersections or superimpositions a virtual solid image is formed which is then regarded as a real object, which produces the perception of relief in either eye, because the conjugate picture in the retina is also solid.

It is evident, then, that a single eye can never see a flat picture in relief, because the requisite intersections can not take place; but we are by no means allowed to argue from this that a single eye can not appreciate relief or distance in real objects, or that relief is the result of binocular perception. This is an absurdity into which many investigators of nature have fallen; they have not comprehended the true origin of this perception, which depends upon the sensitiveness of the retinal film through a certain thickness, and not alone on a surface.

Eyes may be tutored to see two photographs in relief by the following expedients, and without the aid of stereoscopes.

All persons accustomed to close reading or writing, or to the use of magnifying spectacles are more inclined to see *strabonically* than otherwise. They can, in plain language, easily squint inwardly and see the end of the nose.

Strabonic Stereograph.

In the first place, therefore, prepare a number of strabonic stereographs of architectural structures, as follows: "Take the ordinary stereographs of the views in question and throw them into a pail of water until the photographs easily separate from the mounts. Remove the photographs, and passing over the backs with a sponge dipped in starch paste, transpose them upon the original mounts or upon new ones; that is, fix the right-hand photograph on the left side, and *vice versâ*. The student next has to learn to see double. This is effected by holding up the thumb before the eyes, so as to see two thumbs; when he is expert at this, let him next hold up in front of his eyes, at the regular reading distance, both his thumbs, and try if he can see four thumbs. As soon as this is effected, then, by bringing the thumbs closer together, so that their distance apart is about two inches and a half, the two middle ones can be made to overlap each other, whereby three thumbs will appear. The difficulty is now overcome; for the eyes, when well-practised in this strabonic exploit, are prepared for regarding a stereograph which is mounted as above described, when, with a little patience, three photographs will appear, of which the middle one will be very distinct, finely defined, and in full and natural relief, exhibiting all the solidity of reality.

The two outside pictures are indistinct, and the eyes will soon learn to neglect them; or they may be entirely removed from the field of view by the use of a frustum of a pyramid formed of cardboard, whose height is equal to half the distance of distinct vision, that is, half the reading distance; the side of its upper base one inch and a quarter, and that of the lower three inches. By placing the lower base next the eyes and looking through it, the stereoscopic picture will appear alone and distinct.

The second method is founded on a reverse principle, that is, by excluding the rays of light from the middle of the field of view, comprehending a space of one inch and a quarter square. This is effected by placing a piece of cardboard of this width in the middle, half-way between the eyes and the photographs, of which the latter are fixed at the regular reading distance; or the same object can be effected as follows: Take a slip of wood about two feet long, two inches wide and one inch thick; take secondly, a piece of cardboard of the size of a stereograph, and bisect the two parallel sides and the two parallel ends, and join the points of

bisection. Where these lines meet we have the center of the cardboard. From this point right and left on the larger line, mark off a space one inch and a quarter in length, and at either extremity thus marked off draw a circle half an inch in diameter. Lay the slip of wood on its flat surface on a table, and tack the piece of cardboard to one end of the slip at right angles to the table, with an equal portion of cardboard projecting at either end. Previously, however, the wide surface of the slip must be divided longitudinally into two halves, by running a saw from end to end so as to form a groove about a quarter of an inch deep; and at a distance from the cardboard, at the end, equal to the reading distance, another groove is sawed at right angles to the former and of the same depth; in the latter groove an ordinary stereograph is placed, and along the longitudinal groove a piece of cardboard at right angles to it. Now let the observer look through the two apertures at the stereograph; it is evident that the right eye can see only the right photograph, whilst the left eye is restricted in like manner to the left. By concentrating the individual attention of each eye to its respective picture, by pressing the external parts of the ball of either eye with the fingers, or by compressing the eyes as in frowning, the two pictures may be caused to overlap each other, when a new picture will appear possessed of the full stereoscopic effect, apparently of a larger size than the originals. The magnitude in this case will vary with the angle of convergence; if this should happen to be the same as that formed by the axes of the eyes or the lenses when the pictures were taken, the solid picture will be of the same size as the apparent size of the object from which the photographs were taken; at all other degrees of convergence the magnitude will vary.

Now the solid picture, produced by either process, can be magnified *ad libitum* by means of eye-lenses or spectacles; and when these eye-glasses are fixed in proper receptacles, they are then denominated refracting stereoscopes; but it will be seen that they are far from being indispensable; they are, in fact, mere accessories.

The differences of distance between the corresponding points on two photographs taken stereographically, being functions of the parallactic angle, can be easily calculated, and consequently artificial stereographs can be delineated geometrically. The results drawn from such calculations furnish means for detecting the inherent properties of stereoscopicity or their total absence in any given photographs or

designs. In this way it was conclusively determined that the drawings of Chimenti were not stereoscopic. Pages of print can be set stereoscopically, so that one line alternately stands above the other, or in any way whatever. The following is a typographic stereograph. It is formed by setting the alternate lines at different distances from one another; that is, the distance from T to T in the first lines is greater by about one sixteenth of an inch than the distance from H to H in the second lines; and all the rest are set accordingly. Viewed by the stereoscope the odd lines will be seen standing far back behind the even lines; an increase of difference will throw the odd lines still further back into the background. An irregularity of difference produces an irregularity in the relief.

STRABONIC STEREOGRAPH.

BY PROF. TOWLER.

The life of man is but a span,
His avocations many;
He enters poor upon his tour,
And dies—not worth a penny.

And yet we toil ourselves and moil,
To gain or lore or riches,
As if they could avail some good
Across old Charon's ditches.

The rich intend their wealth to spend,
When locks of jet grow hoary;
The learned aim to hoard up fame,
And live upon its glory.

And both regret the time they've let
Slip by in cynic dullness;
And now would give, once more to live,
Their wealth and lore in fullness.

They find at last, when all is past,
They've made a dreadful blunder;
And look upon their goings on
With shame, chagrin, and wonder!

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CHAPTER XLII.

CELESTIAL PHOTOGRAPHY.

Within the last few years the importance of the application of photography to astronomical investigations, as well as to meteorology, has been recognized by natural philosophers as a definite help-mate in the prosecution of these studies. This application consists, when referred to astronomy, in obtaining photographs and stereographs of the moon in its various phases, of the sun, of the planets, and of the comets; and, when referred to meteorology, in obtaining photographic delineations of the different classes of clouds; of the aurora borealis in its various configurations, of meteors, halos, water-spouts, paraselenes, etc.

For this purpose the various forms of telescopes, both reflecting and refracting, may be employed, which are used in observatories. Refracting telescopes, from the fact of their objectives being corrected for the luminous part of the spectrum, are far from being corrected for photographic purposes; and the ground glass has sometimes to be moved as much as an inch from the position of the luminous focus before the actinic focus is arrived at. Reflecting telescopes, on the contrary, not decomposing light, have to undergo no correction for actinism. For amateur astronomical photographers silvered glass mirrors, as recommended by Steinheil, are most easily constructed, are comparatively cheap, and from their lightness very manageable. These, when properly mounted, will give a picture of the moon, etc., of a magnitude varying with the focal length of the mirror. The ground glass is placed in the principal focus of the objective or reflector, and has a motion by which it can be adjusted to accuracy. In such cases the eye-pieces are removed. When the operation is not instantaneous, the telescopes have to be furnished with clock-work, by means of which the axis of the body photographed can always be made to coïncide with the axis of the telescope, during the time of exposure.

We are indebted to Messrs. Bond of Cambridge, Crookes,

De la Rue, Hartnup, Forrest, Edwards, Berry, Hodgson, Secchi, etc., for interesting information and photographs of celestial objects.

The moon naturally claimed the first attention ; the Bonds were the first to obtain a daguerreotype of this satellite; Messrs. Hartnup, Forrest, Berry, and Edwards obtained very beautiful photographs on collodion of the moon in 1854, of an inch and one third in diameter, which they afterward magnified a few diameters on another collodion plate, and then exhibited the photographic representation on a large screen sixty feet in diameter, the picture having been magnified to this extent by means of a magic lantern.

At the same time Mr. Hartnup suggested a plan of taking a stereograph of the moon, by first taking a photograph of this luminary twelve hours before full, and then twelve hours after full, thus changing the shadows from one side to the other. The stereograph was successful, and exhibited the moon in relief. From the fact that the moon revolves on her axis in the same period that she revolves in her orbit, it is difficult to obtain a degree of parallax by which more of one side can be seen at one time than at another ; but the axis of the moon, that is, the moon itself in the direction of its axis, has a sort of libration, which brings to light alternately more of the northern parts than of the southern. By taking photographs at these different periods a sufficient amount of parallactic angle has been obtained, and perfect stereographs have been the result. The moon has been photographed and stereographed in all her phases ; the shadows of the mountains are so well delineated in these different phases as to admit an accurate measurement of the height and diameter of those mountains.

A few seconds' exposure with a good equatorial will, in general, give a tolerable negative. It is not absolutely necessary to be furnished with a telescope in order to get a photograph of the moon ; the photographer will be glad to learn that a long-focussed view-tube will permit him to obtain a copy of this bright luminary, of about half an inch in diameter, which can afterward be magnified to any size desired. The only difficulty is to keep the moon in exactly the same position of the ground glass for a number of seconds.

The sun is easily photographed, because the operation is instantaneous. The act of focussing is performed by placing a piece of violet-colored glass over the opening of the objective, which is retained there during the exposure. In

this way eclipses of the sun can be photographed without that immense trouble and risk which have been so often referred to in celestial photography.

The stars have a high degree of photogenic power, and can be photographed in accordance with the intensity of their light. Mr. Bond has endeavored to base upon this power a means of classifying the stars into magnitudes, which at present are quite arbitrary.

The planets, possessing much less photogenic power than the fixed stars, are in consequence not so easily photographed; but by means of well-regulated clock-work, De la Rue has succeeded in obtaining very excellent photographs of Jupiter and his bands, Saturn and his rings, as also a stereograph of Mars, by taking two photographs at an interval of two hours, and others of Saturn at an interval of three years and a half.

It is supposed there are planets nearer to the sun than Mercury, which have not been discovered by reason of their proximity to the solar orb: it is hoped, however, by means of photography to settle this supposition; for if at any time in any of the numerous photographs which are taken of the sun, a small, round black speck should be discovered, the conclusion of the existence of another inferior planet would soon be drawn.

De la Rue is prosecuting this branch of photography and astronomy with great zeal and success; his labors, too, are highly appreciated. The Astronomical Society of London have conferred upon him their annual large medal as a token of their high appreciation of his merits and the results of his labors.

CHAPTER XLIII.

HELIOCHROMY, OR THE ART OF TAKING PHOTOGRAPHS IN NATURAL COLORS.

Sir John Herschel observed in 1840, that paper, prepared with chloride of silver and blackened in the sun, when exposed beneath red or blue glass, assumed the respective color of the glass; and Edmond Becquerel in 1847 and 1848 produced all the colors of the spectrum on a prepared silver plate, which were permanent as long as the plate was kept in the dark. The surface was sensitized by immersing the plate either in a solution of a bichloride, or in chlorine water.

Niepce de St. Victor, following in the steps of Becquerel, is obstinately persevering in his attempts to fix the colors which can already be obtained. The production of colors is a fact; the fixation of colors is still a problem *unsolved*.

The plate for heliochromic purposes is best prepared in the following manner: A common daguerreotype plate is varnished on the copper side. In one corner a hole is bored in order that the plate can be suspended on a silvered copper wire, which is the positive pole of a galvanic battery. A small plate of platinum soldered to a copper wire forms the negative or zinc pole. As soon as the battery is in working condition, insert the two poles at the proper distance in a vessel containing a mixture of one part of hydrochloric acid and eight parts of water. By the electrolytic decomposition hydrogen affects the negative pole and is given off there, whereas chlorine goes to the silvered plate, combines with the silver, and forms a chloride. The operation is best performed in the dark-room. The amount of deposition is recognized by the different shades of color which the plate assumes. The thinner the film, the more sensitive it is.

Niepce de St. Victor has recommended the production of this sensitive film by immersing the plate in soluble bichlorides, or in chlorides in combination with copper salts.

In whichever way prepared, the plate is dried over the flame of a spirit-lamp, and the surface is gently brushed over

with a tuft of cotton, in order to remove a downy substance arising from impurities.

If this plate be exposed to a diffused light, the film assumes a grayish violet tinge; but if it be exposed to a well-defined and very luminous spectrum, it receives an impression of the various colors of this spectrum, but not with the same facility. The orange, the yellow, and the red are the first colors that appear, and the first to darken and to become gray by a continued action. Beyond the red a rosy hue is made manifest, but this darkens the first of all. The blue, the green, and the violet are the most vivid. Beyond the termination of the violet part of the spectrum there is a decomposition of a gray color.

By keeping the prepared plates exposed to a temperature of about 100° for forty-eight hours in a stove, or to the rays of the sun beneath a piece of red glass, the film becomes much more sensitive, and not only reproduces the spectrum but receives an impression from white light.

If, when the plate leaves the electrolytic bath, it be simply dried, without raising the temperature to such a degree as to change the color of the film, and after this the plate be exposed beneath a colored engraving, a reproduction of these colors will soon be effected; some of these are sometimes latent, whilst others are brilliantly manifest. Those which are latent can be developed by simply rubbing the surface gently with a tuft of cotton impregnated with ammonia, which has been previously used for cleaning a plate. It is hence evident that a colored image is already produced, which may be partially manifest and partially latent.

Two very important problems remain to be solved: to find means of developing the whole of the image at once in all its colors, and of fixing it when developed. Some colors can be always reproduced, whilst others are but partially obtained. None of the colors as yet can be rendered permanent in diffused light. This branch of photography, therefore, is still quite imperfect. It is difficult to form an opinion as to the possibility of the solution of this interesting problem; because as yet no clue, no rational hypothesis can be given of the cause of the reproduction of the colors in question. In the ordinary positive printing on the chloride of silver, the cause of the decomposition is probably just as little understood; but we are satisfied with almost any theory as long as the manipulation is definite in its management, and within our power to continue or restrain. In the reproduction of colors these characters are wanting, and we

are hence tempted to disbelieve in the possibility of the effectuation of so desirable a discovery. On the other hand, the very fact that colors can be once reproduced, engenders faith in the realization of the great object; and because a similar and apparently equally as difficult case of fixation of a fugitive image has already been overcome, hope still points to the goal of final success.

Our knowledge of the image-impressions by contact, by the influence of heat and of electricity, is limited simply to the recorded facts, for which as yet no satisfactory rationale has been assigned. Probably all the pictorial representations of objects in photography, and its congene branches, developed either by mercury, pyrogallic acid, the protosalts of iron, the breath, impalpable powders, etc., may be classified in one and the same category, of which the cause may either be a molecular or polar change—that is, either an absolute change of position of the ultimate atoms in the aggregated material, or simply a change in the attractions of these atoms. The hypothesis thus expressed is founded upon the circumstance that every latent image is developed by means of matter applied to the film, which is attracted to certain parts after exposure by apparent predispositions in these parts, which have been superinduced by this exposure; the resulting pictures are combinations of the new and applied material with the original matter in the film. By an extended course of definite experiments applied understandingly in reference strictly to cause and effect, we have a right, in the course of time, to expect a definite solution of these wonderful manifestations of the presence of an Omniscient Intelligence.

CHAPTER XLIV.

IMPERFECTIONS IN COLLODION NEGATIVES AND POSITIVES, AND THEIR REMEDIES.

The knowledge of an imperfection or an error is half the correction. We must, therefore, first know what the failures in collodion negatives and positives are. Their enumeration is as follows:

Fogginess; Spots and Apertures; Ridges and Undulating Lines; Streaks and Stains; Feebleness of the Image, or Deficiency of Contrast; Harshness, or Excess of Contrast; Imperfect Definition; Solarization; Tender and Rotten Films.

Fogginess.—This is a mist or veil-like appearance that covers the whole negative; it gives it a foggy or clouded appearance. This imperfection may be the result of many and various causes, as for instance: Diffused light in the camera through holes or chinks; reflections from white or unblackened surfaces in the camera; diffused light through apertures or chinks in the door behind the plate in the plate-holder; direct rays of the sun through the objective or lens; an alkaline, neutral, impoverished or contaminated state of the nitrate of silver bath; a similar condition of the collodion; certain iodizers in the collodion and at certain stages of ripening; diffused light in the dark-room; too intense artificial light in the dark-room; too intense a development; fumes of ammonia, of turpentine, of tobacco, of hydrosulphuric acid, and probably almost of any other volatile chemical substance in the developing-room; imperfect cleanness of a glass plate that has been used before; the use of gutta-percha baths and dippers.

Diffused light in the camera, either in front of the plate or behind it; Reflections from white or unblackened surfaces in the camera.—This is a certain cause of fogging, and can easily be remedied. Examine the camera carefully for all chinks and holes. Some photographers are very care-

less ; they screw on the flanges of various-sized tubes on the end of the camera, and neglect filling the apertures left by the screws when withdrawn. Chinks occur invariably in cameras made of green wood ; and the bellows part, by frequent adjustment, sometimes cracks. The plate-holder has also its imperfections ; the slide sometimes allows the entrance of light ; the apertures at the bottom, for the passage of accumulating nitrate of silver, are frequently left open and not filled with sponge, so that light penetrates in this way. The door behind may close inaccurately ; and the plate-holder may slide irregularly and not fill the groove calculated to receive it. All these are errors or defects of workmanship, which must and can be avoided or remedied. Look, therefore, to your camera first in the search of chinks, cracks, and apertures ; secondly, if the inside surfaces of the camera are not of a dead black, cover them with unglazed black woolen or cotton cloth, or wash them over with a thick solution of ink or lampblack.

Direct rays of the sun through the axis of the lens.—Avoid this evil ; like many other troubles, to know it, is its total remedy.

An alkaline, neutral, impoverished or contaminated state of the nitrate of silver bath.—Immerse a piece of reddened litmus paper in the bath, and see whether it changes color, after a while, to a blue—if so, the bath is alkaline.

First remedy.—Make a mixture of six drops of acetic acid in a drachm of water, if you are taking negatives, and of the same quantity of nitric acid and water, if you are taking positives ; add ten drops at a time of either solution until the fogging disappears. Sometimes even more acid may be required.

Second remedy.—Instead of adding acid to the bath, add an old collodion or tincture of iodine to your collodion in present use ; this frequently is the safest plan of action.

If the bath is *impoverished*, it will at the same time be *contaminated*. The remedy is to boil it some time in a glass flask in order to get rid of the ether, alcohol, and the volatile substances produced by decomposition, as also to coagulate organic matter; then allow the bath to cool, and filter. To the filtrate add more nitrate of silver if required. Placing an old bath in the sun for several days is also of great assistance, but it is far from being equal to boiling or distilling.

Certain iodizers in the collodion and at certain stages of ripening.—Iodide of cadmium alone frequently produces

fogginess ; almost any new and limpid collodion has the same effect. Add iodide of ammonium in the first case, and an old collodion or tincture of iodine in the second case ; the sensitiveness will be thereby probably diminished, whilst the condition to fog will be removed.

Diffused light in the dark-room, or too intense an artificial light.—Place the artificial light behind a piece of ground glass, and do not bring it near the negative until the latter is thoroughly fixed. Diffused light must be locked out of the room.

Too intense a developer.—In summer less of the developer, whether of iron or pyrogallic acid, or more of the acid is required than in winter, otherwise fogging will be the consequence—the property of acid is to restrain the action of the developer ; use your judgment, therefore, and do not always keep to the same amount of protosulphate of iron, or pyrogallic acid to the ounce of water in all seasons ; nor restrict yourself unconditionally to the same amount of acid in the developer.

Fumes of ammonia, etc.—Keep your dark-room solely for its legitimate purposes. Keep it rigidly clean ; perform no chemical experiments in it ; abjure smoking in this sanctum ; do not sensitize your papers or fuminate with ammonia in this room ; make no manner of fumes therein.

Imperfect cleanness of the plate, etc.—Wash the old plates with a solution of salts of tartar and water ; if this does not remove the adhering dirt, wash it with dilute nitric acid, and afterward with salts of tartar, and finally clean and polish the plate with rotten-stone and alcohol. Some old plates that have lain long in water in which the old developing solutions have been thrown I have never succeeded in cleaning so as to prevent fogging ; they are contaminated to the backbone.

The use of gutta-percha baths, etc.—Instead of these, use glass, porcelain or photographic ware baths—the latter are very highly recommended ; I prefer glass to every other material.

Spots and Apertures.

Opaque and transparent specks are the most troublesome annoyances in the collodion negative process, and occur to every photographer more or less. These can be attributed to various causes, but seldom for the time being to the right cause ; that is, we know in general what will cause them, but seldom what did cause them.

The opaque spots may be caused in the first place by *dust* on the surface of the glass before the collodion is poured on. The remedy is simple : brush off the dust with a broad, flat camel's hair pencil just before the collodion is applied.

Secondly.—Opaque spots may be caused by *dust* on the surface of the collodion ; this dust may be deposited either from the bath itself, previous to immersion in the bath, or in the camera during exposure. That which is deposited either before or after immersion, are the organic substances in a state of very minute division floating about in the atmosphere or set in motion within the camera by the agitation produced with the plate-holder. This is perhaps the most fruitful source of trouble, which is of two kinds, *opaque* and *transparent* spots. The particles of dust attach themselves to the collodion with different degrees of tenacity ; where the tenacity is small, the dust is washed off in the different manipulations of developing and fixing, and the consequence is the production of *transparent* specks ; on the contrary, where the tenacity is great, *opaque* spots are the result ; for the particles remain imbedded after the final washing. If the dust be deposited from the bath itself, it may arise either from organic materials, in the atmosphere or from an excess of iodide of silver in the bath, in the form of the violet-colored deposit found at the bottom or on the walls of the bath. The remedy is, in the first case, to keep your room-floors moist, and your camera perfectly free from this enemy by dusting and sponging. In the second place, the insoluble deposit in the bath is separated by filtration ; the bath, too, is thoroughly cleaned by a sponge tied to the end of a rod, which can be made to enter into the angular spaces in which the dust is deposited.

Thirdly.—Another source of this trouble with opaque spots is to be found in the collodion, which contains sometimes undissolved pyroxyline in the form both of dust and fibres, or in fine organic dust from impure sources of manipulation. To remedy the evil, allow the collodion to settle thoroughly and use only the clear supernatant part.

Transparent Spots.

These are of much more frequent occurrence than opaque spots. They may arise, in the first place, from undissolved particles of the iodides in the ether and alcohol of the collodion; this is particularly the case with iodide of potassium in anhydrous alcohol; these afterward become dissolved in

the subsequent operations. The remedy is a drop or two of water, or of diluted alcohol, or of bromide of ammonium.

As remarked in reference to opaque spots, particles of dust in the camera or of the insoluble iodide of silver in the bath, adhering to the surface of the collodion, produce specks, both opaque and transparent. The transparent ones result from the fact that, during exposure, and the dust particles being opaque, they prevent the rays of light from acting actinically on the collodion film beneath, and then, being washed off in the subsequent manipulations of development, fixing, intensifying, and washing, they leave the collodion in those parts to the mercy of the fixing solutions, which render them quite transparent. The remedy is to keep the camera and the room free from dust, and the bath from insoluble particles of the iodide of silver or organic materials. If the bath is the cause, the trouble may be avoided by keeping the plate in motion during sensitization.

Another cause of transparent spots, and probably a very frequent one, is to be attributed to a crystalline deposit of iodo-nitrate of silver, which, as the bath becomes weaker, is precipitated in a crystalline form on the surface of the collodion film. This form of deposit occurs with an old bath. Its remedy is to precipitate it out of the bath by adding water, and then by filtration. Then for every ounce of water thus added pour in after filtration the same amount of a nitrate of silver solution to take its place.

When the bath is the cause of transparent spots, a small quantity of a solution of chloride of sodium (common salt) thrown in is found to be of great benefit. Chloride of silver and nitrate of soda are formed by double decomposition; the insoluble chloride probably carries down with it the dust or particles which are the cause of the trouble, or the nitrate of soda dissolves them. I am not able to say what is the true explanation. After filtration the bath is raised to the proper strength, when it will be found to be free from the evil.

Ridges and Undulating Lines.

These are caused by the too great consistency of the collodion, and are found in the direction of the current of the collodion. The remedy is to add sufficient ether to cause the collodion to flow smoothly, easily, and uniformly over the plate. The mottled appearance sometimes apparent on a collodion film, as if covered with flocks of wool, is owing also to the thickness of the collodion, and the evil is remedied in the same manner as the ridges.

Streaks and Stains.

Streaks may arise from an *irregularity* in the immersion of the plate in the silver bath, or in withdrawing it; the plate has to be immersed or withdrawn without any stopping. Streaks and stains are produced, too, by the film of dust swimming on the surface of the vertical bath, which is carried down on the collodion when the plate is immersed.

They arise, secondly, from the *irregular flowing* of the developing solution; the remedy is to use the gutta-percha developing dish already recommended for such purposes. Another remedy may be a proper quantity of alcohol added to the developer, if there happen to be a sort of greasiness or repulsion in the collodion film to the developing solution as it flows along.

The part upon which the developer first comes in contact with the collodion film almost invariably exhibits a streak around a denuded part, as if the developer had swept off the latent image in that part. The remedy is the developing dish, by which the developer acts with little or no momentum greater at one part than at another.

A sort of fortification system of stains and streaks arises from the want of cleanness of the corners of the plate-shield, from an inferior quality of collodion, from the unequal dryness of the film before immersion in the silver bath, as well as from a too great and irregular dryness of the film after exposure and before development. The remedies are self-apparent; avoid the causes.

Stains of a blue color arise from imperfect washing between developing and fixing.

Feebleness of the Image, or deficiency of Contrast.

A new collodion will very frequently be one cause of this trouble—the materials are not yet ripe. As a remedy, add old collodion, or wait for a few days, until the collodion is sufficiently decomposed.

Over-exposure is another and very frequent cause of a feeble contrast in the picture. All the parts are developed simultaneously, and too much deposit of reduced silver is the result all over the picture. A shorter exposure is the remedy.

Too intense a developer, or a developer continued too long, fogs the picture and weakens the contrast.

Imperfect lighting is a third cause, in which the light is either small in quantity, or diminished in intensity by reason of peculiarities in the atmosphere.

Harshness, or Excess of Contrast.

Under-exposure, a too acid bath, a too acid developer, under-development, an old and insensitive collodion: all these will produce pictures of mere black and white; the intermediate tones are totally wanting. The remedy is apparent; use it as the case may be.

Imperfect Definition.

This may be caused by *the want of coïncidence* in the chemical and luminous focus. See that the surface of the ground glass and that of the inserted plate have exactly the same distance from the back lens, and correct this evil according to rules already laid down.

The want of sharpness may arise from *careless focussing*, from the *mobility* of the sitter during exposure, from a *change of position* in the camera when inserting the sensitized plate, or, in fine, from *a bad lens*. The remedy in every one of these cases is obvious, excepting perhaps in the last; for the photographer may not always be in a condition to get a better lens. The only and most advisable remedy in this case is to close his gallery and feign sickness, until the return of the Express from the city, rather than lose his reputation or gain a bad one. In many cases a microscope is employed in very refined focussing, especially in copying.

Solarization.

This trouble does not occur very frequently; it is made manifest by the redness which the high-lights are wont to assume during development, when the exposure has been either too long or the light too brilliant, as in the copying process by the direct rays of the sun. This evil can be remedied by avoiding the causes, or by the use of a *bromo*-iodized collodion, or of citric acid in the developer.

Tender and Rotten Films.

These occur generally in collodion of a certain make, owing to the peculiar nature of the pyroxyline, or the relative quantity of alcohol and ether. The defect may arise, however, by immersing the plate too quickly into the silver bath before the film has set; also by immersing the plate when the film is too dry, in which case it cracks and splits up in the development.

There is no remedy for a rotten film; but a tender or structureless film can be retained on the glass by first filing the edges as recommended, and then by careful manipulations in the various operations of developing, fixing, and washing.

Imperfections in Paper Prints.

These are to be attributed *to defects in the paper; to imperfect albumenizing and salting; to defective sensitizing; to defects in the printing or in the negative; to imperfect washing previous to toning; to defective toning; to defective fixing; to stains of various kinds; mealiness on the print.*

Defects in the Paper.

A defective piece of paper must always be rejected at once. By regarding the paper by transmitted light, very frequently imperfections in the substance of the material can be descried, which otherwise would escape observation. Particles of inorganic matter, such as lime, the oxide of iron, etc., may be found in the substance, which in the various stages of the printing operation become manifest by decomposition. In choosing paper, where you can make the selection, examine each sheet separately for mechanical defects both of structure and of contamination, and reject whatever is in any way defective.

Imperfect Albumenizing and Salting.

The albumenizing and salting require careful and neat management. If the albumen is not very thoroughly broken up, it will assuredly produce irregularities in the albumenizing. The salting materials must be mixed up at the same time with the albumen, but *after solution* in a small quantity of water; otherwise particles of the salt will remain undissolved and give a *spotted* appearance in the printing. Use the albumen while fresh. See that the surface is not composed of bubbles; where these exist you will have a *marbled* or *oölitic* appearance on your print. If the paper exhibits such minute bubbles when removed from the salting solution, break these bubbles all up with a clean feather or soft sponge, and float the paper again until the film is uniform. The amount of salting ought to bear a relation of *equivalents* with the silver solution used subsequently.

Defective Sensitizing.

Filter the silver solution before use, or at least remove all particles of dust or oxide from its surface, otherwise your prints will be *spotted* and frequently covered with *fortifications*. A *marbled* appearance is caused by a weak silver solution, or too short a time of floating. It may arise from defects in the albumenizing, as just referred to. In quick floating the solution must be very strong. In some cases the

solution seems to be rejected from the surface of the albumen; rub over the solution with a tuft of cotton; float again, and the trouble will be overcome.

Defects in the Printing or in the Negative.

A *weak negative* will inevitably produce a *weak print.* Weak prints, too, are the result of too dilute a silver solution. *Bronzing* arises frequently from a want of true relation between the lights and shades in the negative. An intensified ambrotype used as a negative will produce a bronzed picture. Thus *under-exposure* and *over-development* are the causes of bronzing.

A *harsh print* proceeds also from *under-exposure* and *over-development* in the negative; there is a want of middle-tone—the picture is all black and white.

Many prints are spoiled in the act of printing by extreme carelessness. Watch the operation; the two guides of success are: *Print as long as the high-lights are perfectly white, and bronzing has not yet commenced.* The impression of a perspiring finger on the sensitive film, as well as many other similar organic contaminations, also give rise to bronzing.

Imperfect Washing previous to Toning.

The print, when removed from the printing-frame, contains nitrate of silver and nitrate of the alkalies used in the salting solutions, albuminate of silver, chloride of silver; the latter salt has been partly acted upon by light so as to form the picture, and another part has not been changed. The nitrates must all be removed by careful washing in several waters before the toning is commenced, otherwise the *toning will be slow and imperfect.*

The operation of washing must take place *soon after printing and immediately before toning*, in order to secure a good and quick tone.

Defective Toning.

This imperfection may arise from contaminations introduced into the toning solution by imperfectly washed prints; the gold solution becomes thereby decomposed and incapable of toning the printed film. The defect may arise from impure chloride of gold; from an acid condition of the toning solution; from bad paper; from the lowness of the temperature; from an excess of elevation of temperature. The imperfections of toning are:

A red tone after fixing; this is owing to an insufficiency of toning.

A blue tone after fixing; this is owing to an excess of toning; or to an acid toning solution.

A yellow tone in the whites after fixing; this may be owing to imperfect washing, imperfect toning, imperfect fixing, dirty fingers, introduction of hyposulphite of soda into the toning solution, or upon the prints. The defect in question may arise also from the decomposition of the gold in pathces, for want of uniform mixture before the prints are introduced.

Defective Fixing.

A dark mottled appearance in the body of the paper indicates imperfect fixing combined with the action of the light on the unaltered chloride *during fixing*. An exhausted hyposulphite bath may also give rise to this defect. A bath containing hydrosulphuric acid, or a free acid, which will produce the former, gives rise to this dark-gray mottled defect.

A yellow tone in the whites arises very frequently from sulphurized hyposulphite stains of various kinds.

These are owing to irregular and careless manipulations. The introduction of the fingers into the various baths, and indiscriminately from one bath into another, is the cause of a number of stains on the prints, as well as of abnormal action of the baths themselves.

Make rules for yourself, such as the following, and observe them minutely:

1. Print just to bronzing, or until the whites begin to be affected.
2. Wash soon after printing in clean water and clean pails.
3. Move the prints about in the washing; repeat the washing three times; two or three minutes' duration for each is enough. Long washing is injurious.
4. The chloride of gold must be pure; the solution must be neutralized with alkalies or lime.
5. The toning solution must be warm—about 100°—and well mixed—and clean.
6. Wash after toning quickly—in warm or hot water preferable—take care to introduce no gold solution into the fixing solution, and *vice-versâ*.
7. Move the prints about in all the solutions, so as to avoid bubbles and uneven action.
8. Tone to purple or incipient violet.
9. Use fresh toning for a fresh batch of prints.
10. Add fresh hyposulphite every time to the old bath, or use a fresh fixing-bath every time; let the bath be warm.

11. Alcohol is an advantage in all the solutions beginning with the nitrate of silver to the hyposulphite of soda.

12. Wash very thoroughly after fixing.

Mealiness on the Print.

Some authors speak of this defect in albumen prints. It is said to proceed from paper that has been long albumenized, or from the paper itself. The remedy is to immerse the prints in a solution of two ounces of water and eighteen grains of acetate of soda, and to keep them in this liquid for about ten minutes.

Prints frequently appear as if covered *with snow*, but the surface is quite smooth and the whites clear; this defect is attributable to the negative, which has been strengthened by pyrogallic acid containing too much nitrate of silver. The surface of the negative becomes thereby covered with a pulverulent deposit. There is no remedy for such a negative; there is a remedy, however, to such a mode of intensifying. In the first place, the negative must contain the middle tones before you begin to intensify; secondly, intensify slowly, which is effected by adding only three or four drops of silver at a time to the pyrogallic acid, and shaking well before use.

CHAPTER XLV.

WEIGHTS AND MEASURES.

Weights and capacities in England and France are estimated from certain standard linear measurements. In England, a pendulum vibrating seconds of time in a vacuum, at the latitude of London, and at the level of the sea, is assumed as the standard of linear dimensions; it is 39.1393 inches. This is the standard, too, of all our measurement of length, capacity, and weight in the United States. But, like the English, we retain all the old and arbitrary systems of weights and measures; whereas the French have assumed a decimal system in all their measurements that merits the highest praise and imitation. The linear standard of the French, from which they derive all other measurements, is called a *mètre*. It is the ten-millionth part of a quarter of the earth's meridian, and measures 39.371 inches. The *mètre* is divisible decimally in both directions.

The connecting link between the English linear unit and their measures of capacity and weight are as follows:

A cubic inch of distilled water weighed in air with brass weights at a temperature of 62° Fahr., the barometer standing at 30 inches, is equal to two hundred and fifty-two grains and four hundred and fifty-eight one thousandth parts of a grain; of such grains 5760 are required to make the imperial standard troy or apothecaries' pound; and 7000 of such grains make the commercial or avoirdupois pound. The imperial gallon has a capacity of 277.274 cubic inches; and a gallon of distilled water, as above, weighs 10 pounds avoirdupois, or 70,000 grains.

The connecting link between the French linear unit and their measures of weight and capacity, are as follows:

A cubic centimètre of distilled water, at its maximum density, at the temperature of 39.5° Fahrenheit, is the unit of weights and is called a *gramme*, which is divided decimally above and below.

A cubic decimètre is called a *litre*, which is the unit of the measures of capacity, and divisible decimally.

Comparison of Weights and Measures.

Apothecaries' Weight.

						French gramme.
				1 grain	=	0.0647
20 grains	=			1 scruple	=	1.295
60 grains	=	3 scruples	=	1 drachm	=	3.885
480 grains	=	8 drachms	=	1 ounce	=	31.08
5760 grains	=	12 ounces	=	1 pound	=	372.96

Symbols.

Grain = gr. Scruple = ℈. Drachm = ʒ. Ounce = ℥. Pound = lb

Apothecaries' Measure of Capacity. (United States.)

60 minims	=			1 fluid drachm.
480 minims	=	8 fluid drachms	=	1 fluid ounce.
7680 minims	=	16 fluid ounces	=	1 pint.
61,440 minims	=	8 pints	=	1 gallon.

Avoirdupois Weight.

				French gramme.
			1 drachm	= 1.77
16 drachms	=	1 ounce		= 28.328
16 ounces	=	1 pound		= 453.25
112 pounds	=	1 hundred weight		
20 hundred weight	=	1 ton		

Apothecaries' grains.

1 drachm	=	27.34375
1 ounce	=	437.5
1 pound	=	7000.
1 hundred weight	=	784000.
1 ton	=	15680000.

Apothecaries' ounce	=	480 grains.
Avoirdupois ounce	=	437.5 grains.
United States pint	=	16 fluid ounces.
Imperial or British pint	=	20 fluid ounces.
United States gallon	=	128 fluid ounces. = 8 pounds avoirdupois.
Imperial or British gallon	=	160 fluid ounces = 10 " "

Weight of Water at 62° and Capacity of :

		Cubic inches.		*Grains.*
1 gallon (Imperial)	=	277.274	=	70000.
1 gallon (U. S.)	=	231.000	=	56000.
1 quart (Imperial)	=	69.318	=	17500.
1 quart (U. S.)	=	57.750	=	14000.
1 pint (Imperial)	=	34.659	=	8750.
1 pint (U. S.)	=	28.875	=	7000.
16 fluid ounces	=	28.875	=	7000.
1 fluid ounce	=	1.732	=	437.5
1 fluid drachm	=	0.216	=	54.7
1 minim	=	0.0336	=	0.91

French Measures of Length.

		English inches.
Millimétre	=	.03937
Centimétre	=	.39371
Decimétre	=	3.93708
Métre	=	39.37079
Décamétre	=	393.70788
Hectométre	=	3937.0788
Kilométre	=	39370.788
Myriamétre	=	393707.88

French Weights.

	Equivalents in Grains.
Milligramme,	.0154
Centigramme,	.1543
Decigramme,	1.5434
Gramme,	15.434
Decagramme,	154.340
Hectogramme,	1543.402
Kilogramme,	15434.023
Myriogramme	154340.234

A gramme of water = 1 cubic centimétre = 15.43 grains = 17 minims. 1000 grammes of water = 1 litre = 1 kilogramme = 15434.023 grains = 2 lb. 3.27 oz.

	French Liquid Measures. *Cubic inches.*	*United States Liquid Measures.*
Millilitre,	.0610	16.2318 minims.
Centilitre,	.6103	2.7052 fl. drachms.
Decilitre,	6.1028	3.3816 fl. ounces.
Litre,	61.028	2.1135 pints.
Decalitre,	610.280	2.6419 gallons.
Hectolitre,	6102.80	26.4190 "
Kilolitre,	61028.0	264.1900 "
Myrialitre,	610280.	2641.9000 "

CHAPTER XLVI.

COMPARISON OF THERMOMETRIC INDICATIONS ON THE PRINCIPAL THERMOMETERS IN USE.

THERMOMETERS are instruments for ascertaining the temperature of bodies, whether liquid, solid, or gaseous. The principal thermometers in use are: the Centigrade, which is used principally in France; Rëaumur's thermometer, of more especial use in Germany; and Fahrenheit's thermometer, used more especially in Great Britain and the United States.

The temperature of boiling water is

100° on the Centigrade scale.
80° on Rëaumur's scale.
212° on Fahrenheit's scale.

The freezing point of water is indicated by

0° on the Centigrade scale.
0° on Rëaumur's scale.
32° on Fahrenheit's scale.

The number of degrees between the freezing point and the boiling point is

100° on the Centigrade scale.
80° on Rëaumur's scale.
180° on Fahrenheit's scale.

To reduce Centigrade degrees to those of Rëaumur.

Rule: Multiply by 4 and divide by 5.

To reduce Rëaumur's degrees to those of the Centigrade.

Rule: Multiply by 5 and divide by 4.

To reduce Centigrade degrees to those of Fahrenheit.

Rule: Multiply by 9, divide by 5, and add 32 to the quotient.

To reduce Fahrenheit's degrees to those of the Centigrade.

Rule: Subtract 32, multiply the difference by 5, and divide by 9.

To reduce Rëaumur's degrees to those of Fahrenheit.

Rule: Multiply by 9, divide by 4, and add 32 to the quotient.

To reduce Fahrenheit's degrees to those of Rëaumur.

Rule: Subtract 32, multiply the difference by 4, and divide by 9.

Table of the corresponding degrees on the Scales of Fahrenheit, Rëaumur, and the Centigrade.

	Fahrenheit.	*Rëaumur.*	*Centigrade.*
Boiling point,	212	80	100
	203	76	95
	194	72	90
	185	68	85
	176	64	80
	167	60	75
	158	56	70
	149	52	65
	140	48	60
	131	44	55
	122	40	50
	113	36	45
	104	32	40
	95	28	35
	86	24	30
	77	20	25
	68	16	20
	59	12	15
	50	8	10
	41	4	5
	32	0	0
	23	—4	—5
	14	—8	—10
	5	—12	—15
	—4	—16	—20
	—13	—20	—25
	—22	—24	—30
	—31	—28	—35
	—40	—32	—40

All the intermediate indications can be obtained by the use of the preceding rules.

CHAPTER XLVII.

COMPARISON OF HYDROMETRIC AND SPECIFIC GRAVITY INDICATIONS.

The specific gravity of a body is the comparison of the weight of a given bulk of the said substance with that of an equal bulk of distilled water at 62° Fahrenheit. Gases are compared either with air as the standard or with distilled water.

The specific gravity of a body is taken by special instruments for this purpose; some of these instruments are denominated Hydrometers, and give arbitrary indications, which have to be reduced afterward in terms of specific gravity.

Baumé's Hydrometers are in extensive use in France, and Twaddell's Hydrometer in England. Baumé has two Hydrometers: one for liquids heavier than water, and one for liquids lighter than water.

For Liquids Heavier than Water. Baumé.

Deg.	*Sp. Grav.*	*Deg.*	*Sp. Grav.*	*Deg.*	*Sp. Grav.*	*Deg.*	*Sp. Grav.*
0	1.000	20	1.152	40	1.357	60	1.652
1	1.007	21	1.160	41	1.369	61	1.670
2	1.013	22	1.169	42	1.381	62	1.689
3	1.020	23	1.178	43	1.395	63	1.708
4	1.027	24	1.188	44	1.407	64	1.727
5	1.034	25	1.197	45	1.420	65	1.747
6	1.041	26	1.206	46	1.434	66	1.767
7	1.048	27	1.216	47	1.448	67	1.788
8	1.056	28	1.225	48	1.462	68	1.809
9	1.063	29	1.235	49	1.476	69	1.831
10	1.070	30	1.245	50	1.490	70	1.854
11	1.078	31	1.256	51	1.505	71	1.877
12	1.085	32	1.267	52	1.520	72	1.900
13	1.094	33	1.277	53	1.535	73	1.924
14	1.101	34	1.288	54	1.551	74	1.949
15	1.109	35	1.299	55	1.567	75	1.974
16	1.118	36	1.310	56	1.583	76	2.000
17	1.126	37	1.321	57	1.600		
18	1.134	38	1.333	58	1.617		
19	1.143	39	1.345	59	1.634		

For Liquids Lighter than Water. Baumé.

Deg.	Sp. Grav.	Deg.	Sp. Grav.	Deg.	Sp. Grav.	Deg.	Sp. Grav.
10	1.000	23	0.918	36	0.849	49	0.789
11	0.993	24	0.913	37	0.844	50	0.785
12	0.987	25	0.907	38	0.839	51	0.781
13	0.980	26	0.901	39	0.834	52	0.777
14	0.973	27	0.896	40	0.830	53	0.773
15	0.967	28	0.890	41	0.825	54	0.768
16	0.960	29	0.885	42	0.820	55	0.764
17	0.954	30	0.880	43	0.816	56	0.760
18	0.948	31	0.874	44	0.811	57	0.757
19	0.942	32	0.869	45	0.807	58	0.753
20	0.936	33	0.864	46	0.802	59	0.749
21	0.930	34	0.859	47	0.798	60	0.745
22	0.924	35	0.854	48	0.794	61	0.741

Twaddell's Hydrometer.

The degrees on Twaddell are converted into equivalent specific gravities by multiplying them by 5 and adding 1000; then mark off three figures as decimals.

Deg.	Sp. Grav.	Deg.	Sp. Grav.	Deg.	Sp. Grav.	Deg.	Sp. Grav.
1	1.005	8	1.040	15	1.075	22	1.110
2	1.010	9	1.045	16	1.080	23	1.115
3	1.015	10	1.050	17	1.085	24	1.120
4	1.020	11	1.055	18	1.090	25	1.125
5	1.025	12	1.060	19	1.095	26	1.130
6	1.030	13	1.065	20	1.100	27	1.135
7	1.035	14	1.070	21	1.105	28	1.140

CHAPTER XLVIII.

TABLE OF THE ELEMENTS OF MATTER, WITH THEIR SYMBOLS AND CHEMICAL EQUIVALENTS.

Elements.	*Symbol.*	*Chem. Equiv.*	*Elements.*	*Symbol.*	*Chem. Equiv.*
Aluminum,	Al.	14	Molybdenum,	Mo.	38
Antimony, (Stibium,)	Sb.	129	Nickel,	Ni.	30
Arsenic,	As.	75	Niobium,	Nb.	
Barium,	Ba.	69	*Nitrogen*,	N.	14
Bismuth,	Bi.	213	Norium,	No.	
Boron,	B.	11	Osmium,	Os.	100
Bromine,	Br.	78	*Oxygen*,	O.	8
Cadmium,	Cd.	56	Palladium,	Pd.	54
Cæsium,	Cæ.	123	Pelopium,	Pe.	
Calcium,	Ca.	20	*Phosphorus*,	P.	32
Carbon,	C.	6	Platinum,	Pt.	99
Cerium,	Ce.	46	Potassium, (Kalium,)	K.	39
Chlorine,	Cl.	36	Rhodium,	Ro.	52
Chromium,	Cr.	26	Rubidium,	Rb.	85
Cobalt,	Co.	30	Ruthenium,	Ru.	52
Columbium, (Tantalum,)	Ta.	184	*Selenium*,	Se.	40
Copper, (Cuprum,)	Cu.	32	*Silicon*,	Si.	22
Didymium,	Di.	48	Silver, (Argentum,)	Ag.	108
Erbium,	Er.	?	Sodium, (Natrium,)	Na.	23
Fluorine,	F.	19	Strontium,	Sr.	44
Glucinum,	G.	7	*Sulphur*,	S.	16
Gold, (Aurum,)	Au.	197	Tellurium,	Te.	64
Hydrogen,	H.	1	Terbium,	Tb.	?
Ilmenium,	Il.		Thorium,	Th.	60
Iodine,	I.	126	Tin, (Stannum,)	Sn.	59
Iridium,	Ir.	99	Titanium,	Ti.	24
Iron, (Ferrum,)	Fe.	28	Tungsten (Wolfram,)	W.	92
Lanthanum,	La.	44	Uranium,	U.	60
Lead, (Plumbum,)	Pb.	104	Vanadium,	V.	68
Lithium,	Li.	7	Yttrium,	Y.	32
Magnesium,	Mg.	12	Zinc,	Zn.	32
Manganese,	Mn.	28	Zirconium,	Zr.	34
Mercury, (Hydrargyrum,)	Hg.	100			

The Elements printed in italics are the Metalloids; the rest are the Metals.

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flow evenly, do not affect the surface of the paper, give a strong and bright result, and can be used by any body.

Price per Box of Eight Large Bottles, $1.50.

OUR OWN MANUFACTURE OF

COLLODION, VARNISH, and GUN COTTON,

FOR EITHER

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ARE ALL STANDARD ARTICLES WITH THOSE WHO HAVE TRIED THEM.

LIBERAL TERMS TO DEALERS.

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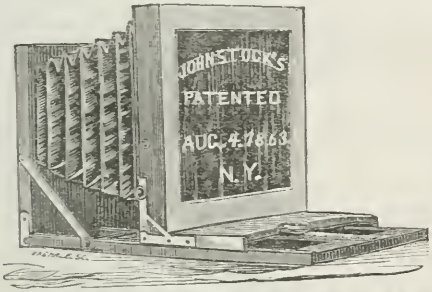
NEAR THE BOWERY,

NEW-YORK,

Beg leave to call the attention of Amateurs and the profession generally to their new patented and improved Camera Boxes, which consist of the following: the

IMPERIAL CAMERA,

For taking Pictures both in the Gallery and in the Field.



THE UNIVERSAL CAMERA,

For all kinds of work—single pictures, four on one plate, and for copying.

THE IMPERIAL FOLDING CAMERA,

For copying; adapted for field and gallery use.

STEREOSCOPIC CAMERAS,

Double and single, with the Patent Dry Plate Box; together with their adjustable

CAMERA TABLE.

This Table is the most useful and convenient article ever offered to the public, and is much admired by all first-class Artists. J. S. & Co. would especially introduce to your notice their **Patent Glass Bath**, universally adopted, and celebrated in every particular as the tested, perfect, and only reliable Glass Bath in the market. They would also call your particular attention to their new Patent

DRY-PLATE BOX AND CAMERA,

This Box and Camera has been thoroughly tested, and is admitted by those who are competent to judge, to be the best arrangement for field work ever introduced. They have also just patented an entirely new instrument,

THE EXCELSIOR CAMERA,

Differing from any thing heretofore known. The Camera is folding, with Baths attached, for taking pictnres in the field or drawing-room in direct sunlight, without the use of a tent or dark room. This instrument will not occupy more than six square inches when folded, including all the apparatus but the tripod. It is indispensable for taking instantaneous views or portraits of deceased persons. J. S. & Co. would also inform their friends and patrons that they continue to manufacture

Every style of Instrument used in Photography,

At the shortest notice, and every article is warranted.

E. M. CORBETT,

MANUFACTURER OF

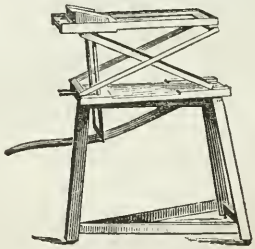
PHOTOGRAPHIC,

AMBROTYPE, AND DAGUERREOTYPE

APPARATUS.

Camera Boxes, Plate Holders, Camera Stands, and Printing Frames made in the Best and Cheapest Manner.

NEW IMPROVED CAMERA STAND!



THE GREATEST INVENTION OF THE DAY.

PATENTED JUNE 24, 1862.

Has an ingenious arrangement for elevating the Camera to any required height. Is in use in all the leading Galleries in this city and elsewhere. No operator can afford to be without one of these Stands.

ALSO MANUFACTURER OF

COLUMNS, PEDESTALS, AND RAILS,

SUITABLE FOR CARTES DE VISITE.

CAMERA BOXES,

With two or four Tubes for Stereoscopic and Card Pictures; all with the latest improvements; **cheap for Cash.**

REPAIRING DONE AT THE SHORTEST NOTICE.

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All orders thankfully received and promptly attended to.

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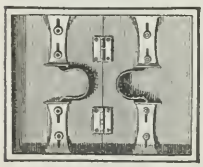
The undersigned would hereby call the attention of

PHOTOGRAPHIC OPERATORS AND AMATEURS

To the Newly-invented and Patented Printing Frame of Mr. J. E. Whitney, of St. Paul, Minnesota, an Operator of twenty years' experience and practice. There have been two or three styles of printing frames in the market, but none which gave perfect satisfaction. It took much time to open them; first, you open one side, and then the other, occupying a minute at least; but this frame can be opened in one second. It will be noticed, by the accompanying cut, that the cross-bars are separated in the centre by a semi-circular spring. By taking hold with the thumb and forefinger of each hand, and slightly pressing these springs, the cover is instantly removed. The edge of the lid is beveled, causing the ends of the bolts to operate as springs, which gives an *even* and constant graduated pressure, adjusting itself to the thickness as well as to all unevenness in glass. There is no possibility of *breaking negatives* in this frame as in the old kinds. All who have seen this Frame have bestowed upon it the highest encomiums. It is universally pronounced to be



THE BEST PRINTING FRAME

ever introduced, and must have an extensive sale. Arrangements are now being completed to manufacture them on a large scale. Parties wishing

THE WHITNEY PRINTING FRAME

will please send their orders to the undersigned, who have been appointed

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for the Inventor and Patentee. All persons are hereby cautioned against infringing on this patent in any manner, as the Agents are determined to protect the rights of the Inventor.

☞ All orders will be filled in rotation. ☜

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W. H. TILFORD,

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Ambrotype, Daguerreotype and Photograph

GOODS AND MATERIALS,

PHOTOGRAPHIC ALBUMS,

And all articles and apparatus appertaining
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CAMERAS,

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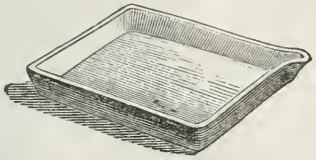
DISHES! DISHES! DISHES!



SOMETHING NEW AND USEFUL!

The Photographic Ware Baths having had such a continued popularity ever since their first introduction to the public some years since, the manufacturers, in order to oblige numerous customers, who have long been inquiring for DISHES to be made of the same materials as the Baths, have now the pleasure of offering their new style of

Photographic Ware Dishes.

Since their first introduction, a year since, the demand for these popular Dishes has been indeed unprecedented. They are driving out of the market all other kinds. In fact, many of the dealers neither offer nor recommend any other kind, for the very good reason that none others give satisfaction. Their advantages are patent. They will not crack or check as a porcelain dish is sure to do, nor will they drop to pieces, as we have seen the rubber dishes do, and they are entirely impervious to all acid solutions. They are very strong, and will last an operator as long as he continues in business. Do not fail to order the PHOTOGRAPHIC WARE DISHES, if you want to get the full value of your money. They can be had

FIVE DIFFERENT SIZES, NAMELY:

5 by 7.....$0 50	10 by 12.....$1 50
7 by 9..... 0 75	12 by 16..... 2 75
8 by 10..... 1 00	and other sizes will soon be furnished.

Thomas Sutton, Esq., Editor of the London *Photographic Notes*, says, "The Photographic Ware answers the purpose for Baths and Dishes admirably," and he ought to know something about them.

For Sale by all Stock-Dealers.

NEW-YORK, *September* 1, 1863.

PATENT

PHOTOGRAPHIC WARE BATHS

The Greatest Photographic Discovery of the Age.

MADE EXPRESSLY FOR THE

PURPOSE OF HOLDING SOLUTIONS

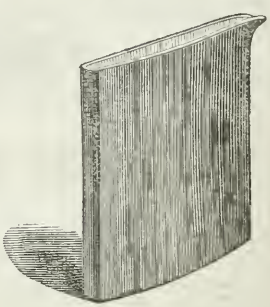
USED IN THE PRACTICE OF

Photography and Ambrotyping,

AND

THE BESTARTICLE EVER INTRODUCED

FOR THAT PURPOSE.



They can be had with or without the overflow, as may be preferred. They are also made to be used as field-baths, for out-door practice, and can be fitted with a cover, so as to be perfectly air-tight. They are found to possess every qualification that can be called for, besides innumerable advantages over any other in use. They hold the least quantity of solution, being made very thin. They will not burst and let out the silver solution like the gutta-percha bath. They will not turn the solution black, as will the rubber bath. They will not check like the porcelain, nor crack from changes of temperature, like the glass baths. They are entirely impervious to all acids, will withstand all atmospheric changes, are made by a scientific man on strictly scientific principles, and will last a lifetime. Is anything more required of a bath?

CERTIFICATES! CERTIFICATES!!

There are no arguments like these. Where persons have used the Photographic Ware Baths and indorse them thoroughly, their testimony convinces the most incredulous. Read the following:

From New-York City Operators.

"I would say—for the benefit of the Photographic and Ambrotype profession generally—that for over three years past I have used, and at the present time am using, in my three establishments in New-York City, no other kind of Bath than the one described above, and believe it to be the best and only reliable article now in use. I have tried all others, and none, except the Photographic Ware, was without objection. I feel confident that all who may give them a trial will never have cause to regret it. I have now seven in daily use, which any one so disposed can see by calling at my establishments.

"J. H. YOUNG, 145 and 198 Eighth Avenue, N. Y."

"371 Broadway, New-York.

"Having used the Photographic Ware Bath since its first introduction, I have the utmost confidence in its utility, and consider it by far the best article now in use for holding the solutions required in the practice of the photographic art. I find it perfectly safe and free from all liability to crack or check like the common porcelain in market, and it will not cause any stain or destroy the silvering solution, which so often occurs when the gutta-percha or India-rubber Baths are used. I can not recommend the Photographic Ware Baths too strongly to the favorable consideration of all who wish a safe, reliable, and perfect article

"C. W. GRAY."

From a Southern Operator.

"I have been using the Photographic Ware Baths in my establishment ever since their introduction, having been the purchaser of the very first one sold. Time has shown that these Baths are perfectly unexceptionable. I consider them to be every thing that the Photographer can desire. For no consideration would I be without them, or return to the use of gutta-percha or porcelain—having seen enough trouble with them before the introduction of the Photographic Ware. B. P. PAGE, Proprietor of Plumb Gallery,
Washington, D. C."

"As Operator for Mr. Page, I have daily witnessed the advantages and superiority of the Photographic Ware Baths, and cheerfully indorse the above. JOHN GOLDIN."

From Western Operators.

"——, Illinois, June 11.

. . . . "You ask how I got along with the Photographic Ware Baths. They sell first-rate. I have some orders for No. 3, field, without the overflow. I sell six of the Photographic Ware Baths to one of any other kind. Yours truly, P. JOHNSON."

"——, Ohio, Oct. 5.

. . . . "Don't fail to send me a lot more of those Photographic Ware Baths with the next goods you ship. My customers have got a taste for them, and nothing else will go down. One Operator says he has saved over fifty dollars by their use already; he is not afraid of bursting and letting out the silver, as his old gutta-percha one did. And then they are so cheap! I shall want one dozen each of Nos. 1, 2, and 3, and six of No. 4. JOHN H. FISHER."

"I have just been witnessing the use of the Photographic Ware Baths, which I can not do without; send one of No. 4, and I'll make you a present of my Porcelain Bath—that is, if you will pay express charges on it to your city. L. B. BARNES."

Extract from the London Dictionary of Photography, (*by Thomas Sutton, Esq., the Editor of* Photographic Notes,) page 131:

. . . . "Porcelain Baths are very objectionable, as nitrate of silver acts on the glaze. There is a substance used in America for baths and dishes called PHOTOGRAPHIC WARE, which resembles Wedgewood Ware, and has no glaze; this answers the purpose admirably."

Extract from Humphrey's Journal, *No. 5, Vol. XI.*

"The Photographic Ware Baths were first made by George Mathiot, Esq., of the United States Coast Survey Office, Washington, for his own use. A friend of his, an artist, was struck with their neatness, durability, and cheapness, and also their special adaptation to the use to which they were put. He advised Mr. M. to take out a patent for them at once, which he did, and now the whole Photographic fraternity have the benefit of them at about one half the price of any other kind of bath. Those who have tried them once will never again return to glass, porcelain, or gutta-percha, each of which is objectionable, besides costing twice as much."

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1-4	$0 75	9 by 11	$3 00
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They can be had of all Stock-Dealers in the United States, and in New-York of the following houses:

HOLMES, BOOTH & HAYDENS;
SCOVILL MANUFACTURING COMPANY;
EDWARD & HENRY T. ANTHONY;
J. W. WILLARD & CO.

New-York, *September* 15, 1863.

HUMPHREY'S
Journal of Photography.

EDITED BY JOHN TOWLER, M.D.

Published Semi-monthly, and containing annually 384 pages of Original and Selected Matter, prepared with the greatest care. This Journal is devoted to the interests of the Operator, and has for years past been widely known as the best and most valuable publication treating on the Heliographic Arts. It was established November 1, 1850, and is consequently the oldest Photographic Journal in the world. It has always been considered a most reliable medium for obtaining information on every thing relating to the art of *Sun-drawing*, and no pains or expense will be spared to enable it, for the future, to maintain its high and commanding position.

The present Editor holds an eminent position as a scientific writer and a practical photographer, and he is one who can reach and interest Operators in a way that few writers in this country are able to do. He will aim to extricate Photographers from their numerous troubles and perplexities, and especially so through the medium of "Answers to Correspondents," which department of our Journal will be found full, complete, and satisfactory.

NOTICES OF THE PRESS.

We insert here a few of the many commendatory notices of *Humphrey's Journal* given by the Press of the United States and England:

"We have received a copy of a valuable Journal (Humphrey's) published in New-York, which has reached the 18th No. of Vol. XI. . . . . We now have the pleasure of quoting from our transatlantic coadjutor."—*Liverpool Photo. Journal.*

"*Humphrey's Journal* is practical as well as scientific in charater."—*American Journal of Science and Arts.*

"It treats the subject knowingly and with force."—*New-York Tribune.*

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"It is highly useful to all who practice 'shadow-catching.'"—*Ohio State Jour.*

"The work is neatly gotten up, and contains many interesting varieties in this new field of science."—*Times.*

"It should be hailed and encouraged, not only by photographers themselves, but by every lover of science and art."—*The Democrat.*

"We can not too strongly urge all artists, and those persons who feel an interest in the heliographic arts and sciences, to take a copy of the work."—*Sentinel.*

"It is indicative of talent worthy of the important art it is designed to elevate."—*American.*

"This art is entitled to its own organ, which could not have fallen into better hands than those of the Editor of *Humphrey's Journal.*"—*Transcript.*

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"It teaches us how to take our own portraits."—*Bee.*

"It will cultivate a taste for photographs."—*Commercial Advertiser.*

"It should be in the hands of all."—*Reveille.*

"It is the photographer's friend."—*London News.*

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FOR

Saving Silver and Gold

FROM WASTE SOLUTIONS.

PATENTED JULY 8th, 1862.

According to experiments made in this country and Europe, analyzing Negatives and Photographs, it is found that only a minute portion of the Silver used enters into the picture, nine tenths or more being wasted during the various manipulations. The Editor of one of the leading British journals, (the *Photographic News*,) in an article upon the subject, takes occasion to remark that not one tenth part of the Silver used enters into the picture, while Prof. Seely, Editor of the *American Journal of Photography*, states the amount at less than one hundredth part. A very large proportion of this waste Silver can be saved by using this Apparatus, and I think, judging from present results, that I am fully justified in estimating that from one half to three quarters of every pound of Nitrate of Silver used can be saved.

Mr. J. Shaw, the inventor, having placed the entire management of the business in my hands, I now make the following very

LIBERAL OFFER.

I will furnish the most important part of the Apparatus **free**, with full instructions, so that every operator can fit up the Apparatus ready to connect with the waste-pipe, at a cost which should not exceed two dollars, and when making returns from the first refining, I will refund this **two dollars** over and above the operator's share of the refinement, thus practically **furnishing the Apparatus free.** If I refine only such waste as the Apparatus saves from developing Ambrotypes and Negatives, (hitherto a dead loss,) I will return half the proceeds of the same ; but if the operator, in addition to the above, will save and forward to me all the other waste, (the instructions for saving which shall be simple, and the cost merely nominal,) I will refine all without cost, and return three fourths the proceeds of the refinement, retaining one fourth for rent of Apparatus and refining.

Mr. M. B. Brady, of this city, and other eminent Photographers in the country, are fully satisfied it is what every operator should have in his chemical room, also with my responsibility to carry out the provisions herein mentioned.

O. S. FOLLETT,

With Scovill Manufacturing Company,

4 BEEKMAN ST., N. Y.