THE DICTIONARY OF PHOTOGRAPHY

FOR THE

Amateur and Professional Photographer.

BY

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REVISED AND BROUGHT UP TO DATE BY

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Illustrated by many specially prepared Diagrams.

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PREFACE

TO THE SEVENTH EDITION.

THE present edition contains about one hundred and fifty pages of new matter, and three hundred fresh headings; also between twenty and thirty new diagrams—these additions being necessitated by the rapid advance of photographic technics.

Notwithstanding these considerable additions, the bulk of the volume has not been considerably increased, as much overlapping matter—or partially overlapping matter—has been eliminated; and this without disadvantage to the reader, as cross-references have been inserted where required.

The Appendix, which, in the sixth edition, formed nearly one-third of the whole book, has been incorporated with the alphabetical portion—a change which will facilitate reference, as it brings all matter into one sequence.

The omission of metric equivalents from the formulæ may appear at first sight to be an undesirable retrogression; but, if so, it is a retrogression which will make the book more convenient for that very large majority who only use the British weights and measures; an addi-

tional column of figures not unfrequently leading to confusion and error.

Those who prefer to use the metric system in compounding their photographic preparations, will probably rather gain than lose by the change, as the tables given in the article WEIGHING AND MEASURING will enable them to effect the necessary conversions with any required degree of accuracy. In giving equivalents of the English weights and measures according to the metric system, very inconvenient quantities, expressed by many figures, are generally necessary if exact equivalence or strict proportion is to be secured; while, on the other hand, the giving of approximate figures may be adopted for the sake of simplicity of expression. Each course is about equally undesirable, and liable to cause inconvenience.

In very few cases, where work of considerable delicacy is involved, and the original instructions were given according to the metric system (*e.g.*, in case of emulsion for the Lippmann process), the original figures have been retained.

THOMAS BOLAS

LONDON, *March* 1897.

In practice, very much depends upon the chemical activity of the developer, and on the rapidity with which it penetrates the film. Moreover, no developer is equally at its best with all plates; so the speed numbers given on pp. 272 and 273 should be considered as largely depending on the method of development, and hence are not strictly comparable.

DICTIONARY OF PHOTOGRAPHY.

A. In chemical nomenclature, *a* as a termination generally indicates the oxide or hydrate of an earthy or alkaline metal; as alumin-*a*, lithi-*a*, potass-*a*, stronti-*a*, or magnesi-*a*. Also as a termination for the names of alkaloïdal organic compounds, as morphi-*a*, but in this latter case the syllable *-ine* is now often used, as morph-*ine*. As a prefix in scientific and technical names *a* signifies negation from the Greek privative prefix *a*; as chromatic having relation to colour, *a*-chromatic not having relation to colour.

A.A. In recipes, especially those in which a Latinoid form is more or less preserved, *a.a.* after the mention of several ingredients stands for "of each one take." Thus :—

Water ...	...	...	...	... 1000 grammes.
Hyposulphite of soda				
Acetate of ammonia, *a.a.*	...	...	100	,,
1 per cent. gold solution	...	...	2	,,

a.a. in this use is generally considered to be an abbreviation of the Greek *ava* in the sense of throughout.

Abaxial. In optics, not coincident with the axis.

Aberration. In optics, aberrations (*aberro*, I digress), are such departures from the ideal performance of a lens or mirror as are inherent to the construction, and thus become matters of compromise rather than complete eradication. The performance of photographic lenses is more or less marred by five kinds of aberration :—Chromatic aberration, spherical aberration, distortion, curvature of field, and astigmatism. The image formed by a pinhole, used instead of a lens, although unsharp, is not affected by any one of the above aberrations, to minimise which is the chief difficulty of the constructor of lenses. Pinhole workers

occasionally introduce something often called astigmatism, although widely different from the astigmatism of a lens, by using a slot instead of a round hole. Some of Mr. Dallmeyer's lenses, in which spherical aberration is corrected to the utmost, are so mounted that the user can disturb the correction should he wish to do so. Hence it will be seen that aberrations, if properly understood, may occasionally be of service to the worker. (See the aberrations under their respective headings: also LENS; PINHOLE; SHARPNESS; SPECTACLE LENSES, THE USE OF; and VISION.)

Absolute Alcohol. See ALCOHOL.

Absolute Temperature. It has been assumed that at a temperature of $-273°$ C., or $-459°$ F., heat would be entirely absent and no further cooling would be possible. On this assumption temperatures reckoned from the absolute zero are called absolute temperatures. Thus 75° C., as ordinarily reckoned, would be 348° C. on the absolute scale. (See THERMOMETER and THERMOMETRY.)

Absolute Zero. See ABSOLUTE TEMPERATURE.

Absorption. In optics, the partial destruction of light in passing through a medium: for example, a blue glass may absorb all rays but the blue rays, these latter being transmitted. Also the destruction of light by an opaque body, another form of energy (generally heat) being produced.

Accelerator. A term applied to any substance which is used to shorten the duration of development and to obtain the impression of the slightest impact of actinic light. Thus, in alkaline pyro development the alkali is regarded as the accelerator, and with ferrous oxalate, hyposulphite of soda has been recommended. A few drops of a weak solution of hypo have a wonderful effect in bringing up detail in an instantaneous negative; indeed, the addition of hypo to ferrous oxalate developer is stated to materially shorten the time of exposure, but it is doubtful whether the action is not rather limited to producing a visible image of every ray of light, which may not be the case with ordinary development. (See also DEVELOPMENT, and DEVELOPERS.)

Accessories. See PORTRAITURE.

Acetate of Amyl. See AMYL ACETATE.

Acetate of Copper. See COPPER ACETATE.

Acetate of Lead. See LEAD ACETATE.

Acetate of Silver. See SILVER ACETATE.

Acetate of Soda. See SODIUM ACETATE.

Acetates are salts formed by the reaction of metals or their oxides with acetic acid; the hydrogen of the acid being replaced by the metal. A table giving the specific gravities of solutions of the more important acetates of different strengths will be found under the heading HYDROMETERS and HYDROMETRY.

Acetic Acid (Ger., *Essigsäure;* Fr., *Acide Acetique;* Ital. *Acido Acetico*). Formula, $HC_2H_3O_2$; molecular weight, 60; synonym, Purified Pyroligneous Acid. The earliest known acid. In dilute form as vinegar by the fermentative oxidation of alcohol, but now largely prepared from wood by destructive distillation and subsequent purification. There are three commercial strengths.

Glacial Acetic Acid contains about 99 per cent. of acid and 1 per cent. of water. Its specific gravity varies from 1·065 to 1·066. When cooled to 34° F. it solidifies into a mass of crystals, and remains solid till the temperature is raised. From this property is derived the term glacial. Care should be exercised in handling this, as it is a powerful escharotic; if any should by chance be spilt upon the naked skin, it should be washed off immediately. It is a poison, by reason of its caustic properties—the obvious antidote is chalk, lime, or other alkalies; but caution should be exercised lest the antidote should be worse than the poison. It is miscible with water and alcohol in all proportions, and is a solvent of pyroxyline.

Commercial "Strong" Acetic Acid. This is one-third the strength of the glacial acid, containing about 33 per cent. of real acid. It can be conveniently prepared from the glacial acid by mixing with it twice its own quantity of distilled water. It is sometimes known as "Beaufoy's Acetic Acid." Specific gravity, 1·044.

Dilute Acetic Acid. Made by mixing 1 part of acetic acid and 7 parts of distilled water, and sold as "distilled vinegar." Specific gravity, 1·006. It contains about 3·63 per cent. of acid. The impurities in the acetic acids may be sulphurous acid or tarry matter, hydrochloric acid, or sulphuric acid. Samples sold for photographic use are, however, usually sufficiently pure. Any sample which gives a precipitate when a drop of strong silver-nitrate solution is added to one-fourth of an ounce, or which becomes discoloured when the mixture is exposed to the light, should be rejected. One convenient and easy way of approximately testing the strength of acetic acid is by determining the specific gravity by a method explained in the article HYDROMETERS and HYDROMETRY, and then referring to the special table which is given for the strengths of acetic acid; but an irregularity there noted renders this method subject to error in certain cases.

Acetone. Formula, C_3H_6O, or di-methyl-ketone. A volatile liquid having a pleasant ethereal odour, prepared by the dry distillation of acetates—calcium acetate, for instance. Acetone mixes with water or alcohol in all proportions, boils at about 57° C., and can be used as a substitute for alkali in the developer, as shown by Lumiere and Seyewetz. (See DEVELOPMENT and DEVELOPERS.) Acetone is a powerful solvent of most resinous substances, and it also very readily dissolves pyroxyline; hence is of special use in repairing articles made of celluloid, the edges being well softened by acetone and pressed into close contact unite firmly, and when dry the article may be as good as if unbroken. Small baths, dishes or protective casings may be easily made from old celluloid films by taking advantage of the softening action of acetone on celluloid.

Aceto-Nitrate of Silver. A mixture of acetic acid and solution of nitrate of silver, used in calotype and some of the earlier processes.

Acetylene. Formula C_2H_2. A gaseous hydrocarbon, obtained by E. Davy, in 1836, by treating an impure carbide of potassium with water; and somewhat later by Wöhler, who obtained it by the action of water on carbide of calcium. Acetylene is formed in many reactions, one of the most interesting being by the

direct combination of carbon and hydrogen at a high temperature as, for example, when an electric arc is produced in hydrogen. Acetylene is remarkable among hydrocarbons as containing stored in itself a large excess of energy, usually referred to as heat; hence such a substance is called endothermic. By virtue of its endothermic nature it is very ready to enter into reaction with other substances, and can, under certain conditions, explode under the shock of a fulminate cap much in the same way that nitroglycerine explodes, the hydrocarbon being resolved into carbon and hydrogen. Such detonation is violent in proportion to the pressure, and appears only likely to be comparable in destructiveness with a nitroglycerine explosion when the acetylene gas is compressed to a liquid, which at the freezing point of water requires a pressure of about 725 lb. on the square inch. A feeble passage of detonation all through the gas has, however, been noticed under a total pressure of two atmospheres; that is to say, a pressure of about 14 lb. on the square inch, as an engineer would ordinarily reckon it, or counting only the additional pressure beyond the normal pressure. In January, 1895, the use of acetylene as an illuminant was first discussed in the photographic papers, and about a year later calcium carbide was quite easily obtainable in London. Photographers began to

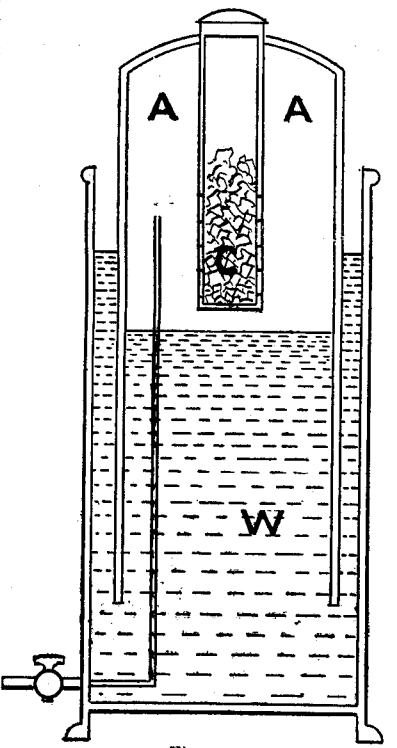


Fig. 1.

experiment, and automatic generators, on the principle of Döbereiner's hydrogen lamp, became common. Mr. Cecil Hepworth, in the *Amateur Photographer*, gives the subjoined sketch as representing the essential features of the usual type of generator. "The calcium carbide is placed in a perforated cage C, and as the water comes in contact with it acetylene gas is generated and the bell A A rises, lifting the cage out of the water, and the action stops (or would stop if the apparatus were absolutely automatic) until some of the gas is drawn off." As regards the automatic character, Mr. Hepworth says:—"As a matter of fact, in a generator of this description the evolution of gas does not altogether cease when the tap is turned off, for calcium carbide—like quicklime—has such an affinity for water that it will suck up moisture in the gas around it (thereby forming new gas), and as it does so fresh moisture continually rises from the water below. This goes to form more gas, and so the generation continues—very slowly, it is true, but surely, nevertheless—until in time the edge of the receiver will be lifted above the water level and the superabundant gas will bubble out beneath. However for such work as the lantern user requires, where gas is to be supplied exactly as it is wanted for two or three hours at a stretch, after which the instrument can be set aside, such a generator as this is all that is required." Such a generator as the above cannot compress the gas to anything like that pressure known by experiment to be dangerous, and as made by Messrs. Thorn & Hoddle, of Camberwell, offers considerable advantage to those wishing to use acetylene for the lantern or as an illuminant for portraiture in the evening. For the optical lantern, Messrs. Thorn & Hoddle employ two very small Bray's fishtail burners, one set behind the other and the flat of the flame towards the condenser. If No. ooo burners are used, each consumes about one cubic foot an hour, and gives a light of about thirty-candle power. Messrs. Thorn & Hoddle's device for portraiture consists of twelve of the small burners arranged in a paraboloid reflector of sheet metal, painted white inside; and as all the burners may be supplied with gas by an india-rubber pipe a little over three-eighths of an inch in diameter, the apparatus may be readily moved or adjusted as required—a matter of some importance, as in using artificial light it is very undesirable to have the illuminating device so immovable that one has rather to adjust the sitter to the light

than the light to the sitter. Brass fittings, or fittings of any copper alloy, are more or less attacked by acetylene, and the product is highly detonative; but the risk of forming considerable quantities of the detonative compound appears only to be notable when the acetylene acts on metal already corroded by other agencies; pure acetylene acting on clean copper or brass merely yielding a bronze-like film so thin as to be harmless, this film being protective in its nature. Putting aside the moot point whether brass fittings should be used with acetylene, old and corroded gas fittings should by no means be used. If acetylene is allowed to bubble through nitrate of silver solution, with or without ammonia, a grey deposit is formed, which, when dry, is highly detonative. Although the use of acetylene under low pressure does not appear to be more dangerous than many other operations connected with photographic practice, it should be borne in mind that there is a potentiality of danger, and a full realisation of this is the chief factor in safety. Care should be taken not to inhale acetylene, as it appears to be absorbed by the blood and to produce toxic effects similar to carbon monoxide, and when mixed with air it has a longer range of explosibility than other hydrocarbons. The kindling point of acetylene is low —480° according to Le Chatelier—another fact to be remembered in working with it.

Achromatic (*a*, prefix signifying negation, and *χρωματικος*, coloured), when applied to a lens, signifies that it has been partially corrected for chromatic aberration, and that the images projected by it are unaccompanied by fringes of various colours. The correction is usually effected by combining two glasses having differing refractive powers, as, for instance, a convex crown-glass lens with a concave flint-glass, or by enclosing a flint meniscus between two concavo-convex. There are several methods, but the latter is the usual method employed for the rapid class of lenses now so much in vogue. (See LENS.) A more completely corrected lens is styled apochromatic. (For the theory involved in rendering lenses achromatic, see DECOMPOSITION OF LIGHT.)

Acidity, or sourness. A frequent property of acids, though not invariably a characteristic (see below); moreover, many substances which are not acids within the usual definition are sour,

Paper stained with blue litmus is a common test for acidity, an acid liquid giving it a reddish tint. Alkalies or alkaline substances restore the blue colour.

Acids may be defined as compounds of hydrogen whose atom or atoms of hydrogen are replaceable by metals, or by radicals having metallic characteristics, and the compound resulting from such substitution is termed a salt. Acids, as the term is now understood, are not necessarily sour, even though they be soluble. (See ACIDITY above.)

Acid-Sulphite Fixing Bath. The use of a sulphite and a free acid in the fixing bath for negatives was shown some years ago by Lainer to be a useful expedient for removing the yellow tint resulting from pyrogallic development, and acid fixing baths are now very commonly used in fixing negative plates, it being generally considered that greater clearness and brightness results than when the simple hyposulphite bath is used. Professor Eder's method of preparing the acid fixing bath is perhaps the most convenient for general use, and is as follows:—

Hyposulphite of soda solution 1 to 5	...	2 pints.
Sodium sulphite solution 1 to 4 ...	...	2½ fl. oz.
Tartaric acid solution 1 to 2 ...	...	¾ „

Mix the sodium sulphite solution with the tartaric acid solution and then add to the hyposulphite. The above is almost equivalent to adding bisulphite of sodium to the hyposulphite solution, but for occasional use has the advantage of being perhaps more certain, as the simple sulphite of sodium is less liable to change by keeping than is the bisulphite. When bisulphite is used the following formula proves satisfactory:—

Hyposulphite of sodium	...	...	...	4 oz.
Bisulphite of sodium	...	...	...	1 „
Water	...	...	...	20 „

Large consumers may advantageously use a concentrated solution of sodium bisulphite saturated with sulphurous acid gas, which is manufactured for use in bleaching works. That made by Messrs. Nashold of Aussig, Bohemia, and sold by them as acid-sulphite lye (*saure sulphite lauge*), is specially recommended by Dr. Eder as being more convenient—better and

cheaper than the first-mentioned preparation. One litre (about 35 fluid ounces) of the ordinary fixing bath, as made by dissolving one part of hypo in 4 parts of water, is mixed with 50 cubic centimetres (or about 1¾ fluid ounces) of the acid-sulphite lye, and the bath is ready for immediate use. Even after the bath has become brownish, it may be restored by a fresh addition of the acid-sulphite lye, and continues to do its work quickly, giving clear, quick printing, and brilliant negatives. An acid-sulphite bath without hyposulphite may often be used with advantage to clear such negatives as show a yellow tint or stain. A fluid ounce of the acid-sulphite lye, or ½ oz. of crystals of bisulphite of sodium, with from 4 to 8 ozs. of water, is acidified with sufficient sulphuric acid—say ½ a fluid drachm—to liberate sulphurous acid abundantly. In this bath the yellow negative is soaked until the stains disappear, after which it is well washed.

Actinic (*ακτινος*, genitive of *ακτις*, a ray, especially of the sun) applies to that portion of light which effects chemical change, in distinction to those portions which furnish light and heat. The actinic portion of the spectrum may be said to be confined to the ultra-violet, violet, indigo, blue, and green; not, as might be supposed, to that portion which appears to us to be the most powerful—viz., the yellow. But the division is entirely arbitrary, as it depends solely upon the substance exposed, as to which rays are actinic or non-actinic.

Actinic Focus of Lens. See Focus.

Actinograph—Actinometer (as above, with *γραφω*, I draw or write; or *μετρὸν*, a measure). Any instrument which measures the actinism of the sun's rays. It usually consists of sensitive paper, which can be exposed to the light in small portions at a time; and the time which it takes to darken to a standard tint will be found to bear a distinct relation to the necessary exposure required for a sensitive film, whether upon glass or paper, due allowance being made for the presence of any object of importance near the foreground of picture. An actinometer can be made by any amateur by soaking a strip of gelatino-bromide paper in a 2 per cent. solution of nitrite of potash, drying the same in the dark. When dry it should be rolled up small and placed in the inside of a box which is light-

tight, and from which the paper can be drawn in small pieces to allow of its exposure to light and comparison with a standard tint, which can be obtained by exposing a plate on a subject the exposure of which is known, and at the same time exposing the actinometer and noting the time of the darkening of the paper to a certain tint. Supposing the correct exposure of the plate to be 3 secs., and it is found that the paper takes 30 secs. to darken, it is obvious that dividing the actinometer time by 10 will give the correct exposure, with a certain stop and class of picture, from which the others can be calculated. Ordinary albumenised paper, which owes its darkening properties to chloride of silver, is sometimes used, and, although the results, with certain modifications, are some guide, it is obviously unfair to calculate the exposure of bromide of silver from the action of chloride. The term Photometer (*q.v.*) is sometimes, but erroneously, applied to such an instrument. Under the title of "Actinograph" Messrs. Hurter and Driffield have devised a system of cylinder and slide rules for determining exposures in conjunction with their system of plate speeds. For details of this and other instruments see EXPOSURE.

Ad. The Latin preposition *ad* is often used in recipes in the sense of "until," or "up to," to signify the making up to a prescribed volume or weight. Thus, after the mention of soluble ingredients, "water *ad* 1 pint," would mean sufficient water to make the ultimate volume 1 pint. Making solutions, rather with the solvent up to a given volume, than by adding a given volume is obviously desirable in all dosimetric operations in which the fluid is ultimately to be measured rather than weighed, as the volume of a liquid is affected by solids dissolved in it. (See SOLUBILITY and SOLUTIONS.)

Adapter. When using two or more lenses of different sizes it is necessary either to have a separate camera front for each lens, or else, by the aid of smaller supplementary flanges, to screw the lens into the largest flange. These supplementary flanges are called adapters; the term has also been applied to a supplementary bellows, which, affixed to the back of a small camera, allows a larger plate to be used. A convenient method of extemporising an adapter is thus given in the *Amateur Photographer*:—"From the unprinted edge of a newspaper—preferably

one of soft texture—cut several long strips of paper about half an inch wide. Using the lens tube as a mould, and some flour-paste, or starch-paste, form the long strips of paper into a ring of such thickness that its smaller diameter firmly grasps the lens thread and its outer diameter is a trifle larger than the flange to be adapted. The first strip of paper round the screw threads should fit rather tightly and be well pressed into the screw threads. It will contract a trifle on drying. When the adapter is dry the outer thread may be cut by using the flange intended to be used. This, however, requires a little patience and care, and must not be attempted until the paper ring is quite dry and hard." A still more rapidly extemporised adapter is a strip of flat indiarubber cut to such a length as to form a ring with a butt join, which will lodge securely in the flange by virtue of its elasticity. When this kind of adapter is used it is generally best to allow the rubber to grip the middle of the lens tube, rather than the screw at one end.

Adiactinic. (See ACTINIC.) A term sometimes applied to red or yellow media for the dark-room window. No light is completely non-actinic.

Aerial Perspective. A term used to denote the idea of distance in a landscape or photograph of the same, which depends upon the obstructive or dispersing influence of the atmosphere; although minute particles in the atmosphere, which particles themselves become illuminated and radiate light, are doubtless a factor.

Aerial Photography. See BALLOON and KITE.

Aerial Screen. Transparent screens for lantern effects date from the time of Kircher who used smoke. M. Philipstal gave striking exhibitions in London, 1802, of a scene representing a witch's cave, a fine curtain of gauze let down in front, receiving images of lightning flash, ghosts, and moving figures. M. Fourtier's plan of a whitened lath rapidly moved up and down, or Mr. Bruce's plan of revolving the lath by a machine, may in some cases give a better aerial screen than the device of Philipstal, but rapidly moving objects in darkened places may be a source of danger.

Aerograph. See AIR BRUSH.

Agar-Agar (Ger. and Fr., *Agar-Agar;* Ital., *Alga di Giava*). This is vegetable gelatinous material obtained from species of white seaweeds (*Fucus spinosus*, or *Gelidium corneum*), common on the coasts of Singapore and Straits Settlements. It has been suggested as a substitute for gelatine, but is liable to give emulsions which are full of transparent nodules. Rebikow has suggested a method of eliminating these nodules, but there appear to be no advantages which warrant its recommendation as a substitute for gelatine.

Agate Burnisher. An obsolete device for burnishing silver prints. In shape the agate burnisher commonly used was somewhat similar either to a shorthanded spade or household meat-chopper. An agate burnisher is sometimes useful in smoothing over parts which have been spotted out or worked on with colour.

Agent. That which has the power of acting, or producing effects, upon anything else—*e.g.*, light is said to be the agent which impresses the image upon a sensitive plate, and the developer the agent which makes such image apparent. In the strict or metaphysical sense no one of those antecedents which are essential to the result can be selected and called the agent.

Air Bells, or **Air Bubbles.** These annoying defects are liable to make their appearances in out of the way places where they are not wanted. They may occur in the glass support, and if of not large size, and in the face or other prominent part of the picture, may be ignored or touched out on the prints. Air bubbles in the emulsion itself sometimes occur, and give rise to small spots of bare glass, which may be touched out with a brush or pencil before printing from the negative. Air bells in the developer frequently adhere with great tenacity to the gelatine film, and give rise to places of less density than the surrounding parts, or even clear glass. It is always advisable to pass the fingers over the plate when first covered with the developer, or a flat, soft camel's-hair brush may be kept for this purpose. If a brush be used care must be taken that it is well washed after use and does not come into contact with any chemical or foreign matter, which would cause streaks on the finished negative.

Air Brush. This is an American invention, by means of which liquid colours can be applied to enlargements and prints.

Air is pumped by means of a foot-blower through a chamber terminating in a fine orifice, the liquid colour being led to the opening by a movable needle or fine tube, where it is converted into a fine spray by the blast of air. A new and more portable form of air brush, similar in form to a pencil, is known as the aerograph. A form of air brush is now occasionally used in painting large surfaces, especially when they are irregular, and the ordinary methods of painting would be troublesome. An air brush may be used in vignetting negatives and in painting backgrounds. The principle of the air brush has been applied to the coating of glass plates with emulsion and to the coating of paper with photographic preparations. With proper precautions and suitable adjustment of the fineness of the spray, it gives an even and not granular coating; but allows of adjustment by which any required degree of granularity can be obtained.

Alabastrine Process. An old process for improving the colour of wet collodion glass positives. It can be applied to gelatine negatives in the following manner (absolute freedom from stains and hypo being a *sine quâ non*):—Soak the negative in clean water till thoroughly moist, and then in following solution: perchloride of mercury, 40 grs., dissolved in pure hydrochloric acid, 1 drm.; chloride of sodium, 20 grs.; sulphate of iron, 20 grs.; distilled water, 2 ozs. Allow the positive to soak till thoroughly bleached; wash, dry, and varnish the back with matt black varnish, or back with black velvet.

Albertype. See COLLOTYPE.

Album. Literally, anything white. Now used in the sense of a blank book, either with openings for the reception of photographs, or blank pages to which they may be affixed.

Albumen. An organic principle found in both the animal and vegetable kingdoms. The purest form in which it can be obtained, and the one in which it is used photographically, is the white of egg, its chief use being the preparation of albumenised paper. It may be obtained commercially in a dry form, which is convenient for such purposes as the albumen substratum.

Albumen Process. The finest, but most difficult, of all processes that are used for lantern-slide making. The plates

are slower even than gelatino-chloride plates, and are therefore especially suitable for contact printing; but the delicacy of results, the fineness of the deposit and the transparency of the shadows gives it a high place. Glass plates are first thoroughly cleaned by brushing with nitric acid and water, rinsed in distilled water, and allowed to dry spontaneously; they are then edged with solution of indiarubber in benzole, and coated with an old "sherry-coloured" collodion. As soon as the film has set immerse in distilled water till all greasiness has disappeared; it is then ready for albumenising. Take 10 ozs. of the whites of new-laid eggs, from which the germs have been removed, and add gradually, with constant stirring, 1 oz. of distilled water, to which 30 mins. of glacial acetic acid have been added. Cover with a piece of muslin, or soft linen, and set aside for twenty-four hours in a cool place. At the expiration of this time remove the coagulated scum, and filter the albumen, when it is ready for the iodiser.

Ammonium iodide	50 grs.
„ bromide	5 „
Liquor ammonia ·880	35 mins.
Distilled water	1 oz.

Add this to the albumen and filter. The plate is coated with the iodised albumen and drained, and a second coating of albumen applied. The plate is then allowed to dry spontaneously, or by a gentle heat, the latter being preferable. The plate is now ready for sensitising, and as in this condition it will keep indefinitely a stock may be prepared. The plates are sensitised in a dipping-bath as in wet collodion, the following being the sensitiser :—

Nitrate of silver	480 grs.
Distilled water	10 ozs.
Glacial acetic acid...	1 oz.

Dissolve and add—

Potassium iodide	2 grs.

Shake well, allow to stand for half an hour, and filter. The plates must be sensitised in yellow or orange light, and should remain in the bath for about half a minute in summer to one minute in winter. After sensitising, place in a dish of distilled water for five minutes, wash under the tap, and dry. Plates thus prepared will keep, under proper conditions, for several

weeks. The exposure, which should always be to daylight, will be about 30 to 40 seconds under a negative of average density. The developer is as follows :—

No. 1.

Pyrogallol	40 grs.
Acetic acid	35 mins.
Distilled water	10 ozs.
Citric acid	12 grs.

No. 2.

Silver nitrate	12 grs.
Citric acid	12 ,,
Distilled water	2 ozs.

For use add two or three drops of No. 2 to No. 1. Before development give the film an edging of rubber solution, and place in a dish of warm distilled water for one or two minutes. Place the developer in a porcelain dish, and heat gently by the aid of a spirit lamp to 100° F. ; place the exposed plate in the hot developer, and the image will gradually appear and gain density, this being accelerated, if desired, by the addition of more No. 2. The developer must be maintained at the above temperature, although errors in exposure may be compensated for by using a developer of higher or lower temperature. When sufficiently dense it may be fixed in—

Hyposulphite of soda	1 oz.
Water	6 ozs.

or a 20-grain solution of cyanide of potassium. These slides may be reduced or intensified by any of the ordinary methods; though, for the latter process, mercuric chloride, followed by ammonia, gives the most satisfactory tones. The image may be toned with the old *sel d'or* bath, the following being a near equivalent :—

Sat. sol. of hyposulphite of soda... ...	2½ ozs.
Chloride of gold	1 gr.

Or a platinum bath may be used—

Bichloride of platinum	1 gr.
Water	1 oz.

After washing and drying, the slides will be ready for binding.

Albumenised Paper. Paper coated with albumen and salt. This has now become so necessary an article that it is prepared commercially so cheaply and in such perfection that the ordinary amateur had much better buy it already prepared. The following short directions will give some idea of the method of procedure:—Absolutely fresh eggs are generally recommended, but many professional albumenisers prefer stale eggs as giving a more even and lustrous coating. Crack each egg into a separate cup or measure before mixing with the bulk, so that in case of the yolk breaking the whole of the albumen may not be spoilt. Take out the germ of each egg. Every fair-sized egg will yield about 7 drms. of albumen.

Albumen	6 ozs.
Chloride of ammonium	60 grs.
Rectified spirit	96 mins.
Distilled water	14 drms.

Dissolve the salt in the spirit and water, add to the albumen and beat with an egg-whisk for fifteen minutes; allow it to settle and filter it through a tuft of cotton-wool, previously well washed with distilled water. This is sufficient for a quire. The paper should be either Saxe or Rive. Put the albumen into a large flat dish; take the paper by two opposite corners, and bring the hands close together, so as to make the paper bow out in the middle; lay the middle of the paper on the surface of the albumen, gradually lowering the ends till it rests on the albumen. When the paper has floated for a few seconds, bubbles will be shown by the numerous puckers; lift the paper, and wet the bubbles with a camel's-hair brush; allow the paper to float for eighty seconds—not longer, or the albumen will sink into the body of paper—then gradually raise by one corner, and suspend from two corners to dry; when thoroughly dry, roll between steel rollers, and keep flat. Double albumenised paper is made by coagulating the first layer of albumen by steam or alcohol, and treating in the same way again.

Alcalinity. The reverse of acidity, which see. (Also see ALKALI.)

Alcohol (Ger., *Weingeist, Alkohol;* Fr., *Alcool;* Ital., *Alcool*). $C_2H_5HO = 46$. A generic term; but when used without qualifica-

tion common or ethylic alcohol is understood. Synonyms: Rectified Spirit, Ethylic Alcohol, Hydrate of Ethyl, Spirits of Wine. It is prepared by distillation from fermented saccharine solutions, or any vinous fluid. There are three recognised strengths:—

Absolute Alcohol, which may perhaps contain 1 or 2 per cent. of water. Specific gravity, ·800.

Rectified Spirit. Contains 16 per cent. of water, and is what is termed 56 degs. over-proof. Specific gravity, ·838.

Proof Spirit. Made by diluting five parts of rectified spirit with three of water.

The strength of alcohol can be very rapidly and accurately determined, provided nothing else but water is present, by taking the specific gravity and reference to a table such as is given under the heading HYDROMETERS and HYDROMETRY.

Alcohol, Methylated. Rectified spirit to which 10 per cent. of crude wood spirit has been added to render the mixture unpalatable has long been sold, by permission of the Excise authorities, without being subject to the heavy duty payable on alcohol in other forms; but by a regulation which came into force in 1891 such methylated spirit as is sold retail in the shops must contain, in addition to the 10 per cent. of crude wood spirit, $\frac{5}{8}$ of 1 per cent. of petroleum, having a specific gravity of not less than ·800. This petroleum is separated on the addition of water, rendering the liquid milky or turbid; and methylated spirit containing the petroleum is partially unfitted for several uses to which it was formerly applied in connection with photography. Methylated spirit of the old kind can be obtained, in quantities of not less than ten gallons, under regulations which can be ascertained by writing to the head of the Excise Department, Somerset House, London. On making formal application to the Somerset House authorities for a permit to purchase from a distiller ten gallons of methylated spirit free from petroleum, the applicant is waited upon by a local exciseman, and after complying with a number of formalities, more or less detailed according to the degree to which the exciseman is punctilious, the permit is given. (See following article.)

Alcohol, Methylic. An alcohol containing CH_2 less than ordinary or ethylic alcohol, and therefore having the formula

CH_4O. It is a chief constituent in the crude wood spirit, used for mixing with ordinary alcohol for the constitution of the methylated spirit of commerce (see ALCOHOL, METHYLATED); when pure, methylic alcohol has not the characteristic taste and smell of wood spirit, but rather resembles ordinary or ethylic alcohol. Its specific gravity is ·8142, and it boils at about 65° C. The purified commercial methylic alcohol, which costs about 2*s*. per lb., may be used in most cases as a substitute for ordinary alcohol, but the crude wood spirit, costing about 4*s*. a gallon, is generally a less desirable material to use, even than the methylated spirit containing $\frac{3}{8}$ of 1 per cent. of petroleum.

Alcoholometer. A hydrometer specially graduated so as to give the strength of alcohol at one reading. (See ALCOHOL; also HYDROMETERS and HYDROMETRY.)

Aldehyde. A substance differing from an alcohol by containing less hydrogen. The only aldehyde of special interest in connection with photography is the aldehyde of methylic alcohol which is sold as a 40 per cent. solution under the name Formalin, which see.

Alethoscope (*αληθεία* truth, and *σκοπεω*, I look at). A device of Signor Ponti, of Venice, in which a large single lens is used in looking at a transparency or an ordinary positive. A device not very different from the "Pantoscope," or "Lanternoscope," now sold for looking at small transparencies or lantern slides. It was claimed for the alethoscope that it showed ordinary photographs stereoscopically—a claim which was disputed and even ridiculed. As bearing on the matter, the following may be quoted from the *Amateur Photographer*: "Physically it is impossible for one eye to see stereoscopically, and yet many persons by looking at a photograph with one eye can see it to a certain extent as stereoscopic. The most obvious explanation depends upon what a biologist would call a psychical effect as distinguished from physical. In looking at a natural scene first with both eyes and then with one eye, the effect of solidity very often fails to entirely disappear, as the mind recognises that the scene is solid, and this recognition prevents the physical image as cast by the lens of the eye being implicitly accepted. If, now, a person who fails to see a natural scene as

completely flat when he views it with one eye, regards a photograph or picture with one eye, he sees that photograph just as he would see the natural scene if he closed one eye, and the association of ideas and perceptions gives it a stereoscopic effect to him."

Alizarine. The characteristic colouring principle of madder, used in the form of an iron or alumina lake in preparing permanent pigments for "carbon' printing and collotype printing.

Alkali. The antithesis of an acid. Alkalies turn litmus paper blue which has been reddened by an acid. They precipitate certain metals from acid solutions, as oxides or hydrates. Their chief characteristic, however, is their readiness to react with acids to form salts. The mineral alkalies are the hydrates of potassium and sodium, KHO and NaHO, also the hydrates of certain rarer metals, notably lithium. Ammonia NH_3, hydrazine N_2H_4 and some other organic substances, are powerful alkalies. Alcalinity as a quality is not confined to bodies strictly called alkalies, as such salts as borax and the alkaline carbonates show alkaline properties to test paper. (See ACID, ACIDITY, and ALCALINITY.)

Alkaline Development. See DEVELOPMENT.

Allyl Sulphocarbamide; Allyl Thiocarbamide. See THIOSINAMINE.

Alpha Paper. One of the first introduced of the commercial papers coated with a chlorobromide emulsion, as suggested by Eder in 1883. Such papers are intended for development, and not printing out; and from the ease with which warm or cold tones can be obtained at will, and from its being possible to obtain prints by its aid at night which are equal to ordinary printed-out papers, it has received a good deal of attention. Several formulæ have been given for this emulsion-paper. Wellington suggests the following:—

Solution A.

Silver nitrate...	10 parts.
Citric acid	10 ,,
Distilled water	144 ,,

Alpha Paper

Solution B.

Sodium chloride	2 parts.
Potassium bromide	4 „
Citric acid	10 „
Gelatine	4 „
Distilled water	144 „

Heat both solutions to 66° C., and add A to B, shaking violently; then add 20 parts gelatine previously swollen in water and melted; shake the whole well, and pour out into a dish to set; allow it to remain for twenty-four hours, break it up, wash, re-melt, and coat the paper or other support. One of the advantages of alpha papers is that it is possible to obtain prints of great beauty, rivalling albumen in tone, and superior to them in surface, without the trouble of having to print out; it being a development printing process. A fault often found with it, however, is that it is difficult to obtain a certain number of prints from one negative all of one colour; but this is due to faulty manipulation, and not to the paper. The best method of working it is as follows:—Gas or some artificial light must be used: daylight is too variable. Assume that we are using a No. 5 Bray burner, which is turned up as full as possible without flaring. At a distance of 9 ins. from this burner on the table, shelf, or wall, draw a straight line. This is the mark on which the edge of the printing frame should always rest. Having chosen your negative, which we will assume to be one of the ordinary character, place your paper in contact with it, and set the frame to the mark. Turn up the gas, and give the paper four different exposures of 90, 100, 110, and 120 secs., covering part of the frame up with a piece of black or nonactinic paper at each exposure; develop the paper as described below, and you will at once have a guide to the correct exposure for any particular colour for that particular negative. It must be remembered that alpha prints can be toned; but for a photographic purple the developed print should be a pinkish violet after development, and this is the best colour to aim at for all other tones. Having found the correct exposure for the particular negative, expose as many pieces of paper as prints are required, taking care to give *exactly the same exposure by a metronome or watch*, and then proceed to develop them. Either ferrous oxalate, hydroquinone,

eikonogen, or glycin can be used, but for warm tones hydroquinone is preferable; and the formulæ for these developers suggested for bromide paper may be used if dilated with two or three parts of water and some bromide of potassium added. The final tone depends to a great extent on the exposure, long exposures tending to give warmer tones. If the iron developer is used the prints must be placed in an alum and citric acid clearing-bath for two minutes, well washed, and then fixed. Alpha prints may be toned in a combined bath, when of course fixing need not be done as a separate operation, or preferably in the following :—

Chloride of gold	1 gr.
Calcium choride (crystal)	10 ,,
Water	10 ozs.

Place the prints in this after well washing out the fixing solution, and tone till the desired colour is reached. The prints only want well washing and drying to be ready for mounting. Alpha prints can be rolled and burnished, provided too great a heat be not used. Over-exposure gives flat prints without any depth in the shadows and without pure whites, whilst under-exposure gives harsh prints with greenish tones.

Alum. Under this name a series of important double salts are classed. These salts are characterised as being double sulphates of monatomic and triatomic metals crystallising in octahedra, and containing 24 molecules of water of crystallisation, and have therefore the common formula of $M_2'SO_4$, $M_2'''(SO_4)_3$, $24H_2O$, but occasionally written as half, namely, $M'\ M'''(SO_4)_2$, $(H_2O)_{12}$. The principal alums are ammonia alum, chrome alum, and potash alum.

Ammonia Alum (Ger., *Ammoniakalaun;* Fr., *Alun Ammoniacal;* Ital., *Allume di Ammoniaca*). $(NH_4)_2SO_4Al_2(SO_4)$, $24H_2O$ = 906. Solubility: 1 in 7 of cold water, 1 in 0·2 of boiling water, 1 in 2 of alcohol.

Chrome Alum (Ger., *Chromalaun;* Fr. *Alun de Chrome;* Ital., *Allume di Cromo*). K_2SO_4, $Cr_2(SO_4)_3$, $24H_2O = 998$. A deep purple crystalline salt, soluble 1 part in 10 of cold water, insoluble in alcohol. Its solution is purple by reflected, and reddish by transmitted, light. It is used for hardening gelatine

as, for example, in the preparation of emulsions for dry plates to prevent frilling.

Potash Alum (Ger., *Alaun;* Fr., *Alun;* Ital., *Allume comune*). $K_2SO_4Al_2(SO_4)_3$, $24H_2O=948$. Is found native in some places, but is usually made from aluminous clay. It is used for rendering the films of gelatine less liable to mechanical injury, by hardening them, and also clears them from stains. (See CLEARING BATH.) It has also been recommended as a Hypo-eliminator (*q.v.*), but its action and benefit are doubtful. Solubility: 9·5 in 100 of cold water, 10 in 8 of boiling water; insoluble in alcohol and ether.

Aluminium (Ger. and Fr., *Aluminium;* Ital. *Alluminio*). Al = 27. A silvery white metal, formerly obtained principally by reducing the chloride with sodium, but now by the reduction of the oxide, alumina, in an electric furnace. It has been used to replace brass for lens mounts and camera fittings on account of its lightness; its weight, bulk for bulk, being less than half that of brass. It has also been used as a substitute for magnesium, for flash light, and has been suggested by Lainer as a means of precipitating silver from residues. Although pure aluminium retains its lustre and does not corrode, even in moist air, much of the metal now obtainable becomes soon covered with spots of a white incrustation, even when the atmosphere is moderately dry. Such aluminium contains, according to M. Moissan's experiments, from 0·1 to 0·4 per cent. of sodium. This sodium, instead of being equally distributed, is often so local that the highly contaminated parts form an electric couple with the purer aluminium. Carbonaceous particles also appear to form couples in aluminium and lead to deterioration. (For the use of aluminium in connection with the Flash Light for instantaneous work in the evening, see FLASH LIGHT.)

Aluminium Chloride (Ger., *Aluminiumchlorid;* Fr., *Chlorure d'aluminium*; Ital., *Clorure di aluminio*). Al_2Cl_6 is formed by heating alumina and charcoal and passing over it a stream of chlorine gas. It occurs in white tabular crystals which are hygroscopic. It is soluble in water, alcohol, and ether. It has been suggested as a toning agent for gelatino-chloride prints.

Aluminium Sulphate (Ger., *Aluminiumsulfat;* Fr., *Sulfate d'aluminium;* Ital., *Solfato di aluminio*). $Al_2(SO_4)_3$, $18H_2O$ is

formed by dissolving aluminium hydroxide $Al_2(OH)_6$ in sulphuric acid. It has been suggested as a substitute for the ordinary and chrome alums, for hardening gelatino-chloride prints, and in emulsion making.

Aluminium Sulphocyanide (Ger., *Aluminium sulphocyanid Rhodanaluminium;* Fr., *Sulfocyanure d'aluminium;* Ital., *Solfocianuro d'aluminio*). Can be formed by double decomposition of barium sulphocyanide with aluminium sulphate. It is decomposed below 212° F., and forms a dark violet red crystalline compound; but is very difficult to obtain in a well-defined crystalline form as it is very deliquescent.

Amber (Ger., *Grauer Amber, Bernstein;* Fr., *Ambre;* Ital., *Ambra*). A fossil resin from an extinct species of pine. It is used for preparing a Varnish (*q.v.*).

Ambrotype. An American synonym for a collodion positive.

Amidol (Ger., Fr., Ital., *Amidol*). $C_6H_3OH(NH_2)_2 = 124$. Synonym: Diamidophenol. The peculiar characteristic of this substance is that it will develop without the addition of alkali. It is a white crystalline powder readily soluble in water. The aqueous solution does not keep well, not even with sulphite, but soon loses its developing power; it is preferable therefore to keep it dry and dissolve as required. It is advisable to keep a stock solution of

Sodium sulphite	5 ozs.
Distilled water	20 ,,

For ordinary negative work take

Amidol dry	2½ grs.
Sol. sod. sulphite	¼ oz.
Sol. bromide of potash 10%	10 drops.
Distilled water	1 oz.

To accelerate the development the strong solution of sodium sulphite may be added by degrees. Another form of developer has been proposed, which is as follows :—

Solution A.

Water	20 ozs.
Potassium metabisulphite	2 ,,
Amidol	1 ,,

This solution will keep for a very long time if well corked.

Solution B.

Water	20 ozs.
Soda crystals	2 ,,

Solution C.

Water	20 ozs.
Sodium sulphite, cryst., pure	4 ,,

Results similar to pyro may be obtained with

Solution A	10 parts.
,, B	6—10 ,,
Water	70 ,,
Bromide (1 : 10)	3 ,,

But this formula may be considerably modified, according to requirements; it is not, however, advisable to increase the quantity of alkali, for fear of inducing fog. For over-exposed plates, add the solution B in the above formula little by little, until the desired effect is obtained, never exceeding the amount above prescribed. Images of a softer character are obtained as follows:

Solution A	10 parts.
,, B	20—40 ,,
Water	70 ,,
Bromide (1 : 10)	$\frac{1}{2}$—$\frac{3}{4}$,,

Solution D.

Water	20 ozs.
Sodium sulphite, pure cryst.	$\frac{2}{5}$ oz.
Amidol	2 ozs.

This solution remains colourless for a long time in full and air-tight vessels. When opened it changes from yellow to red, which, however, does not affect the developing power, or coloration of plates.

For use take—

Solution D	5 parts.
Water	50—70 ,,
Solution C	20—30 ,,
Bromide (1 : 10)	1$\frac{1}{2}$,,

This formula also has the advantage, by gradually adding solution C, of controlling development up to the point desired, which is specially important for over-exposed plates. As the image loses on fixing, it is recommended to develop strongly.

For Bromide Paper. Both for prints and enlargements either of the above formulæ may be used, and the freedom from stains will prove of great advantage. With diluted solutions clear grey tones are obtained.

For Chloride Plates and Lantern Slides. Transparencies of the blackest tones are developed with :—

Water	20 ozs.
Sodium sulphite, cryst., pure	1 oz.
Amidol	40 grs.

Warmer tones are obtained through longer exposure and the liberal addition of bromide, even up to one ounce in the four-ounce developer. Practically the ordinary methods of development may be followed with amidol—namely, for over-exposure, dilution of the developer with water, increase of bromide, or decrease of the accelerator; for under-exposure the contrary directions of course hold good. Amidol is likely to prove of great value especially in instantaneous work: it gives fine steely blue or grey-black images, and there is no tendency to stain. The author has found that for subjects with great contrasts, under-exposed plates, and portraiture, this developer will place a great power in the hands of the intelligent worker, because the images given are soft and harmonious, and one is thus enabled to intensify, to gain the requisite density, without getting harshness.

Ammonia (Ger., *Wasseriges Ammonia, Salmakgeist;* Fr. *Ammoniaque;* Ital., *Ammoniaca*). $NH_3 = 17$. Is an extremely volatile, pungent gas, but is known to photographers as a solution in water, termed liquor ammoniæ fortissimus. Specific gravity, ·880, containing about 35 per cent. of NH_3. It should be kept in stoppered bottles, as the gas is freely evolved at ordinary temperatures, carbonic acid being absorbed from the air, forming carbonate of ammonia. It is used in alkaline development as an accelerator for pyrogallol. The fumes are extremely suffocating, causing sudden contraction of the glottis and consequent death is possible. Its use in ill-ventilated dark-

rooms is said to cause permanent irritation of the mucous membranes of the throat, nose, and eyes. There is a weaker strength, known as liquor ammoniæ (specific gravity, ·936), only one-third the strength of the liq. ammon. fort. The strength of ammonia can be estimated by determining the specific gravity, and the data will be found under the heading HYDROMETERS and HYDROMETRY, in the table which gives the specific gravities of caustic alkali solutions.

Ammonia, Fuming with. See FUMING.

Ammonium Bichromate (Ger., *Dichromsäures Ammoniak;* Fr., *Bichromate d'ammoniaque;* Ital., *Bicromato d'ammoniaca*). $(NH_4)_2Cr_2O_7=252$. Made by neutralising chromic acid with ammonia. It is used occasionally instead of the potash salt in photo-mechanical printing.

Ammonium Bromide (Ger., *Bromammonium;* Fr., *Bromure d'ammonium;* Ital., *Bromuro d'ammonio*). $NH_4Br = 98$. Made by neutralising hydrobromic acid with ammonia, or by double decomposition from bromide of calcium. Its chief use is as a Restrainer (*q.v.*), but it is sometimes used in the preparation of gelatino-bromide emulsion. Solubility: 1 in 1½ of cold water, 1 in 13 of alcohol.

Ammonium Carbonate (Ger., *Ammoniumcarbonat,* or, *Kohlensäures ammoniak;* Fr., *Carbonate d'ammoniaque;* Ital., *Carbonato d'ammoniaca*). The normal carbonate—which, however, is very subject to change—contains $(NH_4)_2CO_3$. Made by sublimation from chalk and sal-ammoniac. It is used occasionally for development, but is not so suitable as liquor ammoniæ. Solubility: 1 in 4 of cold water, sparingly in alcohol.

Ammonium Chloride (Ger., *Chlorammonium, Salmiak;* Fr., *Chlorure d'ammonium;* Ital., *Cloridrato d'ammoniaca*). $NH_4Cl = 53·5$. Synonym: Muriate of Ammonia, Hydrochlorate of Ammonia, Sal-ammoniac. Is prepared by neutralising ammoniacal gas liquor with hydrochloric acid and subsequent purification. It is principally used for salting albumenised paper, and for preparing chloride emulsion. Solubility: 1 in 3 of cold water, 1 in 55 of alcohol.

Ammonium Citrate (Ger., *Ammoniumcitrat;* Fr., *Citrate d'ammoniaque;* Ital., *Citrato d'ammoniaca*). NH_4, H_2, C_6H_6O

or $(NH_4)_2$, H, $C_6H_5O_7$. This is usually met with in the form of solution, the salt itself being so deliquescent, that it is an extremely difficult matter to keep it. It may be conveniently prepared by exactly neutralising citric acid with solution of ammonia or carbonate of ammonia, the following being the method adopted by the British Pharmacopœia.

Citric Acid	12 parts.
Strong solution of ammonia	11 „

Neutralise the acid with the ammonia, and add sufficient distilled water to make 24 parts. This can be preserved as a stock solution for use in alkaline development. (See DEVELOPMENT.) It has been employed in the preparation of gelatino-chloride emulsions, but its principal use is as a restrainer in development of chloride emulsions.

Ammonium Hyposulphite. $(NH_4)_2S_2O_3+5H_2O$, has been recommended as a fixing agent in place of the sodium salt, but is—and is likely to remain—much more costly; the sodium salt being obtained as a by-product.

Ammonium Iodide (Ger., *Jodammonium;* Fr., *Iodure d'ammonium;* Ital., *Ioduro d'ammonio*). $NH_4I = 145$. Made by neutralising hydriodic acid with ammonia; or better, by mixing warm saturated solutions of potassium iodide and ammonium sulphate in equivalent quantities, and then extracting the magma with alcohol. Used for making Iodised Collodion (*q.v.*). Solubility: 4 in 3 of water, 1 in 4 of alcohol, 1 in 20 of ether, and 1 in 20 of alcohol and ether.

Ammonium Oxalate (Ger., *Ammoniumoxalat;* Fr., *Oxalate d'ammonium;* Ital., *Ossalato di ammoniaca*). $(NH_4)_2C_2O_4 = 124$. Made by neutralising oxalic acid with ammonia. It has been recommended lately for preparing the paper for platinotype printing. Solubility: 1 in 3 of water; insoluble in alcohol.

Ammonium Sulphide (Ger., *Ammoniumsulfid*, or, *Schwefelammonium;* Fr., *Sulfure d'ammoniaque;* Ital., *Solfuro d'ammoniaca*). $(NH_4)_2S = 68$. Synonym: Sulphuret of ammonia. Prepared by passing sulphuretted hydrogen through ammonia solution until the gas ceases to be absorbed. It is used in Intensification (*q.v.*) to blacken the white image obtained by bleaching the negative with mercuric chloride. A caution is

necessary as to the use and storage of this in any room where sensitive surfaces of any kind are kept, as liable to blacken the same without exposure to light. If an amount of ammonia equal to that originally used is added after saturation with sulphuretted hydrogen, ammonium sulphydrate is formed; this being often preferred for the above use.

Ammonium Sulphocyanate (Ger., *Rhodanammonium;* Fr., *Sulfocyanure d'ammonium;* Ital., *Rodanuro*, or, *Solfocianuro d'ammonio*). $NH_4CNS = 76$. A compound of sulphocyanic acid and ammonia. Also prepared commercially by boiling powdered sulphur with ammonium cyanide which is obtained as a refuse from gas liquors. It is used for toning gelatino-chloride printing-out papers, and has also been recommended as a fixing agent instead of hypo, but from its comparatively high price, without any increased advantages, it is hardly likely to come into general use. It is a very deliquescent salt, soluble also in alcohol.

Amphitype (*ἀμφί*, on both sides, and *τὺπος*, an impression, as of a seal). A curious process which was discovered by Sir John Herschel, who thus describes his method of procedure:—

"Paper proper for producing an amphitype picture may be prepared either with the ferro-tartrate or the ferro-citrate of the protoxide or the peroxide of mercury, or of the protoxide of lead, by using creams of these salts, or by successive application of the nitrates of the respective oxides, singly or in mixture, to the paper, alternating with solutions of the ammonio-tartrate or ammonio-citrate of iron; the latter solution being last applied, and in more or less excess. Paper so prepared and dried takes a negative picture in time varying from half-an-hour to five or six hours, according to the intensity of the light; and the impression produced varies in apparent force, from a faint and hardly perceptible picture to one of the highest conceivable fulness and richness both of tint and detail, the colour in this case being a superb velvety brown. This extreme richness of effect is not produced except lead be present, either in the ingredients used or in the paper itself. It is not, as I originally supposed, due to the presence of free tartaric acid. The pictures in this state are not permanent. They fade in the dark, though with very different degrees of rapidity, some (especially if free

tartaric or citric acid be present) in a few days; while others remain for weeks unimpaired, and require whole years for their total obliteration. But though entirely faded out in appearance, the picture is only rendered dormant, and may be restored, changing its character from negative to positive, and its colour from brown to black (in the shadow), by the following process :— A bath being prepared by pouring a small quantity of solution of pernitrate of mercury into a large quantity of water, and letting the subnitrated precipitate subside, the picture must be immersed in it (carefully and repeatedly clearing off the air-bubbles), and allowed to remain till the picture (if anywhere visible) is entirely destroyed, or, if faded, till it is judged sufficient from previous experience; a term which is often marked by the appearance of a feeble positive picture of a bright yellow hue on the pale yellow ground of the paper. A long time (several weeks) is often required for this, but heat accelerates the action, and it is often complete in a few hours. In this state the picture is to be very thoroughly rinsed and soaked in pure warm water, and then dried. It is then to be well ironed with a smooth iron, heated so as barely not to injure the paper, placing it, for better security against scorching, between smooth clean papers. If, then, the process has been successful, a perfectly black positive picture is at once developed. At first it most commonly happens that the whole picture is sooty or dingy to such a degree that it is condemned as spoiled, but on keeping it between the leaves of a book, especially in a moist atmosphere, by extremely slow degrees this dinginess disappears; and the picture disengages itself with continually increasing sharpness and clearness, and acquires the exact effect of copperplate engraving on a paper more or less tinted with pale yellow."

Amyl Acetate (Ger., *Amylacetat;* Fr., *Acètate d'amyle;* Ital., *Acetato a'amile*). $C_5H_{11}C_2H_3O_2 = 130$. Synonym: Essence of Jargonelle pears. Prepared by distilling 1 part of sulphuric acid, 1 part of amylic alcohol, and 2 parts acetate of potash. The distillate is purified by washing with water, dried with calcium chloride, and then redistilled from a mixture of massicot (oxide of lead), which absorbs any free acetic acid. It is a colourless liquid with, at first, a fruity smell, but which soon becomes intensely nauseous, and gives rise to vertigo and headache. It is

insoluble in water, but soluble in all proportions in alcohol and ether. It boils at 138° C., and burns with brilliant flame, which is, however, richer in the more refrangible rays than the violet. It is used in the amyl-acetate lamp (*q.v.*); also as a solvent of pyroxyline in the preparation of celluloid and celluloid varnish.

Amyl-Acetate Lamp. This instrument was devised in 1884 by Hefner-Altenek, and was adopted by the International Congress of Photography in Paris in 1889 as a convenient standard light for photographic purposes. Amyl acetate is burnt in it with a cotton wick, the internal diameter of the wick tube should be 5 mm., and the height of the flame 25 mm. 1 cm. from the axis of the flame is placed a thin metal chimney, in which is a small aperture 4 mm. broad and 30 mm. long, and this can be shifted up and down so as to bring it opposite the brightest part of the flame. The amyl acetate should have a constant boiling point of 138° C., and be free from acetic acid and water. The spectral composition of the flame is similar to that of a candle, and compared to the English standard candle, setting the amyl-acetate lamp as = 1, the candle = 1·140. All metallic parts of the lamp should be made of fine silver, as the fluid so corrodes brass and other metals as to render them useless.

Anaglyph, Anaglyphoscope (*ἀνά*, in the sense of back; *γλυφω*, I carve). A means of producing stereoscopic effect due to MM. Louis Ducos du Hauron and D'Almeida. One picture of the stereoscopic pair is printed in red and the other in a greenish-blue—at any rate, the tints must be nearly complementary. As both impressions are superimposed on the same white paper, and the two unlike pictures cannot exactly coincide, a somewhat confused double image results. If this anaglyph be viewed by the anaglyphoscope—a pair of spectacles, one glass of which is blue and the other red—each eye sees only one element of the two coloured stereograms, and a stereoscopic effect is produced. The application of three-colour heliochromy to the anaglyph is a more recent advance by M. Louis Ducos du Hauron, and consists in making two of the coloured elements of the three-colour set correspond to one of the pictures of the stereoscopic pair, and making the third element of the three-colour set correspond to the other picture of the stereoscopic pair. The effect of relief is produced by the difference in drawing

which exists between one element of the three-colour set and the two other elements of the three-colour set. Amongst the possible methods of carrying out the idea the following may be mentioned:—The right eye looks through a turquoise-blue medium at the red and yellow images superimposed, the blue image being invisible to this eye. When the red pigment lies over the yellow the resulting red-orange appears black to the right eye, as the blue glass will not allow red-orange to pass; where, on the other hand, there is only the red (purplish-red) pigment, the blue glass allows blue-violet to pass; where the paper is only covered with yellow pigment, the turquoise-blue glass allows green to pass, green being one element of the yellow pigment. The left eye looks through ruby glass and sees as light and shade that which is printed in blue pigment, and it sees as orange-red that purple-blue which the right eye sees as blue-violet. Thus the right eye receives the impression of green and blue violet, and the left eye the impression of orange-red; while each eye also receives an effect corresponding to a monochrome basis, which gives the requisite drawing in a complete sense. The principle of the anaglyph is applicable to stereoscopic projection with the magic lantern. According to one method the two pictures of the stereographic transparency are projected upon the same screen by means of two lanterns, but in the course of the luminous rays of each lantern there is interposed a coloured glass; the two colours being complementary to each other, the double and confused image on the screen being viewed by an anaglyphoscope, having glasses of corresponding colour, the stereoscopic effect is obtained. For projection purposes, De la Blanchère uses blue and yellow glasses, D'Almeida and Freshwater employ copper-ruby and signal-green. Gold-pink and a yellowish-green is a good combination. A rough test of the suitability of any two coloured glasses is the giving of a maximum of opacity when superimposed, but with the effect of great transparency when one of the glasses covers each eye. In carrying out stereoscopic projection by the anaglyphic method it is desirable to cut the lantern glasses and the glasses of the coloured spectacles from the same sheet.

Analysis (*ἀνά*, in the sense of thorough, and *λύσις*, a release). In common language, the term analysis is often applied

to a mere testing whereby evidence of the presence of a substance is obtained, although no attempt is made at the separation of the substance, and the use of litmus paper in testing for acids and alkalies (see ACIDITY) would often be spoken of as a rudimentary operation in analysis. When the object of analysis is merely to separate sufficient of a substance for recognition, the operation is called qualitative analysis, while the operation is called quantitative when the amount of a constituent is determined. A person without thorough chemical training is very liable to be misled by any attempt at systematic analysis or testing; but in spite of this we give a very concise abstract of a modification of the usual routine of systematic testing for the common metals, as applied to substances soluble in water or in acids: About 20 grs. of the substance in two drams of water—either with or without the aid of an acid—forms the original solution, O.S. Add to O.S. hydrochloric acid drop by drop; a white precipitate insoluble in excess indicates lead, silver, or mercurous compounds. Let the precipitate settle, pour off liquid, add water; shake; allow precipitate to settle, and pour off; then add ammonia. The dissolving of the precipitate indicates silver; if unchanged, lead; if blackened, mercury. If hydrochloric acid gives no precipitate add excess of sulphuretted hydrogen solution to the same solution. A black precipitate indicates mercury (mercuric), copper, or lead (if proportion in original was small). To O.S. add ammonia; a cobalt blue coloration, preceded maybe by a greenish precipitate, indicates copper; mercury is indicated by boiling original substance with water and a drop or two of nitric acid, a bright copper wire being immersed, when the copper will be coated with mercury; if lead, the original solution will give a white precipitate with sulphuric acid, this precipitate being insoluble in nitric acid. To original solution add ammonia; ferrous salts give a dark precipitate, becoming rust-coloured on exposure to air; ferric salts give the rust-coloured precipitate at once; aluminium salts give a transparent white precipitate under these circumstances; chromium, a greenish precipitate. If no precipitate on adding ammonia, add a little chloride of ammonium and carbonate of ammonia. A white precipitate indicates calcium, or a metal (strontium, barium) of the calcium group. The acid of a salt may often be recognised by putting a few grains of the salt in a test tube and adding a little sulphuric acid.

Effervescence, with odourless gas, indicates a carbonate; with smell of burning sulphur, a sulphite or hyposulphite, white flocks of sulphur being liberated in the fluid in this latter case. Smell of hydrocyanic acid (which to some recalls bitter-almond oil) indicates a cyanide. If no change, apply heat. Fumes of hydrochloric acid, recognisable by small white clouds, if rod moistened with ammonia is introduced, and producing turbidity in drop of silver nitrate on glass rod, indicate a chloride. Bright yellow coloration, with liberation of a yellow gas which explodes when heated, indicates a chlorate. Violet fumes indicate an iodide; odour of vinegar suggests an acetate.

Too much confidence must not be placed in the results obtained by such an examination as is outlined above, as the conditions under which each reaction takes place require to be minutely studied; but such an examination may occasionally be useful in assisting or confirming the memory with respect to unlabelled materials. The so-called test tubes of thin glass are used in trying the reactions, and at every stage care and caution is needed. The face should never be held over the mouth of the test tube, fumes being smelled by diverting a little with the hand. The mention of an explosive gas in connection with chlorates suggests the precautionary measure of always using very small quantities in the first trial of a reaction. (As bearing on this subject, see HYDROMETRY and HYDROMETERS; also EQUIVALENCE, CHEMICAL.)

Anamorphoscope, Anamorphosis (*ἀνά*, in the sense of back, and *μόρφωσις*, the act of putting into shape). M. Linde's Photoanamorphoscope is a device by which a revolving picture is photographed on a revolving plate, the directions and speeds being different, but in order to secure definition only a narrow radial strip is exposed at one time. The result in no way suggests the original, and appears a confusion of whirl-like markings, but when viewed in an apparatus corresponding to that employed in its production (anamorphoscope) the original is reconstituted to the eye.

Anastigmatic (*ἀνά*, in the sense of back, and *στιγμή*, a dot or a mathematical point). A lens should be said to be anastigmatic—or simply stigmatic—when it refers every point on the scene accurately to a corresponding point on the plate; but in

practice the terms are used as signifying freedom from that aberration called astigmatism. (See LENS.)

Angle, Critical. See CRITICAL ANGLE.

Angle, Mid. This is a term applied to a lens which has a focal length intermediate between the ordinary rapid rectilinear and the so-called wide-angle.

Angle of View, or **Width of Angle.** It is sometimes essential to know the angle inclosed by a lens, and for this purpose it is only necessary to divide the diameter of its field by the focus, when reference to such a table as the following will at once give the result :—

SORET'S TABLES OF ANGLES INCLUDED BY A LENS.

Diameter of the field.	Angle included by lens.	Diameter of the field.	Angle included by lens.
$2f + \frac{3}{8}f$	106° 16′	$f + \frac{1}{8}f$	58° 6′
$2f + \frac{1}{2}f$	102° 43′	$f + \frac{1}{10}f$	57° 37′
$2f + \frac{1}{3}f$	98° 50′	f	53° 6′
$2f + \frac{1}{4}f$	96° 44′	$f - \frac{1}{10}f$	48° 27′
$2f$	90°	$- \frac{1}{8}f$	47° 54′
$f + \frac{3}{4}f$	82° 22′	$f - \frac{1}{8}f$	47° 15′
$f + \frac{2}{3}f$	80° 33′	$f - \frac{1}{7}f$	46° 24′
$f + \frac{1}{2}f$	72° 44′	$f - \frac{1}{8}f$	46° 11′
$f + \frac{1}{3}f$	67° 31′	$f - \frac{1}{5}f$	44° 23′
$f + \frac{1}{4}f$	64°	$f - \frac{1}{4}f$	41° 7′
$f + \frac{1}{5}f$	61° 55′	$f - \frac{1}{3}f$	36° 52′
$f + \frac{1}{6}f$	60° 30′	$f - \frac{1}{2}f$	28° 4′
$f + \frac{1}{7}f$	59° 28′	$\frac{1}{3}f$	18° 36′
$f + \frac{1}{8}f$	58° 42′	$\frac{1}{4}f$	14° 20′

Example: What angle is included by a 12-in. lens on a plate the diagonal of which is 10 ins. $12 = 10$ or $f + \frac{1}{5}f$, and against this we find 61° 55′.

As the full field of the lens would be a circle corresponding to the diagonal of the plate, this diagonal would be taken by some as the diameter of the field. Others would measure one of the longer sides of the plate, and the angle of view is usually estimated on this basis. A good deal of discussion has arisen as to

the meaning of the term, "angle of view," but notwithstanding what has been said to the contrary, the simplest way out of the difficulty is to limit the term to the definition given above, and to explain the angle included by the lens on a given-sized plate as the picture angle. If this is adhered to we avoid several difficulties. Mr. W. Rice suggests the following simple formula :—

Let

P = length of plate.
F = focus of lens.

Then

$$\text{Angle} = \frac{63\,P}{F + \frac{P}{5}}.$$

Or, expressed in words:—Multiply the base line of plate by 63 and divide the product by the length of focus, added to $\frac{1}{5}$ of the diagonal of the plate.

Example:—What is the angle given by a 10-in. lens on a 12-in. plate?

$$\begin{aligned} 12 \times 63 &= 756. \\ 10 + {}^{13}\!/_{5} &= 12\tfrac{2}{5}. \\ 756 \div 12 &= 61^{\circ} \text{ practically.} \end{aligned}$$

This formula will only apply when the angles included are less than 90°. When the angle is greater than 90° the following should be used:—

$$\text{Angle} = 180^{\circ} - \frac{126\,F}{\frac{P}{2} + \frac{2F}{5}}.$$

Or, expressed in words:—Subtract from 180 the quotient obtained by dividing 126 times the focus of the lens by $\frac{1}{2}$ the base line of the plate, added to twice the focus divided by 5.

Example:—What is the angle included by a 4-in. lens on a 12-in. plate?

$$\begin{aligned} 126 \times 4 &= 504. \\ 12 \div 2 &= 6. \\ (4 \times 2) \div 5 &= \tfrac{8}{5}. \\ 6 + \tfrac{8}{5} &= 7\tfrac{3}{5}. \\ 504 \div 7\tfrac{3}{5} &= 61. \\ 180 - 61 &= 119^{\circ} \text{ approximate angle included.} \end{aligned}$$

One of the most usual methods, and perhaps the most convenient

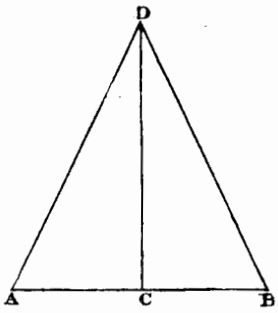


Fig. 2.

method of all, is by means of the following plan. Draw a straight line A B equal in length to the longer base of the plate used, bisect

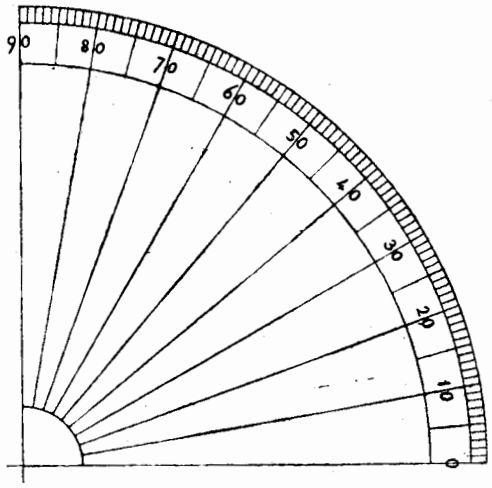


Fig. 3.

this accurately at C, from C draw a perpendicular D C equal to the focal length of the lens, connect A D, D B, then the angle included

by the lens is equal to the angle A D B, which may be measured by laying a protractor on it and reading off the degrees included. For those who may not have a protractor handy, the diagram, fig. 2, is given, which may be copied on a lantern plate, and the developed, fixed and varnished negative used as a protractor.

Angle, Wide. Applied to certain forms of lenses which embrace a larger amount of view than the usual run of lenses. Wide-angle lenses exaggerate perspective most painfully, in increasing the apparent size of near objects entirely out of all proportion with those more distant, unless the photograph is viewed from a point corresponding to the focus of the lens used —a course more practicable as an experiment than as a means of looking with ease at the photograph. As the angle of view of the human eye in ordinary clear vision does not exceed about 50°, no lens for general work should be employed which would

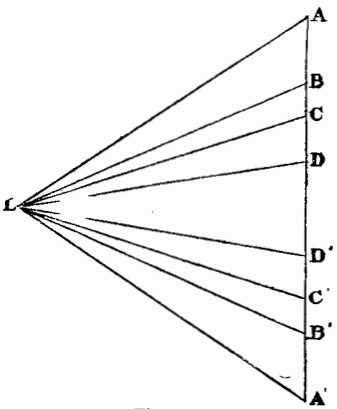


Fig. 4.

include a greater angle than 50°, the wide-angle lens being reserved for obtaining representations of objects not obtainable without it, as high buildings in narrow streets. Practically a lens includes a wide angle, or a large amount of subject, only when its focus is short as compared to the plate with which it is used. The diagram (fig. 4) may make this clear. Let us assume that L is the optical centre of a lens, which will cover

a half-plate, CC'. The same lens will also cover a quarter-plate, DD'; it may also cover a whole plate, BB'; and a 10 by 8; and a 12 by 10. Therefore with the quarter-plate it would be a narrow angle or long focus, with the half-plate an ordinary angle, on a whole-plate a mid-angle, on a 10 by 8 a wide-angle, on a 12 by 10 a wider angle.

Anglol. Under this name was introduced an English manufactured Eikonogen (*q.v.*).

Angular Aperture is a relation borne by the working diameter of a lens to its focal length; that is to say, the angle which the aperture of the lens subtends at the equivalent focus. The wider the angular aperture the less the depth of focus and covering power of the lens. This is well seen in a portrait lens.

Anhydrous, Anhydride. Anhydrous means free from water, as in the terms anhydrous alcohol, or anhydrous ether. By anhydride is understood what was formerly understood by an anhydrous acid—a body derived from an acid by the removal of the elements of water, and now recognised not to be an acid in the true sense of the term.

Aniline. $C_6H_5NH_2 = 93$. Synonym: Phenylamine, Amidobenzine, or amidobenzol. It is prepared commercially by the reduction of nitrobenzine by heat, steam, iron filings, and hydrochloric acid, and is an oily liquid; strongly basic, and forming salts with acids. Solubility: 3 in 100 of cold water; very soluble in alcohol, ether, and benzine. It is used in the aniline process (*q.v.*), and also as a base from which numerous colouring matters used in orthochromatic photography are derived.

Aniline Colours. With aniline as a starting-point numerous colouring matters have been obtained; but the term aniline colours is now very generally but loosely applied to all colouring matters derived from coal-tar products.

Aniline Process. In 1865 Willis patented this process which consists of impregnating paper with ammonium bichromate and phosphoric acid, drying, and then exposing under a negative to the action of light, and subjecting it to the fumes of aniline, by which means aniline colours were formed. H. W. Vogel suggests the following method of procedure:—

Aniline Process

Sensitising Solution.

Potassium bichromate	1 parts.
Phosphoric acid, Sp. Gr. 1·124	10 ,,
Water	10 ,,

Good paper, such as Rives or Saxe, is allowed to float on this for one minute, and then quickly dried. It is then exposed under negative or line drawing, and developed by placing in the bottom of a box, to the lid of which is affixed a sheet of blotting paper impregnated with commercial aniline 1 part, benzine 16 parts. The image appears fairly quickly (in a few minutes), and of a greenish-blue black, which turns to blue when the prints are soaked in water. If the fuming is carried on for some time the tones become blacker. With over-exposure the ground becomes tinged, and this may be removed by alternately bathing in dilute sulphuric acid (1 per cent.) or in hydrochloric acid (5 per cent.), and washing and then bathing in dilute ammonia. Philippe suggested, in 1884, floating gelatinised paper on 10 per cent. solution of bichromate of potash and ammonia. After exposure the print is laid in 1 per cent. solution of potassium cyanide till the whites are clear, then rinsed and developed in

Aniline	10 parts.
Oxalic acid	10 ,,
Water	100 ,,

In 1866 Endemann suggested the use of vanadic acid. Well-sized paper is sensitised with

Salt	480 grains. or 5 grms.
Potassium bichromate ...	480 ,, ,, 5 ,,
Sodium vanadiate	320 ,, ,, 3·3 ,,
Water	20 ozs. ,, 100 c.cm.

When dissolved add the following mixture after it has become cold—

Sulphuric acid	2 ozs. or 10 c.cm.
Water	10 ,, ,, 50 ,,

When the paper is dried it is exposed under a negative or drawing for about 7 minutes, and then exposed to the vapour from a heated mixture of 1 part of aniline and 50 parts of water. The image then appears brown, and the print is left in a room

full of steam for two hours, or till the image turns black, and finally washed in 1 : 6 ammonia water.

Animatograph. See ZOETROPE.

Anthion. Persulphate of potassium $K_2S_2O_8$, a highly oxidising salt obtained by the electrolysis of potassium sulphate, is sold as a hyposulphite eliminator under the name of anthion. (See ELIMINATORS.)

Anthotype (*ἄνθος*, a flower). An old process yielding exceedingly fugitive prints, depending for its principle upon the bleaching action of light upon chlorophyll and other vegetable juices, when the same are spread upon paper and exposed under a negative. More recently Messrs. A. and L. Lumière have suggested to reproduce a coloured transparency by exposing under it a sheet of paper prepared with a mixture of fugitive colours, as for example, quinoline blue, and curcuma. Attempts to fix such images have been unsatisfactory, as metallic bases which will unite with the colouring substances alter the tint.

Anthrakotype (*ἀνθρακος*, genitive of *ἀνθραξ*, charcoal or coal). A process for reproducing in carbon or pigment such subjects as show little or no half-tone. Paper is coated with plain gelatine, say 1 to 8 or 10 of water, and when dry is sensitised in a bichromate bath—say 1 part of potassium bichromate in 20 of water. The paper is now exposed under a positive, soaked in water, blotted off, and then dusted over with the pigment, which adheres to those parts where the gelatine was protected from light, and is consequently swelled by the water. Careful sponging now removes all excess of pigment. Tracings may be reproduced with remarkable perfection by the anthrakotype process.

Anthraphotoscope. A kind of photographic peep-show, backgrounds and figures being marginally mounted on glass discs, by suitably turning which various combination scenes can be produced—as, for example, a play in dumb show.

Antiplanat (*ἀντί*, in sense of against; and *πλανάω*, I lead astray). A term applied to a particular type of lens constructed by Steinheil. (See LENS.)

Antipyr. A name under which Formalin (*q.v.*) is sometimes sold.

Antiseptics. Substances which prevent putrefactive change. Phenol or carbolic acid and salicylic acid are frequently used in gelatinous mixtures. Alcohol, if present to the extent of about 20 per cent., effectually prevents the putrefaction of most organic mixtures.

Antispectroscopic. As applied to a lens. Synonymous with Achromatic.

Aperture of a Lens, Working. By this term is meant such clear way of the lens as is actually utilised in impressing the image of the plate. Many persons suppose that the working aperture of the lens is the diameter of the diaphragm, others that the whole surface of the lens is always utilised; but this is not so. The following method will prove the working aperture of any doublet lens, which varies with each separate diaphragm:—Rack the camera out to the true equivalent focus of the lens; replace the focussing screen by a sheet of cardboard, in the exact centre of which is a minute hole (a pinhole will do); behind this, exactly level, place a strong light, such as a paraffin lamp, and it will be found on looking at the lens that when a diaphragm is inserted in the slot a central portion only of the lens is illuminated. This can be easily seen by breathing upon the lens surface. It should be accurately measured, and this area will be the true working aperture of the lens with the diaphragm used. This area of illumination will be found to differ in geometrical proportion with each separate diaphragm.

Aphengoscope (*φέγγω*, I make bright). A device by which opaque objects are exhibited by means of the optical lantern.

Aplanatic (*a*, negating particle, and *πλανάω*, I lead astray). A term applied to a lens to denote that spherical and chromatic aberration have been eliminated so far as is practicable; it is impossible to do it theoretically. Practically it means that a lens will give reasonably sharp definition with its full aperture. (See LENS.)

Apochromatic. See ACHROMATIC.

Apparatus. The materials used in producing photographs, such as lens, camera, stand, slides, etc., which will be severally described under their various headings.

Aqua Fortis. See NITRIC ACID.

Aqua Regia. See NITRO-HYDROCHLORIC ACID.

Arabic Gum. See GUM ARABIC.

Architectural Photography. Specialisation in photographic work will often repay an amateur far more than the mere taking of anything and everything that he may come across, and which looks pretty. Architectural photography, if taken up as a special study, will well repay any one; but it is first necessary, to do this intelligently, that he should have some knowledge of the various styles of architecture. Good books upon this subject are the reprint of articles from *The Amateur Photographer*, by the Rev. T. Perkins, price 3s. 6d. (see BIBLIOGRAPHY), and "An Introduction to Gothic Architecture," by J. H. Parker, price 5s. For this particular branch of our art a square bellows camera is required. This form is preferable to the conical as being somewhat more rigid, and there being no chance of the bellows cutting off any portion of the subject. The size of the camera will of course depend entirely upon individual tastes. The lenses must be doublets, and at least three should be obtained—a short-focus, embracing an angle of at least 75°; a medium-angle, about the same focal length as the base of the plate, and a longer focus, which should be half as long again as the base line of plate. All should fit the same flange, or adapters should be obtained. Possibly the most convenient sets of lenses will be found in the so-called "Casket Lenses," which consist of various combinations of varying foci, which screw into a tube forming doublets of the ordinary type varying in focus from very short to long. A plumb and level must be attached to the camera, and the camera back must swing from the centre. The stand should be firm and solid, and the tips of the legs should be provided with cork bungs or indiarubber pads to prevent slipping on stone or marble floors. Equipped as above it will be possible to undertake almost every branch of architectural work, and by using one only of the combinations of above lenses we may obtain lenses of still longer focus. It is true that these will be single lenses, and therefore liable to give marginal distortion, but really this may be ignored, as in the case of a long-focus lens, as only the centre

of the field is used; in fact, when a single lens is the sole instrument which a worker has, let him not hesitate to boldly attack architectural studies, and no one will be the wiser, if the lens is not strained. Finally, we may dismiss all further reference to lenses, with the parting advice to use as long a focus lens as the situation of the object will allow. Obviously, we cannot think for one moment of including directions as to the best time of day, position, etc., of taking buildings, churches, etc., but a few hints may be acceptable. Seldom take a church or house full face, or with the sun directly behind the camera or directly in front; try to get a side or corner view and side lighting. In all church or cathedral exteriors, where fine delicate carving or tracery exists, a somewhat long exposure should be given in order not to lose the same. For interior work there is one absolute essential—that thickly coated plates, backed, should be used. No plate that is not backed will give perfect results; for not only is halation more troublesome, but also the negatives as a rule are less brilliant. When unbacked plates are used, the rapidity of the plate is really of no moment provided one can give long exposures; but if from any cause this is impossible, then the most rapid plates attainable should be employed. We may add here that colour-sensitive plates are decidedly to be preferred, and that the multiple-film plate will be found of great value for all architectural work, especially interiors. The aperture of the lens should always be the largest that will give satisfactory definition over the whole of the screen. Seldom place the camera exactly in the centre, rather a little to one side, of a church or cathedral. The question of exposure is always an extremely difficult one, and, whilst experience is invaluable, some such guide as an actinometer or exposure meter, which actually gauges the chemical activity of the light, will be of immense advantage. To correctly judge the exposure for interiors, especially if there is much coloured glass about, without some such guide is almost an impossibility. By far the best light to choose for exposure is, for the east end, the afternoon, for the west end the morning, and never in sunshine: diffused light is far superior and less likely to give rise to halation. With regard to development, thin delicate negatives are the most suitable, and the newer developing agents, amidol and metol, will be found of great value. If records and not

pictures of architectural subjects are desired, then it is wise to include in the view a two-foot rule, placed in the same plane as some characteristic feature, to indicate the scale on which the object is taken; and the plane of the plate should be parallel to the plane of the wall or surface of the building. The following short account of the characteristics of the various styles of English architecture may be useful:—*Norman* (1060—1100): Round topped door and window ways; short, heavy pillars and zigzag patterns. *Transition* (1100—1200): As Norman, with introduction of pointed windows. In the later examples of this style—often called *Early English*—(to about 1280) the windows are narrower and the pillars are clustered. Still later (to about 1380) much tracery was introduced in the windows, this being the so-called *Decorated Period.* The *Perpendicular Period* (1380—1547) is characterised by prevailing upright lines in windows, doorways, and often square top to windows. This developed into the *Tudor Style* (1550—1600) in which the square top is developed and carried out as a leading ornamental idea in other ways. The *Jacobean Style* (1603—1650) is very mixed; but with a considerable infusion of classical.

Area System of marking Lenses and Diaphragms. This was proposed by Mr. George Smith to replace the existing methods of marking stops. It is not so simple and has never come into general use. The actual method, as described by the inventor, is to measure the aperture of stop in sixty-fourths of an inch. This number is squared; the product is the exact area of the aperture in circles, each one sixty-fourth of an inch in diameter. Thus, supposing a stop aperture measured 20 sixty-fourths, 20 × 20 = 400, the last figure is struck off and the stop called No. 40, no matter what focus lens was used. Any lens is measured for its actual focus by measuring the distance of its burning point from the back of the lens in complete quarter-inches neglecting fractions. Suppose a lens was found to measure 20 quarter-inches; 20 × 20 = 400, striking off the last figure, its area number would be 40. Any other lens would be measured in the same way in quarter-inches. Thus it will be seen that every stop has its own number, and that whatever relation that number has to that of the lens it is used with gives at a glance the exposure required. It need hardly be pointed out that this method is subject to grave inaccuracies.

Argentometer. An instrument constructed on the principle of a Hydrometer (*q.v.*), and marked with a scale to show the number of grains per oz. of nitrate of silver in a silver bath. This is, of course, only applicable when the solution is pure.

Argentotype. A name applied to one particular make of gelatino-bromide paper.

Aristogen. Under this name Liesegang has introduced a concentrated hydroquinone developer, specially designed for developing gelatino-chloride prints. Its formula is said to be

Hydroquinone (10% alcoholic sol.) ...	10 parts.
Sodium sulphite conc. sol.	10 ,,
,, acetate 20% sol.	5 ,,
Citric acid, 20% sol.	5 ,,
Water	100 ,,

Aristotype. A name applied to one particular make of gelatino-chloride paper, but occasionally applied as a general term to printing-out papers with a base of collodion and gelatine.

Arrowroot (Ger., *Pfeilwurzelmehl;* Fr., and Ital., *Arrowroot*). The starch obtained from the tubers of Maranta Arundinacea. It is a fine, white, tasteless, odourless powder which has a particular crepitating feel in bulk. It is used for sizing papers.

Artificial Light, Portraiture by. See PORTRAITURE, also FLASH LIGHT and ACETYLENE.

Artigue's Process. A method of carbon printing without transfer, which has come into extensive use among those who strive for pictorial effect, as it allows very complete control in development, and the permanency of the results is assured and does not depend upon the fulfilment of any special or occult conditions in development, toning, fixing, etc. Many workers prefer to purchase the "*Papier Velours*," or special tissue, made under the directions of M. Artigue from his agents (*e.g.*, M. L. Soux, 48, Rue de la Victoire, Paris). Others, however, may wish to themselves prepare a somewhat similar paper. The following method, due in the main to Mr. Duchochois, if carefully carried out, gives results very similar to those obtained upon M. Artigue's own paper. In 15 parts of water 5 parts of white and carefully picked gum arabic are dissolved—the round and slightly friable lumps being selected. When the

solution is complete, a matter sometimes of days, the mucilage is strained through muslin, and we next add 100 parts of white of egg and a quantity of Indian ink or other finely ground water-colour sufficient to give a coating on paper, which shall be nearly full black or full coloured by reflected light, but not so opaque as altogether to obscure a coin behind the paper when both are held up to the window. Enough liquid ammonia to make the preparation slightly alkaline to test paper is now stirred in, but a minimum of two drops to each fluid ounce may be added in any case. The preparation is now ready for coating the paper which should be done by brushing on a thin and uniform layer with a broad camel's hair brush. (See CARBON PRINTING.) The paper may be writing-paper or drawing-paper of any required texture; but to obtain the finest and sharpest detail by the artigue method, a fine paper, such as "Rives," should be used, and this should be coated with a film of plain gelatine before applying the pigmented mixture. The gelatinous mixture for use as a substratum may consist of

Hard gelatine, as Coignet's gold label ...	1 part.
Water...	8 parts.

Soak, melt in water bath, strain through muslin into a warmed porcelain dish. The mixture must not be allowed to cool, and each sheet much be floated for an instant, and then be pinned up to dry. (See PINS.) When dry it is coated with the Indian ink mixture in the way already described. The paper thus coated is insensitive to light, and must be sensitised by being floated, face upwards, on a solution of ammonium bichromate containing 1 part of the salt dissolved in from 10 to 20 parts of water. If the paper is soft and porous in texture the weaker solution should be used, and floating for a few seconds may be sufficient; but if the paper is close in texture and is covered with a substratum of gelatine, the stronger sensitising liquid must be used, and the paper must remain floating on the bath for a longer period. The criterion is the penetration of the bichromate to the face of the paper, and when this is the case the pigmented film can be rubbed off by gentle friction with the finger. Should it be preferred to prepare the paper so that it shall be sensitive to light in the first instance, $2\frac{1}{2}$ parts of powdered bichromate of ammonium are stirred into the mixture, as given

above, immediately after the Indian ink has been added. The insensitive paper will keep indefinitely, but the sensitive paper will only keep good for a few days. When the paper is dry—and it should be dried in a place which, like a kitchen, has a fire constantly burning, and the walls of which are dry—it is exposed under the negative until details are visible at the back. The development is an operation in which very widely different treatment may be necessary, according to atmospheric conditions and other circumstances which affect the solubility of the pigmented film; but the instructions given for the development of the *non-transfer* carbon print, under CARBON PRINTING, may be taken as generally applicable. When the basis is smooth paper coated with gelatine, it becomes almost essential to adopt M. Artigue's expedient of developing with a soup-like mixture of ground sawdust and water, as then the image lies in what is in effect a delicate intaglio, and any other attrition than that of the wet sawdust would tend to wipe it out of the intaglio. The sawdust may be of any wood; but it should either be ground in a roller-mill, or should be sifted, and only that used which will pass through a No. 12 (12 meshes to linear inch) sieve. The sawdust being mixed with water of the required temperature to the consistency of soup, this mixture is flushed and re-flushed over the pigmented surface until development is complete—any increase in the temperature of the mixture being regulated by the considerations given above. As artigue printing is somewhat new in this country, and it is essentially a method for those few who do not mind extra care and trouble in order to obtain the desired results, we give the experience, opinions, and working directions of Mr. Andrew Pringle, in the shape of some extracts from an article which he contributed to the *Amateur Photographer* towards the beginning of the year 1896. It must be remembered that Mr. Pringle's experience and remarks have reference to the genuine artigue "*Papier Velours*," and not a home-made substitute such as is referred to in the early part of this article. Mr. Pringle expresses a confident opinion that two prints by Artigue's process, which were exhibited in the Salon of 1895, surpassed any prints he had ever seen by any photographic process. After remarking that in the ordinary carbon process we either get our image reversed, or we require a double transferring process to right

matters, while the artigue tissue, being developed from the front, gives a properly placed print by one process, Mr. Pringle says: "To sensitise this tissue, we immerse it boldly in a solution of potassium bichromate—2 per cent. of the salt in water will be found suitable. In the printed instructions an alternative method is given—brushing the solution twice on the back of the tissue—but this will probably be found more irksome and less satisfactory than immersion. The tissue is immersed in the solution for about two minutes, or till it lies quite flat and limp in the dish. It is then, in the writer's practice, laid down on a sheet of glass with a surface free from scratches and other defects, and a squeegee lightly passed over the back in order to remove superfluous solution. It is then hung up or laid out to dry naturally. Along with the tissue, we immerse in the sensitising solution a strip of ordinary for use in the actinometer. When we come to print, no image appears visible under the action of light; and with the paper is sent out a very convenient 'actinometer.' The strip of paper sensitised in the bichromate solution is first placed in the actinometer with a portion projecting beyond the part protected by the opaque part of the actinometer, and on this projecting part the light is allowed to act till the yellow paper has taken a print as dark as it will take; this then becomes the standard tint. A weak negative may require two tints, a medium four, a dense one six or more. The artigue paper sensitised as above takes rather more printing than the new specially sensitive tissue of the Autotype Company —roughly speaking, about 25 per cent. more. The development is performed with tepid water, to which is added a very fine sawdust, specially prepared, till the liquid is about as thick as strong pea-soup. The thicker the 'soup' the more rapid the development, and it is found a waste of time to attempt the process with plain water; a certain amount of friction is required, without which the process would take a very long time. The 'soup' is put into a good-sized basin, and it is kept and used repeatedly. For pouring on the soup a kind of coffee pot, with an unusually large spout, is used. It does not do to play with the temperature of the water. A thermometer must be used, otherwise trouble will certainly arise. The exposed tissue is first immersed in water, plain, at 29° C. (84° F.), and then left for a few minutes till a very faint image appears. It is then

laid on a piece of glass, and the 'soup,' at about 27° C. (80° F.), is poured on from a little height. There must be no forcing of the operation by heating the 'soup.' In a minute or two the image will begin to appear more clearly, but still very ill defined, and the operation is continued, the 'soup' being kept up to its original temperature by a heater or by the gradual addition of hot water. The thicker portion of the 'soup' will of course be at the bottom of the basin, and may be used to accelerate matters, but, as a rule, the water must not be above 27° or 29° C. If the shadows and the high lights at first appear pretty closely together, and if gradually the high lights clear themselves from the shadows, the exposure has been right; but—and here is a curious fact—if the exposure has been too great, the high lights will run away from the shadows, and the lights will be white before the shadows have shown enough of detail, and the print will be strong black and white. On the other hand, if the shadows and the lights keep on coming up together, it is a sign of under-exposure, and the print will end by being dirty grey, the high lights refusing altogether to clear."

Mr. Pringle, in the paper from which the above particulars are quoted, says that development with warmer "soup"—say 30° C. —may sometimes be a remedy for the greyness arising from under exposure, and if the image comes up black and white at an early stage the best plan is to soak the print for an hour or so in almost cold water. Development should be very fully carried out, as the prints, when dry, look unexpectedly dark. The sawdust being rinsed off, the print is tanned in a 5 per cent. alum solution, washed, and allowed to dry. Mr. Pringle recommends the beginner to use decidedly plucky negatives. Lieut.-Col. Saint Florent recommends a cold saturated alcoholic solution of bichromate of ammonia for sensitising the artigue paper, the solution being poured over the carbon surface, and after draining off the excess the paper can be dried in two minutes. After exposure, the print is soaked for half an hour in cold water, laid face upwards on a glass plate and developed by rinsing and gentle friction with a tuft of cotton wool. Warm water may be required for development if the sensitised paper has been kept long. For details of other single transfer carbon methods, some of which border closely on the artigue method, see CARBON PRINTING.

Artotype. See COLLOTYPE.

Asphalt (Ger., *Asphalt, Judenpech;* Fr., *Bitume de Judée Asphalte;* Ital., *Bitume di Giudea, Asfalto*). Synonym: Bitumen, Jews' pitch. It is met with in commerce in black or brown lumps of peculiar gassy and tarry odour, and is obtained from Syria, Trinidad, and other places. Syrian bitumen is the one most generally used in photography as it contains 52 per cent. of the light-sensitive preparation. It is prepared for photographic purposes by three different methods: (1) Solution of the asphalt in chloroform and precipitation with from three to five times the quantity of ether. (2) Kayser's method of washing powdered raw asphalt with ether, and using the dried marc for the preparation of the light-sensitive varnish. (3) Husnik's method of dissolving raw asphalt in the smallest quantity possible of German turpentine and precipitating with several times the quantity of ether. Kayser proved that the light-sensitiveness of asphalt increased with the proportion of sulphur, and Valenta based the following processes of increasing the sensitiveness on this statement. To prepare the light-sensitive preparation 7 to 10 parts of sulphur should be dissolved in a sufficient quantity of bisulphide of carbon, and added to 100 parts of powdered Syrian asphalt. The solution is then freed from the bisulphide of carbon by evaporation, and best heated for about an hour in a mortar to 110° C., with constant attrition with the pestle; then in a roomy air-bath slowly heated till sulphuretted hydrogen escapes, and be kept at a temperature of about 180° to 200° C. for 5 to 6 hours. The formation of burnt products, which prove a decomposition of the asphalt, are caused by too high a temperature, and is to be avoided. The asphalt thus prepared, which now only smells faintly of sulphuretted hydrogen, should be kept in a well-closed bottle in the dark. For working in diffused daylight, and especially if high sensitiveness is desired, it is advisable to free this asphalt from any existent resin, and from traces of burnt products, which may be effected by powdering and treating the powder with ether, and with agitation in a wide-mouthed bottle fitted with a cork. After sufficient action, 2 to 3 hours, the ether is poured off and the insoluble portion dried by spreading it out in thin layers on several thicknesses of blotting paper. For use, four parts of sulphurised asphalt, treated as

above, are to be dissolved in 100 parts of benzol (not the so-called benzoline), the solution filtered, and finally diluted till the film which is formed by pouring it on the zinc plate appears a golden-yellow colour. (An exposure of from half-an-hour to one hour of the solution of asphalt in an open flask to direct sunlight is advisable.) To develop the asphalt pictures, rectified oil of turpentine free from acid, as for example French or Austrian turpentine, should be used. As accelerator of development with strong over-exposure, an addition of so-called Russian or Hungarian turpentine may be made, which oils, when used alone, would attack the image. As restrainer in developing, an addition of ligroin, benzoline (petroleum benzine), or wood oil may be used. The development is best effected by merely rocking in a dish without the help of any pad of cotton wool; and soon, when the image is developed clear, it should be well washed in a stream of water and allowed to drain and dry. (In order to avoid the unpleasant action of adhering drops of water, the plate may be washed with petroleum benzine before washing with water.) It is advantageous before gumming the plate to expose it, as the image adheres better. Valenta also suggests the following simplified method of preparing light-sensitive sulphurised asphalt or bitumen:—100 grammes of raw Syrian asphalt are to be boiled with an equal quantity of commercial pseudo-cymene in which 12 grammes of sulphur flowers have been dissolved. When, after about three or four hours, the formation of sulphuretted hydrogen has ceased, the cymene is distilled off, and the product is the light-sensitive asphalt from which the film is prepared in the usual way by solution in benzol. The new preparation is soluble in benzol, toluol, cymene, xylol, and turpentine; it is said to be even more sensitive than that prepared by Valenta's other method. Bitumen is used in several photomechanical processes for making a light-sensitive film, and raw bitumen for laying the ground in photogravure. A kind of artificial asphaltum has been prepared from petroleum, Messrs. Mabery & Byerley having found that, if petroleum is slowly distilled in a current of air, and at a temperature not exceeding 650° F., asphalts of various degrees of hardness are formed. They do not appear, however, to have studied the sensitiveness to light of the new asphalts, but being able in some sense to control these, the viscosity or brittleness of the product

should be an advantage in those etching processes on metal in which dusted on resists are used.

Astigmatism (*'a*, negative particle, and *στιγμη*, a dot or point). A defect in lenses from which vertical and horizontal lines near the margin of the field cannot be both accurately focussed at

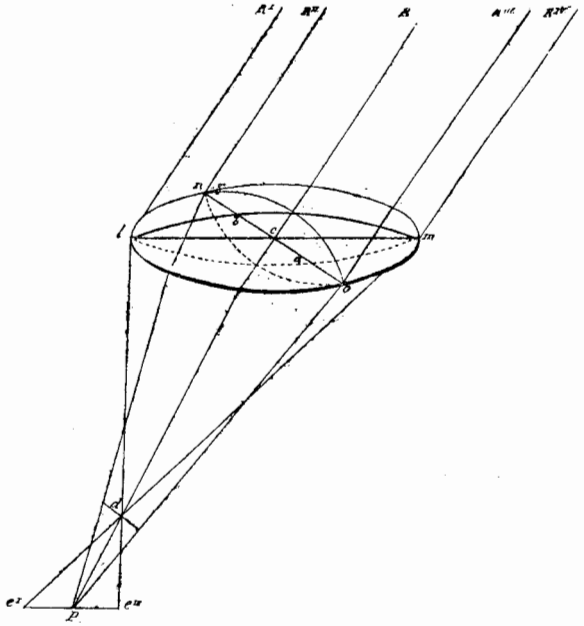


Fig. 5.

the same time. It is particularly noticeable with lenses of large aperture, and is cured to some extent by the use of small diaphragms or by special selection of the glass and calculation of the curves. This should not be confounded with curvature of the field, as in this case the alteration of the focus will improve the marginal definition, though destroying the focus in the centre. To explain this we must have recourse to a figure. If we assume *l o m n* to be a convex lens, and *a b* its axis, and

R,R,R,R,R rays proceeding from a point at some distance from the axis, and from this point draw a line R P, cutting the axis at *c*, and draw through this point, and the principle axis of the lens, a plane, the lens will be cut by the line *m*. At right angles to this we draw the plane O N, through which the plane of rays, R″,R,R‴, shall pass. We shall now see that the rays passing through *o c n* will meet at the point P, but the rays, R′,R′, passing through

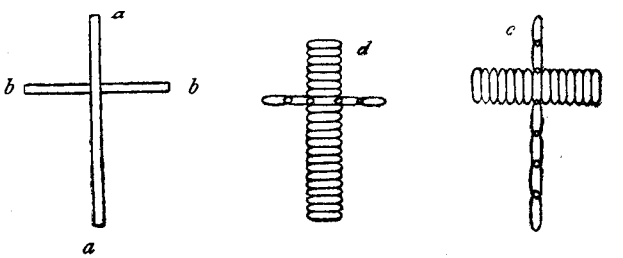


Fig. 6.

l m will cut the axis R P at *o*. If we assume that we have two straight lines as in fig. 6 to reproduce at the margins of the focussing screen, we shall find that we can at the point P obtain an image of *b b* every point of which is slightly lengthened, and can be represented as in fig. 6 *d*, whilst the upright line *a a* will be represented by *e′*, *e″* and appear as in fig. 6 *d*. If, however, we focus on *a a*, then we shall obtain a sharp image at *e*, whilst *b b* will be

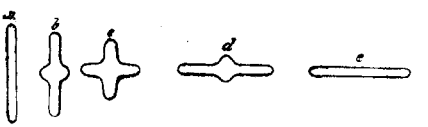


Fig. 7.

represented as in fig. 5 *c*. Some of the later forms of lenses are free from astigmatism over a certain field, notably the Anastigmats of Zeiss and Goerz. In the old forms the optician has to make a compromise between curvature of the field and astigmatism; and the best lenses are those which represent a point as a somewhat thickened star. In focussing a line at P, fig. 5, and racking the lens in to *o*, it goes through the shapes shown in fig. 7.

Astronomical Photography. This is to a great extent beyond the reach of the ordinary worker, as the size of the images given by ordinary photographic lenses is excessively small, being, in the case of the sun or moon, $\frac{1}{10}$ of an inch in diameter for every ten inches of focus, but with Dallmeyer's telephotographic lenses considerable augmentation of the size is obtained; on the other hand, when it is desired to obtain negatives of any portion of the sky, portrait lenses of about 6 inches aperture and 30 inches focus may be used for half or whole plates, which will give fairly successful results. A useful article on this subject will be found in *Astronomy and Astrophysics*, October 1892, p. 641. Possessors of a $2\frac{1}{2}$ or 3-inch refracting telescope may, however, wish to utilise the same for lunar or stellar work, and in such a case it is necessary to remove the eye-piece, and attach a very light camera in its place, the operation of focussing and exposing being the same as usual, using very rapid plates, and giving exposures of about $\frac{1}{8}$ or $\frac{1}{4}$ sec.; longer than this will cause blurring of the image, due to the combined movements of the earth and moon. As astronomical telescopes are corrected for the visual and not the chemical rays, it is necessary to find out experimentally the difference; and this is best done by focussing with the eye as sharply as possible, and then racking the plane of the sensitive surface further out by sixteenths of an inch, making an exposure after each movement till the sharpest image is obtained on the negative after development. The distance thus found may be once for all marked on the draw-tube of the telescope. A simple and remarkably ingenious device, described by Lord Crawford about twenty years ago, serves to transform the pillar and claw stand into a form of equatorial, very serviceable for such work as the ordinary amateur is likely to undertake; any object in the great revolving sphere of the heavens being now easily followed by one movement of the telescope or camera, instead of the double movement otherwise necessary. The sketch shows a form of Lord Crawford's device, easily arranged by any one possessing a small telescope and stand of the usual pattern. In the first place the telescope stand must be mounted on a firm slab or bench, as shown in our sketch, the bench being adjusted as accurately as possible north and south. When we say the telescope stand is to be mounted on the slab, we mean that provision should be made for readily mounting it, as the

bench should ordinarily be a rough, heavy table kept out of doors, a recess in the bench and thumbscrew for each foot being sufficient; and care should be taken that when the stand is in its place the pillar is vertical. A position B is now found on the meridian line B C, where a line drawn from the centre of motion of the altitude axis A will form at B the angle A B C equal to the latitude of the place. A Londoner would therefore make the

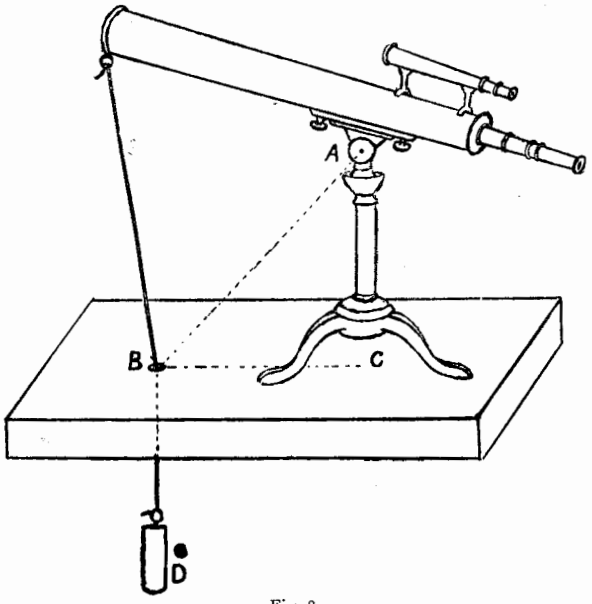


Fig. 8.

angle A B C equal 51° 30′, and a worker in Edinburgh would make it equal 56°. A cord is now attached to the telescope at the object glass and passed through the hole B, this cord being kept conveniently tense by a weight D, which weight should not be so heavy as to interfere with the free control of the telescope by the observer. The object having been found, the cord is clamped at B, and the object can now be followed by so moving the telescope as to keep the cord tense. A peg of wood in the

hole B will serve to clamp the cord, although Lord Crawford used a clamping screw which drove the cord into a narrow groove, and so very accurately fixed its position. When the telescope is used as a camera a finder as shown in the sketch, is especially useful, although it is not difficult to so mount the original eye-piece of the telescope in the focussing screen frame of the camera that it will serve as a finder. To photograph a group of stars will generally involve an exposure of some minutes, and each star will be represented not as a point, but as a tracing of its apparent path. Such a stellar photograph has, as Dr. Stolze pointed out some years ago, the special advantage that a spot on the plate is not liable to be confounded with a stellar image. Photographs of the sun may be so instantaneous that the movement does not count.

Atmosphere in a Photograph. See AERIAL PERSPECTIVE.

Atmospheric Action. It must not be forgotten that developers are substances more or less ready to take up oxygen from the atmosphere, and that in so doing not only is their developing action weakened, but more or less objectionable products are formed. When a made up developer is required in considerable quantity, so as to be ready for frequent use, the device sketched below serves admirably as a protection against deterioration by atmospheric action, and yet allows small quantities to be drawn off for use as required. Let A be the top of the work bench in which is cut a hole large enough to easily admit the neck of the bottle, B, which bottle stands on a shelf, I, so trimmed at one end as to allow of the bottle being placed in position as shown. The bottle, A, may be of any required size, from a pint to a gallon or more, and it is fitted with a doubly perforated indiarubber cork (obtainable at Hancock's Rubber Works, Goswell Road). Two bent glass tubes pass through the cork as shown, instructions for obtaining and bending these being given under the article GLASS (*q.v.*). The cork bearing the tubes having been removed the developer is poured in, and then sufficient of the ordinary paraffin oil used for lamps to form a floating layer, H, about an inch deep. The cork being placed in position, any required quantity of the developer can be made to flow out of the doubly bent tube, E, into the developing cup, F, by blowing in the tube, D. When the paraffin oil is first poured in, the tube, E, should be

sufficiently immersed in the fluid to well cover the end, in order to prevent any oil entering the tube in question. When fresh developer is to be added to the contents of the bottle, a convenient plan is to pour it through D, to which a funnel, J, is temporarily connected by an indiarubber tube, as by this means the paraffin oil is kept from the end of the tube, E. Other means of providing for this will suggest themselves, such, for example, as the precaution of closing the upper end of E with the finger when replacing it after removal. If the developer is poured in

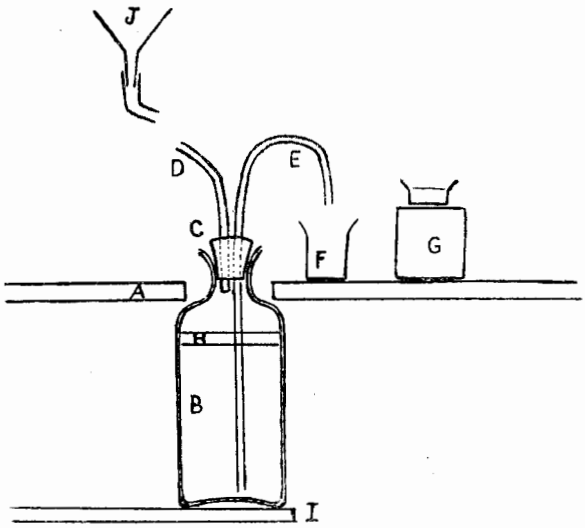


Fig. 9.

through D, the attachment of a short length of rubber tube as a mouthpiece is an obvious precaution. Another way of filling the apparatus is to raise the developing cup, F, so that E about touches the bottom, pour in the developer and suck out the air at D, keeping a sufficient supply in F. In practice this is unpleasant, owing to the vapour of paraffin which is inhaled, to say nothing of the possibility of sucking liquid paraffin into the mouth. Although the atmospheric action through the upper end of E will never be considerable, it may often—or, indeed,

generally—be closed by a small cup of water, in which a crystal of sodium sulphite may be dissolved, this cup being retained in position by a suitable block, G.

Atomic Theory, Calculations based on. See EQUIVALENCE, CHEMICAL; also WEIGHTS AND MEASURES.

Aurantia. $N(C_6H_2[NO_2]_3)_2NH_4$ is formed by the nitrification of Diphenylamin. The commercial preparation contains numerous impurities insoluble in alcohol, but the pure dye is easily soluble in alcohol, is not destroyed by acids, and with alkalies turns more reddish. It has been used in orthochromatic photography, not only for sensitising plates, but also for the preparation of the coloured Screens (*q.v.*), and in the preparation of a solution which has been recommended as an addition to developers, so that plates could be developed in ordinary rooms without fogging. The formula of such a preparation is as follows:—

Aurantia	...	...	...	...	...	16 parts.
Carmine	...	...	...	...	...	8 ,,
Water	...	...	...	...	...	24 ,,
Alcohol	...	...	...	...	...	24 ,,

Add sufficient ammonia to effect complete solution. Six parts of this to be added to every 100 of developer. Its use, we need scarcely add, is not to be commended.

Aurine. Synonyms: Rosolic acid, Yellow coralline. This is a dark, amorphous mass of reddish-green, iridescent tinge, formed by the treatment of carbolic acid with acids, etc. It is insoluble in water, but soluble in spirit and ether, which it colours yellow. It has been suggested to make non-actinic leather collodion, which should be poured on the back of the dry plate to prevent halation.

Autogravure. A term applied to prints obtained by the Photogravure process (*q.v.*).

Automatic Oxygen Generators. Several devices exist in which the gas-holder itself controls the generation of the gas—a clever contrivance by Mr. G. R. Prouse being described in the *Magic Lantern Journal* for 1892. Another by Mr. McIntosh, of Chicago, was very highly spoken of by Professor Burton.

Automatic Photography. Several machines have been invented, consisting of mechanism set in motion by dropping a

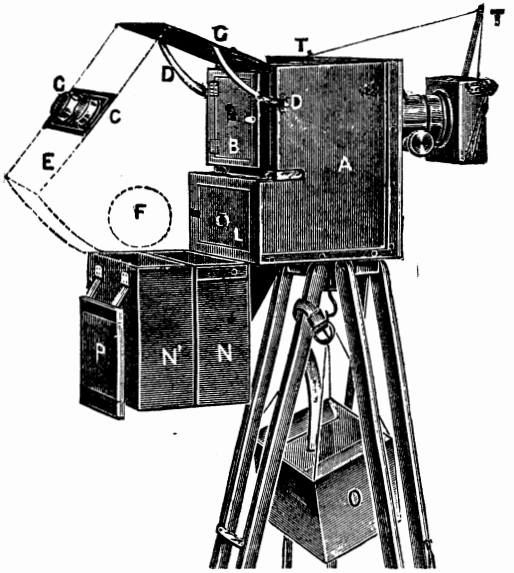


Fig. 10

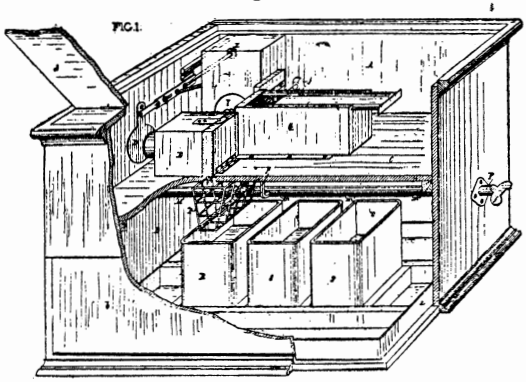


Fig. 11.

coin in a slot, and which are supposed to turn out photographs. Such devices have hitherto been unsuccessful, and generally it has been necessary to provide an attendant to look after the working of the machine. Semi-automatic machines, in which the passage of the plate through the various baths is controlled by an operator outside, and in which the use of a dark room is avoided, have been more successful—notably, the apparatus of Mr. Nievsky, which is shown in the subjoined sketch (Fig. 10), taken from the Photogram, the dotted portion being a black cloth tent, and the apparatus supplied by M. Faller, of Paris, the interior of which is shown by Fig. 11. (See also following article.)

Automatic Printing Machines. As far back as 1860, Mr. Fontayne, of Cincinnati, had in operation an exposure machine in which two hundred exposures a minute were made upon a band of sensitive paper. Fontayne used sunlight concentrated upon the negative by a large condensing lens, and at the meeting of the American Photographical Society, held on August 13th, 1860, Mr. C. H. Babcock exhibited bands of paper upon which Mr. Fontayne had made prints by his machine. In 1882 Mr. Tromel introduced a very much simplified form in which the paper was not exposed automatically; in fact, Mr. Tromel's device was really not much more than a combination of a roller slide and a printing frame; but a year afterwards, Dr. Just, of Vienna, called renewed attention to the subject of automatic exposures on a band of paper, by exhibiting some interesting results at the Brussels Exhibition in 1883. He showed four series of prints made by ordinary daylight at the rate of from 400 to 500 an hour; the time required for exposure limiting the speed. He also showed platinotypes printed on bands of paper by his machine, the rate of production being, of course, very slow in this case. Soon after this, Colonel Hoe, a member of the celebrated firm of printing-machine makers, Messrs. Hoe & Co., of New York, gave some attention to the matter, and suggested the possibility of newspaper printing by flashing the electric light a hundred times a minute, or six thousand times an hour, through a negative representing one side of the paper, and on to a web of sensitive paper passing under the negative. In 1886 Herr E. Krauss constructed an ingenious

device by which numbers and letters might be impressed from transparent bands upon a sensitive plate, thus laying the foundation for something like a photographic type-writer, by which a "letterpress" negative may be made as rapidly as a type writing; an interesting novelty in connection with a recent invention by Mr. Friese Greene. One form of Mr. Friese Greene's machine contains what may be regarded as a cylindrical and self-luminous negative; a glass cylinder upon which is wrapped a celluloid negative, containing an incandescent electric lamp. As the band of bromide rolls over this it becomes impressed, and before it leaves the machine it is developed, fixed, washed, and dried. This machine is intended for magazine printing, the text being printed with the pictures, by the type-writer device above mentioned. A single line of characters being brought into order by Mr. Greene's machine, this line is photographed on a roll of film which moves just the depth of a line, when another line is set, and photographed on the same roll of film.

Autotype Process. See CARBON PROCESS.

Aux Deux Crayons. A certain style of stained or toned silver print is or has been known by this expression in the United States. Mr. W. Bell, who advocated this style, says, "Make two solutions, viz.:—No. 1. Aloes, powdered, 1 oz., alcohol 12 ozs. No. 2. Water 12 ozs., liquor ammoniæ 15 drops. Immerse prints on albumenised paper in No. 1 until they take a bright lemon colour, then wash them well, and put them in solution No. 2. Let them remain until they are a warm orange colour, and again wash them. Mount and touch up the whites with Chinese or any good white, and the blacks with Indian ink. After touching up the whites and blacks, coat the pictures with the following:—Plain collodion 6 ozs., castor-oil 12 drops." A similar proceeding may be carried out with bromide, platinotype, or other prints.

Auxiliary Exposure. It is needless to state that a certain minimum exposure is necessary to obtain any action. When, from certain circumstances, the exposure is too short to allow of the whole of the image, particularly in the shadows, affecting the film, it has been stated that an auxiliary exposure is of great assistance. The auxiliary exposure may be either pre-

liminary to or after the real exposure. In the old daguerreotype days it was sometimes customary to expose the plate, after the real exposure had been given, to the light passing through red or yellow glass, and a more fully exposed image was said to be obtained. With the wet-plate process a similar proceeding was warmly upheld by several experts. With gelatino-bromide plates, in consequence of their rapidity, the auxiliary exposure is so extremely short that indubitable proof of its advantage is hard to obtain. A method suggested, and which has certainly the merit of simplicity to recommend it, is to replace the ordinary lens cap with a flap shutter, the inside of which is a sheet of pale yellow glass, ground on one side. The shutter is so arranged that the glass and flap can be lifted together to give the true exposure; and, when this is completed, the shutter alone is lifted, leaving the yellow glass covering the lens, and a flash as quick as possible is given through this. It is only fair to add that the benefit of an auxiliary exposure with dry plates is much disputed, and possibly because it has to be so short, or else general fog supervenes. The *rationale* of auxiliary exposure is that it either commences the necessary chemical action, or else adds to the action already commenced by the true exposure, and thus gives a developable image, or one which develops more easily. Auxiliary exposure has also been suggested for printing processes, and with regard to gelatino-chloride paper there is no doubt that a preliminary exposure to white light prevents loss of detail in the high lights during the processes of toning and fixing.

Axis. The axis of a lens is the imaginary straight line which passes through the optical centre of the lens. The principal axis passes through the centre of the radius of curvature and the optical centre; any other straight line passing through the optical centre is termed a secondary axis.

Azaline. This is a mixture of quinoline, or chinoline, red and quinoline blue, or cyanin, in the proportion of 10 parts of the former to 1 part of the latter dissolved in 1000 parts of alcohol and, when mixed with ammonia and water, is used in orthochromatic photography to sensitise plates for red and yellow. The actual bath is prepared as follows:—

Azaline solution, as above	4 parts.
Liq. ammonia	1 ,,
Alcohol	30 ,,
Water...	70 ,,

Azote, Azotate. Old synonyms for nitrogen and nitrate.

Background. Anything used, as the name implies, as subordinate to or behind the principal figure or figures or objects in a photograph. There are many kinds—natural, artificial, interiors, exteriors, or plain. Natural backgrounds when properly used are the most pleasing, and as these cannot be made to order, the intelligent amateur will choose his own. The artificial background is too well known from the work of the professional to need much description. A pleasing plain background can be made with a workhouse or dark brown blanket, or with one of the ordinary kind. An ordinary white sheet, or even brown paper of the kind used for placing under carpets, may be pressed into service in place of better material. The following directions for making a movable background may be of service to some:—Make a frame of inch deal 6 ft. high and 4 ft. 6 ins. wide. It can be made to take to pieces by using iron pins at the corners. At the top have two projecting iron rods, about 4 ft. long, at an angle of 135°. This to be made extendable at will. Side-shades should be made in the same manner. Unbleached calico can be used, which should be freely painted over with the following distemper:—

Common whiting	1 lb.
Glue powder...	¼ ,,
Treacle	½ pint.
Water	½ gall.

Mix the above thoroughly, and add

Ivory black	1 oz.
Ultramarine	½ ,,
Red ochre	¼ ,,

ground down into a very fine cream with water. It can be darkened or lightened according to amount of colour added; the colour is lighter when dry. Some of the most artistic results are to be obtained by the use of graduated or shaded backgrounds;

these, though somewhat difficult to successfully make at home, may be obtained at a very reasonable price from nearly all dealers. A convenient frame or support for amateurs' backgrounds has been devised by M. D'Abmonville. To each end of the background is nailed a roller of bamboo; and the supports are two long lengths of bamboo carrying a point at each end,

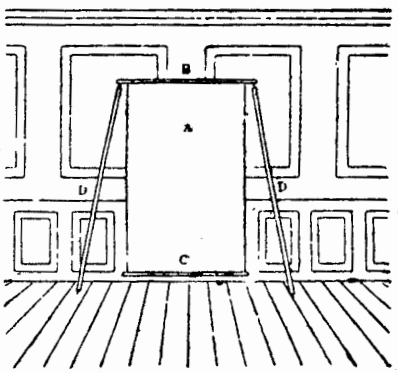


Fig. 12.

these serving to support the background against a wall as shown in the sketch (Fig. 12), the lower points engaging slightly in the floor so as to hinder them from slipping outwards. For portability, the two long lengths which serve the double purpose of struts and supports may be divided and furnished with a socket-joint at D. (Also see PORTRAITURE.)

Backing Plates consists of coating the back of plates with some black or non-actinic substance to prevent Halation (*q.v.*). The essentials of a perfect backing are that it should reflect no rays of light—or, at least, only those that are non-actinic—and that it should be in absolute optical contact with the back of plate. Several methods have been recommended, coating the back of the plate with collodion stained with aurin or any non-actinic dye being a method which is easier advised than done in the dim light of the dark-room. The following, if spread upon brown paper and damped before applying to the plate, answers well :—

Powdered burnt sienna	1 oz.
Gum	1 ,,
Glycerine	¼ ,,
Water...	10 ozs.

Or

Gelatine	50 grs.
Glycerine	¼ oz.
Water	1 ,,
Indian ink or ivory black	30 grs.

Whatever backing is used, it must be removed before developing. Debenham has suggested the use of caramel or burnt sugar and sienna; it has been found to be the most effective and easily prepared of any, and is made with

Mucilage	1 oz.
Caramel	1 ,,
Burnt Sienna in powder	1 ,,

Mix in a mortar; distribute this over the back of the plate with a roller squeegee or pad of lint. Cornu recommends a mixture of 6 parts of oil of cloves, and 1 part of oil of turpentine made into a paste with lampblack.

Bain Marie. A water bath, similar in principle to the ordinary glue pot.

Balance, for weighing. See WEIGHING AND MEASURING.

Balance of Effect. A term used in composition to denote the proper relation of lines and lights and shadows, so as to secure harmonious and symmetrical pictures. The subject is much too comprehensive to treat of here, H. P. Robinson's "Pictorial Effect in Photography" being the best guide on the subject.

Balloon Photography. As early as 1858 Nadar of Paris obtained a photograph of the earth below from the car of a balloon, and during the American war of 1861-2, photography from balloons was practically applied to warfare. Since that date numerous experiments have been made, both with captive and free balloons, to obtain results which might be of value in warfare. The attempts have proved that such work is not only possible, but may prove of value.

Balsaming, Re-, of Lenses. In order to reduce reflection and consequent degradation of image, those contact surfaces of lenses which are ground to the same curve are usually cemented together with Canada balsam. Occasionally these cemented surfaces separate more or less completely, or the balsam undergoes a kind of congelation; while occasionally it becomes so yellow as to make the lens extremely slow in its action. The separation, cleaning, and recementing which then becomes necessary is neither difficult nor does it involve much risk, although, where practicable, it is better to send the lens to the maker. The principle points of the operation, as described by Mr. J. Trail Taylor, are:—(1) Boiling the combination in water, with precautions against mechanical damage and sudden heating; (2) separation by sliding one glass over the other; (3) clearing by ether, old collodion, or alcohol; (4) recementing. For this purpose the lens with the concavity is laid on a sheet of paper and a large drop of clear Canada balsam is placed centrally on the concavity. The convex surface is now brought down steadily into its place, so that the balsam exudes all round. The two glasses are now tied with a long string, which is made to cross and recross in many directions, care being taken that the edges of the glasses coincide. In this condition the lens is allowed to remain in a warm place until the balsam at the edges has hardened, when the string is removed and the lens cleaned by similar means to those previously employed.

Barium Bromide (Ger., *Baryum bromid;* Fr., *Bromure de baryum;* Ital., *Bromuro di bario*). $BaBr_2$. Prepared by neutralising hydrobromic acid with barium carbonate. Crystallises with $2H_2O$. Solubility: 100 parts are soluble in 96 parts of cold water, and in 75 parts boiling; it is also soluble in alcohol and ether. Occasionally used in collodion. Like all barium salts it is poisonous.

Barium Chloride (Ger., *Bariumchlorid or Chlorbarium;* Fr., *Chlorure de baryum;* Ital., *Cloruro di bario*). $BaCl_2$. Prepared by heating barium carbonate with hydrochloric acid, or by heating in a reverberatory furnace, powdered heavy spar ($BaSO_4$), calcium chloride, chalk, and coal dust, extracting the chloride of barium with water, and crystallising, when it takes $2H_2O$. It occurs as white tabular crystals, permanent in air, which lose their water

of crystallisation at 150°. It is poisonous. It is occasionally employed in salting albumenised paper, and for making Baryta Paper (*q.v.*) and imitation opal glass. Solubility: 36 per cent. in cold, 59 per cent. in boiling, water; 0·01 per cent. in cold alcohol, 0·5 per cent. in hot alcohol, 10 per cent. in glycerine.

Barium Iodide (Ger., *Iodbarium;* Fr., *Iodure de baryum;* Ital., *Ioduro di bario*). $BaI_2 = 391$. Prepared by heating iron filings and iodine till colourless or pale yellowish green, then adding barium hydroxide as long as a precipitate is formed, filtering and evaporating. It occurs in deliquescent tabular crystals. Solubility: 1 in ·48 of cold, and 1 in ·35 of hot water; soluble in spirit, and slightly so in ether. Used in collodion.

Barium Nitrate (Ger., *Bariumnitrat;* Fr., *Azotate de baryum;* Ital., *Azotato di barite*). $Ba(NO_3)_2 = 261$. Prepared by neutralising dilute nitric acid with barium carbonate, evaporating and crystallising. It occurs in octahedral translucent crystals. Solubility: 8 per cent. in cold, 35 per cent. in hot water; insoluble in alcohol. It is poisonous. Used to prepare ferrous nitrate—a developer for the wet-plate process. It is also recommended as an addition to the silver bath to prevent the formation of pin-holes, and has been suggested as an ingredient in magnesium flash-light.

Barium Sulphate (Ger., *Bariumsulfat*, or *Schwerspath;* Fr., *Sulfate de baryum;* Ital., *Solfato bi barite*). $BaSO_4$. Synonym: Heavy spar, Blanc fixe, Mountain snow. Used as a pigment and in the form of an emulsion to prepare baryta paper and imitation opal glass.

Baryta Paper (Ger., *Kreide-papier*, or *Baryt-papier*). Paper coated with an emulsion of sulphate of barium, made partly insoluble by chrome alum, and which is used as a support for gelatino-chloride printing-out emulsions and for collotype printing, etc. A formula for its preparation is the following:—

I.

Gelatine, Heinrich's	90 grs.
Barium chloride	30 „
Distilled water	5 ozs.

II.

Ammonium sulphate	15 grs.
Distilled water	2½ ozs.

Soak the gelatine in the water till soft, add the barium, and dissolve by heat; then add solution II. in small quantities, shaking between each addition; allow the emulsion to set; break up into small pieces; wash thoroughly, and add 7½ grains of chrome alum previously dissolved in a little water.

Base, and **Basic.** An approximate definition of a base is having properties allied to those of an alkali (*q.v.*), as far as reacting with acids to form salts is concerned. Basic salts are salts in which the metallic, basic, or electro positive, side predominates; iron (ferric) and lead being especially ready to form basic salts.

Bas-relief, Photographic. See SCULPTURE, PHOTOGRAPHIC.

Bath. This term is used indiscriminately to describe dishes and other vessels, and also the liquids which are used in the same. The vessels are made of various materials, such as porcelain, glass, ebonite, celluloid, etc. The only term which requires explanation in connection with the liquids is that which is frequently used when speaking of the strength of a bath: it is customary to say, "a 60, 50, or 48, etc., grain bath"—this means that 60, 50, or 48 grains of any chemical are contained in each ounce of the liquid.

Beach's Developer. Named after its inventor, Mr. F. C. Beach, of New York. It is rather complicated in formula, but has been widely used. It is made as follows:—

Pyro Solution.

Hot distilled water	2 ozs.
Sulphite of soda	2 ozs.

When cold add

Sulphurous acid	2 ozs.
Pyrogallol	½ oz.

Potash Solution.

Carbonate of potash	3 ozs.
Sulphite of soda	2 „
Water	7 „

Dissolve the salts separately and mix. For a plate having had the normal exposure, mix the pyro and potash solutions in equal proportions, using 1 dram of each to every 1 oz. of water; for under-exposure, use more of the potash solution, and *vice versâ*.

Beechey's Emulsion Process. See COLLODION.

Beeswax (Ger., *Wachs;* Fr., *Cire;* Ital., *Cera*). This is obtained from the honeycomb of the bee, and is a yellow mass breaking with a granular structure and of pleasant smell. It should be entirely soluble in hot oil of turpentine, and is insoluble in alcohol and water. White wax is the above bleached by exposure to air and light, and cast into flat round cakes. In certain processes of carbon printing it is important to obtain pure wax; this being difficult unless the original comb can be obtained from a beekeeper who does not fit his hives with the artificial combs now used so largely to increase the output of honey.

Bellows. That portion of the camera which unites the back and front portions is called the bellows, and is usually constructed of calico or leather. For those anxious to make their own bellows full instruction will be found in the *Amateur Photographer* for July 10th, 1891, p. 25. There are three principal varieties of bellows in use—the square, the oblong, and the conical. The first entails most weight, the second is almost obsolete, and the third the most prevalent and lightest. The question as to which is the best is a matter of personal opinion, but when the camera is to be used with a very wide-angle lens a conical bellows may prove obstructive, owing to the unequal stiffness of the folds.

Benzine (Ger., *Benzin;* Fr., *Benzine;* Ital., *Benzina*). Synonym: Benzole. $C_6H_6 = 78$. A colourless liquid, with characteristic smell resembling coal gas, obtained commercially by fractional distillation of coal tar, between 36° and 150° C.; it is purified by a second distillation at 80° C., and should crystallise at 0° C. It is insoluble in water, but soluble in all proportions in alcohol and ether. It is a solvent of all fixed and volatile oils, and greasy substances generally. It boils at about 85°C., and at ordinary temperature gives off a vapour which is extremely

explosive. It is used in photography as a solvent in encaustic paste, for the preparation of matt varnishes, and as a developer or solvent of bitumen in certain photomechanical processes not to be confounded with Benzoline (*q.v.*).

Benzoline. A light petroleum spirit used for burning in lamps. It is far inferior in solvent power to true benzole or benzine, and will seldom replace it in photographic operations.

Berkeley's Sulpho-Pyrogallol. See SULPHO-PYROGALLOL.

Bibliography of Photography. The number of photographic books which have been published is much greater than may be supposed by those who have not taken pains to study the subject, and a complete list would form a large volume in itself. Those persons who wish to follow up the records relating to any particular branch of photographic literature will find very special facilities in the admirable free technical library maintained by the Patent Department (Southampton Buildings, Chancery Lane, London), and which is open until 10 o'clock in the evening every day except Sundays and public holidays, the fact of it being open late on Saturday evenings being a special advantage to many. At the British Museum library the collection of photographic books is very complete, but not so readily accessible as at the Patent Department library. The photographic books belonging to the Royal Photographic Society (12, Hanover Square, London), have been considerably added to recently, and they are very conveniently arranged for reference. This library is not public, and although a member's introduction is strictly necessary, there is very little doubt that any person having a sufficient reason for research, and not acquainted with a member, would be assisted by the permanent officials of the Society (Mr. Child Bayley and Mr. Bartlett), in obtaining the required introductions. The short list of books given below comprises two classes: handbooks or special treatises now in print, and important monographs or works on special branches of photography only likely to be obtainable second hand, or to be available for reference at the libraries mentioned. Three handbooks and one history of photography are so notable and complete that they merit a special note, as reference to these may often save further trouble. These are:—

Traité Encyclopédique de Photographie. By C. FABRE. Four Volumes, and Supplement. Price 60 fr. Published by Gauthier-Villars & Son, 55 Quai des Grands-Augustins, Paris.

Ausführliches Handbuch der Photographie. By Dr. J. M. EDER. Four Volumes. Published by Knapp of Halle a S.

Handbuch der Photographie. By G. PIZZIGHELLI. Three Volumes. Published by Knapp of Halle a S.

Geschichte der Photographie. One Volume. By C. SCHIENDL. Published by Hartleben, of Vienna, Pest, and Leipzig.

GENERAL LIST OF WORKS IN PRINT AND STANDARD REFERENCE BOOKS.

ABNEY. *Instruction in Photography.* 3s. 6d. (Sampson Low.)

—— *Photography with Emulsions.* 3s. 6d. (Sampson Low.)

—— *Negative Making.* 1s. (Sampson Low.)

—— *Recent Advances in Photography.* (Society of Arts.)

ABNEY and ROBINSON. *The Art and Practice of Silver Printing.* 2s. 6d. (Sampson Low.)

ACKROYD, W. *The Old Light and the New, Dealing with Radiography.* (Chapman & Hall.)

ANDREWS, I. *Studies in Photography.* 3s. (Hazell, Watson, & Viney, Ld.)

BADEN-PRITCHARD. *The Photographic Studios of Europe.* (Carter & Co.)

—— *About Photography and Photographers.* (Carter & Co.)

BAYLEY, R. CHILD. *Modern Magic Lanterns.* 1s. (Gill.)

BOLAS, T. *The Application of Photography to the Reproduction of Printing Surfaces and Pictures in Pigment.* 2s. (Society of Arts.)

—— *The Photographic Studio; a Guide to its Construction, Design, and Selection of Locality.* 2s. 6d. (Marion.)

BURNETT'S ESSAYS (reprint). (Lund.)

BROTHERS, A. *Photography: its History, Processes, Apparatus, and Materials.* (Charles Griffin & Co.)

BURTON, W. K. *Modern Photography.* (Sampson Low.)

—— *Optics for Photographers.* (Sampson Low.)

—— *Pocket-Book for Photographers.* (Sampson Low.)

—— *Practical Guide to Photographic and Photomechanical Printing Processes.* (Marion & Co.)

BURTON, W. K., and PRINGLE, A. *Processes of Pure Photography.* (Iliffe.)
CHADWICK. *The Stereoscopic Manual.* 1s. (Chadwick, Manchester.)
CLARK, LYONEL. *Development.* 1s. (Hazell, Watson, & Viney, Ld.)
—— *Platinum Toning.* 1s. (Hazell, Watson, & Viney, Ld.)
DALLMEYER, J. H. *On the Choice and Use of Lenses.* 1s. (Dallmeyer, Newman Street.)
—— *The Telephotographic Lens.* 1s. (Dallmeyer.)
DAVANNE, M. *La Photographie; Traité Theorique et Pratique.* Two Volumes. (Gauthier-Villars, Paris.)
DEMACHY and MASKELL. *The Gum-Bichromate, or Photo-Aquatint Process of Printing in Pigment without transfer.* 1s. (Hazell, Watson, & Viney, Ld.)
DENISON, H. A. *Treatise on Photogravure.* (Iliffe.)
DRESSER, A. R. *Bromide Enlarging.* (Out of print.)
—— *Lantern Slides, and how to Make them.* 6d. (Fallowfield.)
EDER, J. M. *Ausführliches Handbuch.* Four Volumes. (Knapp, Hallé.)
—— *Modern Dry Plates.* 1881. Translated by WILMER. (Carter & Co.)
EMERSON, H. P. *Naturalistic Photography.* 5s. (Sampson Low.)
FABRE, C. *Traité Encyclopédique de Photographie.* Four Volumes and Supplement. (Gauthier-Villars, Paris.)
GAMBLE, C. W. *Wet-Collodion Photography.* 1s. (Hazell, Watson, & Viney, Ld.)
HARDWICH. *Photographic Chemistry.* (Churchill.)
HARRISON, W. J. *Photography for all.* 1s. (Iliffe.)
—— *A History of Photography.* (Iliffe.)
HEIGHWAY. *Esthetics of Photography.* 1s. (Carter & Co.)
—— *Practical Portrait Photography.* 1s. (Carter & Co.)
HENRY, E., and WARD, H. S. *Photo-Ceramics.* 1s. (Dawbarn & Ward.)
HEPWORTH, T. C. *Photography for Amateurs.* 6d. (Cassell.)
—— *Evening Work.* 2s. 6d. (Hazell, Watson, & Viney, Ld.)
—— *The Book of the Lantern.* 3s. 6d. (Hazell, Watson, & Viney, Ld.)
HINTON, A. HORSLEY. *Platinotype Printing.* 1s. (Hazell, Watson, & Viney, Ld.)
—— *Handbook of Illustration.* 3s. 6d. (Dawbarn & Ward.)

HINTON, A. HORSLEY. *L'Art Photographique dans le Paysage.* Translated by H. COLARD, from the Author's articles in the *Amateur Photographer.* (Gauthier-Villars, Paris.)

—— *Kunstlerisches Landschafts-Photographie, in Studium and Praxis.* Translated by E. TAUBE, from the Author's articles in the *Amateur Photographer.* (Gustav Schmidt, Berlin.)

HODGES, J. A. *Elementary Photography.* 1s. (Hazell, Watson, & Viney, Ld.)

—— *The Lantern Slide Manual.* 2s. (Hazell, Watson, & Viney, Ld.)

—— *Practical Enlarging.* (Iliffe.)

HUBERT, J. *The Art of Retouching.* 1s. (Hazell, Watson, & Viney, Ld.)

HURTER and DRIFFIELD. *Photo-Chemical Investigations.* (Marion.)

—— *The Actinograph.* (Marion.)

JOHNSON, R. *Art of Retouching Negatives, and Finishing and Colouring Photographs.* (Marion.)

JUST, DR. *Bromide Paper.* 1s. (Lund & Co.)

LAMBERT, REV. F. C. *The "A. P." Note-Book.* Series No. 1. Reprinted from the *Amateur Photographer.* 1s. (Hazell, Watson, & Viney, Ld.)

LEAPER, C. J. *The First Principles of Photography.* 5s. (Iliffe.)

—— *Materia Photographica.* 5s. (Iliffe.)

MASKELL and DEMACHY. See DEMACHY.

MELDOLA, R. *The Chemistry of Photography.* (Macmillan.)

MIDDLETON, E. C. *Schnauss' Collotype and Photolithography.* 5s. (Iliffe.)

MILLS, F. W. *Art and Practice of Interior Photography.* 2s. 6d. (Iliffe.)

—— *Photography for Architects.* 2s. 6d. (Iliffe.)

—— *Photography applied to the Microscope.* 2s. (Iliffe.)

MILLS, F. W., and PONTON, A. C. *Stenopaic or Pin-hole Photography.* 1s. (Dawbarn & Ward.)

NEVILLE, W. J. *The Photographic Colourist.* 6d. (Iliffe.)

NORTON, GOODWIN. *The Lantern, and How to Use it.* 1s. (Hazell, Watson, & Viney, Ld.)

PERKINS, REV. T. *Handbook of Gothic Architecture.* Reprinted from the *Amateur Photographer.* 3s. 6d. (Hazell, Watson, & Viney, Ld.)

PIQUEPÉ. *Enamelling and Retouching.* 2s. 6d. (Carter & Co.)

PIZZIGHELLI and HÜBL. *Platinotype Printing.* 1s. 6d. (Photographic Society, Great Britain, through Harrison, Pall Mall.)
PRINGLE, A. *The Optical Lantern.* 2s. 6d. (Hampton Judd.)
—— *Practical Photo-Micrography.* 5s. (Iliffe.)
PRINGLE, A., and BURTON. *Processes of Pure Photography.* 5s. (Iliffe.)
PUYO, C. *Notes sur la Photographie Artistique.* (Gauthier-Villars, Paris.)
ROBINSON, H. P. *Photography as a Business.* 1s. (Percy Lund.)
—— *Picture Making by Photography.* 2s. 6d. (Hazell, Watson, & Viney, Ld.)
—— *Pictorial Effect in Photography.* (Sampson Low.)
—— *Art Photography.* 1s. (Hazell, Watson, & Viney, Ld.)
—— *Letters on Landscape Photography.* 1s. (Sampson Low.)
—— *The Studio and what to do in it.* (Sampson Low.)
ROBINSON, H. P., and ABNEY. *Art and Practice of Silver Printing.* (Carter & Co.)
SALOMONS, SIR DAVID. *Note-Book and Formulæ.* 1s. (Marion.)
—— *Photographic Notes.* 1s. (Marion.)
SAWYER. *ABC Guide to Autotype Printing.* 2s. 6d. (Autotype Company.)
SCHNAUSS. *Collotype and Photolithography.* 5s. (Iliffe.)
—— *Photographic Pastimes.* 1s. (Iliffe.)
SLINGSBY, R. *Practical Flash-Light Photography.* 4s. (Marion.)
TAYLOR, J. TRAILL. *The Optics of Photography.* 3s. 6d. (Whittaker.)
THOMPSON, E. P. *Röntgen Rays and the Phenomena of Anode and Cathode.* (Spon.)
WARD, H. SNOWDEN. *The Practical Ferrotyper.* 6d. (Percy Lund.)
WARD, H. SNOWDEN, and WOODBURY. *Just's Bromide Paper.* 1s. (Percy Lund & Co.)
WELFORD, W. D. *The Hand Camera, and How to Use it.* 1s. (Iliffe.)
WILKINSON, W. T. *Photogravure.* 1s. 6d. (Iliffe.)
—— *Photo-Mechanical Processes.* 5s. (Hampton Judd.)
WOODBURY, W. E. *Gelatino-Chloride Printing.* 2s. (Hazell, Watson, & Viney, Ld.)
—— *Encyclopædia of Photography.* 7s. 6d. (Iliffe.)
YOUNG, A. *The ABC of Retouching.* 6d. (Percy Lund.)

Bichromate Methods. Processes in which the material sensitive to light is an alkaline bichromate in contact with organic matter, such as gum, albumen, or gelatine. Most methods of photographic block and plate making come under this heading. (See CARBON PRINTING, ARTIGUE'S PROCESS, PHOTOGRAVURE, COLLOTYPE, HYDROTYPE, ANILINE PROCESSES, etc.)

Biconcave. An optical term denoting that the two sides of a lens are hollowed out. (See LENS.)

Biconvex. An optical term denoting that the two sides of a lens are bulged out. (See LENS.)

Binocular Camera. Another name for Stereoscopic Camera (*q.v.*).

Bioscope. See ZOETROPE.

Bitumen. See ASPHALT.

Black Glass. Glass deeply coloured with manganese and iron. Sometimes used as a reflector in photographing clouds.

Black Varnish. See VARNISH.

Blacking. The interior of all cameras, dark slides, and lens tubes should be coated with a dead black to prevent the reflection of light and consequent fog on the plate. A good black can be made by grinding lamp or ivory black into a paste with japanners' gold size. Another method is by coating the wood, etc., with a solution of sulphate of iron, and, when dry, applying a solution of tannin or decoction of logwood, two or three successive applications being sometimes necessary. For blackening lens mounts, two or three different methods are employed. Where the mount will not be touched by the fingers, drop-black ground up with weak glue and water may serve, but a better method and a more lasting one can be made by mixing fine lampblack with lacquer, and applying it in two or three successive coats to the heated mount; but where the mount will be fingered, it is obvious that some other method must be employed. We have the choice of two, one of which results in a bronze colour, the other is a non-reflecting dead black. For the former colour, solution of perchloride of platinum acidulated with nitric acid is used. This method is especially useful where any soldered joints

exist; where solder is not used, an absolute dead black can be obtained by dipping the article, heated fairly hot, into a solution of nitrate of copper, made by dissolving copper wire in dilute nitric acid; it is then heated over a Bunsen burner or spirit lamp, the green colour of the copper first showing, and at the proper temperature a fine dead black appears. Another method is to dissolve 1 part of carbonate of copper in 8 parts of solution of ammonia and adding 18 parts of water. Clean the brass well and immerse in the solution till black, rinse with water, dry in bran or sawdust, and give a rub over with thin oil varnish. Another formula to blacken wood is as follows:—

Extract of logwood	½ oz.
Chromate of potash	30 grs.
Water	35 ozs.

Dissolve the extract in boiling water, add the chromate also in solution. This is a deep violet liquid which changes to black in contact with the wood. To blacken leather-covered hand cameras which have become shabby, the following may be useful:

Glue	4 oz.
Vinegar	1½ pints.
Gum arabic	2 oz.
Black ink	8 oz.
Isinglass	2 drm.

Break the glue in pieces, put in a basin, pour over it about a pint of the vinegar, let it stand till it becomes perfectly soft. Put the gum in another vessel with the ink until it is perfectly dissolved; melt the isinglass in as much water as will cover it, which may be easily done by placing the cup near the fire about an hour before required for use. To mix them, pour the remaining vinegar with the softened glue into a vessel and heat on a sand bath over a gentle fire; stir till dissolved, and do not let heat be over 80° C. Add the gum and heat to 80° C., add the isinglass, and it is ready for use. Put as much as required in a saucer, beat it till thin, and apply with a small sponge. If the article is dried quickly in the sun or before the fire it will have a better polish.

Blanchard's Brush consists of a piece of swansdown calico doubled and fastened by means of an indiarubber band round a

strip of glass 2 inches wide and 6 inches long. It was used for coating plates, etc., with substratum for the collodion process, and is useful in direct carbon printing; also in many processes

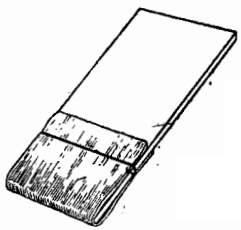


Fig. 13.

where paper has to be mopped over with a liquid. The Blanchard brush is shown in the subjoined sketch, fig. 13. (See also BUCKLE'S BRUSH.)

Bleaching Powder. The so-called chloride of lime of the shops, the active ingredient of which is probably calcium hypochlorite, and this in contact with acids liberates the powerfully oxidising hypochlorous acid.

Bleaching Prints or Engravings. This is often necessary before making a photographic copy. Agitate ½ oz. of fresh bleaching powder (see preceding article) in a pint of water, and filter. The print is first soaked in water and then transferred to this solution, and ten minutes or so should be allowed for complete penetration. The print being removed, a dozen drops or so of hydrochloric acid are stirred in and the print returned to the bath, where the discoloration should gradually disappear; but failing this, the print should be once more removed and acid again added. When the bleaching is complete, a very thorough removal of the bleaching agent by long soaking in many changes of water is essential.

Blisters. One of the worst troubles of an amateur, whether working with plates or paper. On the former, blistering is usually the precursor of a general Frilling (*q.v.*). Blisters invariably make their appearance on prints, either in the fixing bath or the first washing after. It is more generally a fault with papers that are heavily charged with albumen and salt, and in this case it is

most likely due to exosmose action. The remedy is to plunge the prints immediately after fixing into a saturated solution of salt, and use all solutions at the same temperature. Blisters are frequently caused also by an accumulation of gas behind the film of albumen, and in this case it would seem to be the action of hypo upon a partially decomposed albumen. A cure for this is to dip the print on the first sign of blistering into a bath of methylated spirit. In the case of some kinds of gelatino-bromide papers, which seem particularly liable to blisters, a bath of chrome alum 2 grs., water 1 oz., methylated spirit 1 oz., will be found efficacious. Formalin, properly used, is an almost certain preventive. See FORMALIN.

Blue Glass, for glazing the studio and for making lenses. Both these ideas were carried out at a very early period in photographic history, and are occasionally revived. A lens of blue glass is roughly achromatised by the cutting off of the yellow and green, but is much inferior to the usual cemented combination. Exposures in a studio glazed with blue glass are longer than in a studio glazed with colourless glass.

Blue Printing Process. See CYANOTYPE.

Blue Tones in Prints. A sure sign of over-toning, due to too great a deposit of gold (see TONING), or to sulphuration, due to an acid toning bath.

Blurring. Any image possessing an indistinct or double outline is said to be blurred, and may be caused either by movement of the object or the camera. When photographing in a high wind, a loop of stout twine, tied to the bottom of the tripod, and hanging down to within 6 inches of the ground, in which the foot can be placed, will be found to steady it, or a bag may be attached to the string and filled with stones. (See also HALATION.)

Books, Photographic. See BIBLIOGRAPHY.

Borax (Ger., *borsäures natron;* Ital., *Borace*). $Na_2B_4O_7$, $10H_2O = 179$. Synonyms: Pyroborate, Sodium borate, or Biborate. It occurs in colourless octahedral crystals containing 30 per cent. of water, or in hexagonal prisms with 47 per cent. of water; also as an amorphous white powder. It is found native

in various parts of the world, or made by neutralising boric acid with soda. Solubility: 6 per cent. in cold, 200 per cent. in hot water; very little soluble in alcohol, 60 per cent, in glycerine. It is used in toning, and has also been suggested as an addition to developers, and when added in the proportion of 3 parts to every 4 of sulphate of iron is said to give brilliancy to the image. It is a restrainer when used with pyrogallol and pyrocatechine, but an accelerator with eikonogen and hydroquinone.

Boric Acid (Ger., *Borsäure;* Fr., *Acide borique*, or *Boracique:* Ital., *Acido borico*). Synonym: Boracic Acid. $H_3BO_3 = 62$, Occurs native in several parts of the world. Solubility, 4 per cent. in cold, 29 per cent. in boiling water, 25 per cent. in alcohol. Of very limited use in photography, but has been suggested as an antiseptic in conjunction with alum.

Brenzcatechin. See PYROCATECHIN.

Brilliancy. A term applied to negatives to denote that the lights and shadows are harmonious, each having their due proportion of deposit, and there being no fog; the resulting prints are in an equal way perfect in their power of rendering light and shade, distance and effect. This can only be obtained by careful attention to exposure and all the subsequent manipulations.

Broken Negatives. When such an unfortunate accident as the breakage of a negative occurs, and the film is uninjured, it may be removed as described under NEGATIVE, STRIPPING (*q.v.*); but should the film be broken, lay the negative, film downward, upon a perfectly level surface, carefully place the fractured pieces together, and apply strips of gummed paper along the edges of the negative. When thoroughly dry, turn the negative over, and apply some strips of paper along the margin on the film side; allow it to thoroughly dry, and varnish the film. To print from broken negatives, suspend the frames from an ordinary roasting-jack, or place the frame at the bottom of a box without a lid about 18 ins. deep.

Bromide Paper. Paper coated with an emulsion of bromide of silver in gelatine and intended for obtaining prints by development either by contact printing or enlarging with daylight or artificial light.

Bromide Paper

Emulsion for Bromide Paper and Opals. Those workers desirous of preparing their own bromide paper and opals will find the following directions useful. Dr. Eder states that "the emulsion for positive prints should work slowly, have little sensitiveness, should be completely free from fog, and give delicate details. This is best obtained by means of an emulsion, which contains plenty of iodide of silver, is not strongly ripened, and contains plenty of gelatine." He suggests the following:—

No. 1. For Black Tones.

A.	Ammonium bromide	20 parts.
	Gelatine	50—80 ,,
	Distilled water	400 ,,

Allow the gelatine to soak in the water for twelve hours, then dissolve at a temperature of 50—60° C., and add the bromide; then in the dark room add gradually, with constant and violent shaking, the following solution heated to 50—60° C.:—

	Silver nitrate	30 parts.
	Distilled water	400 ,,

Allow the solutions to stand from half to one hour, and then pour out into a flat dish to set. When thoroughly set break up into small pieces, and wash in the usual manner.

No. 2. For Brown Tones.

A.	Ammonium bromide	18 parts.
	Potassium iodide	2—4 ,,
	Gelatine	50—80 ,,
	Distilled water	400 ,,
B.	Silver nitrate	30 ,,
	Distilled water	400 ,,

The directions for making the same as above. This (No. 2) emulsion gives dark brown tones with ferrous oxalate. If 20 parts of citric acid be added to No. 2 A the tone is brighter. If the citric acid be omitted, and 4 parts of ammonia be added instead, the tone is a darker brown. Commercial bromide paper is usually sold in three grades—A, smooth surface and thin paper suitable for mounting and small prints; B, smooth surface and thick paper suitable for larger prints and book illustrations; and C, rough surface and thick paper suitable for enlargements.

Some manufacturers also issue a special extra rough paper, and others a paper which has a highly glazed surface slightly tinted and obtained by coating tinted baryta paper. It is usually stated that a particular class of negative is more suitable for bromide paper, but almost any negative may be used provided a suitable paper be chosen; for very dense and harsh negatives a rapid paper should be chosen, for thin negatives a slow paper; the former may be exposed a very short distance from the light, the latter a longer distance. For all bromide contact-printing artificial light should be used, either gas or magnesium. Commercial bromide paper is sold of various rapidities, and the following table is calculated from one by Mr. Alfred Watkins.

Eastman permanent slow	50
,, hard enamel	50
,, Nikko	50
,, extra rapid (Eng.)	10
,, extra quick	15
,, soft enamel	15
Morgan and Kidd	20
Anthony rapid	6
Eastman's transferrotype	50
Ilford slow	100
,, rapid	10
Dr. Just's	75
Mawson and Swan	50

In this table the sensitiveness of the slowest is placed at 100 and the numbers will therefore give the relative exposures. The important item for successful results is correct exposure, and the simplest method of ascertaining this is the following:— The standards used are a No. 5 Bray burner turned up to its fullest extent without flaring, a fixed distance for exposure from the Bray burner, viz., two feet, a fixed scale of feet from the burner, or a six-foot inch tape, and lastly a piece of flashed opal, smoothed or ground on the opal side (any size may be used, but about half-plate will be found convenient). The opal glass is placed in contact with the film of the negative, and the two held up before the gas burner, the negative being next the operator, at the full length of six feet from the burner. Now examine the image, and approach the negative nearer the light till the details,

such as the markings on a brick or stone wall, or the trunk of leaves of a tree, just become visible. Note the distance between this point and the end of the inch tape, and give an exposure corresponding in number of seconds to number of inches—for instance, the details of negative become visible 36 inches from the six-foot mark; therefore 36 seconds exposure will be required for that particular negative at a distance of two feet from the burner. An alternative method is to cut little strips of bromide paper, and place one in contact with the half-tones, and a deep shadow of the negative, and give the strip an exposure; then replace by another strip, and give a longer exposure; and then repeat for a third time. On development it is easy to see the correct exposure. The first essential for development is of course a developer; and for enlargements the old ferrous oxalate still stands pre-eminent as the best, and, we think, the most used, though many operators now use quinol or eikonogen, or a mixture of the two. The formula for a good all-round ferrous oxalate developer is given:—

I.

Neutral oxalate of potash	6 ozs.
Distilled water	25 „

II.

Ferrous sulphate	2¼ ozs.
Sulphuric acid	2 drops.
Distilled water	7½ ozs.

III.

Bromide of ammonium	480 grs.
Distilled water	30 ozs.

To make the developer, add one part of solution of ferrous sulphate to six parts of oxalate solution, and a few drops of solution of bromide as a restrainer. In mixing the developer *it is essential that the solution of iron be added to the oxalate, and not the reverse*, or a thick yellow precipitate of ferrous oxalate will be formed. It is advisable to use distilled water for all solutions, or a precipitate of oxalate of lime will be formed, and the solution will be clouded, and both the oxalate and ferrous sulphate solutions should be distinctly acid to test paper. Another formula which we have used with success is the following:—

Bromide Paper

One Solution Formula.

Neutral oxalate of potash ...	... 2,600 grs.
Citric acid	... 100 ,,
Ferrous sulphate	... 975 ,,
Boiling distilled water	... 20 ozs.

Dissolve the oxalate in the water, and add the citric acid, and finally the ferrous sulphate; stir till the whole of the latter is dissolved, and a deep orange yellow solution is formed. For use one part of this solution is diluted with three parts of water, or preferably with the same quantity of the following solution, when it will be about equal in strength to that made by the first formula. The solution may be kept good for months in the syphon bottle (Fig. 9), described under ATMOSPHERIC ACTION.

Solution for Diluting Concentrated Developer.

Neutral oxalate of potash	... 120 grs.
Distilled water	... 4 ozs.

Another formula for a one-solution developer, which was suggested by Carey Lea, the well-known American scientist, is as follows:—

Neutral oxalate of potash	... 1,600 grs.
Distilled water	... 10 ozs.

Heat to the boiling point, and add

Ferrous oxalate	... 500 grs.

Stir till dissolved, and bottle whilst warm. Some ferrous oxalate may precipitate out, but this will have but little effect upon the action of the developer, which is a saturated solution of ferrous oxalate. But the two latter methods were those first used, and have been gradually supplanted by the two-solution formula.

Ferrous Citro-Oxalate Developer. This modification of the oxalate developer was suggested by Abney in 1881, his original formula being:—

Neutral potassium citrate	... 100 grs.
Ferrous oxalate	... 22 ,,
Distilled water	... 1 oz.

The citrate of potassium is dissolved in the water by the aid of heat and the ferrous oxalate added, and the whole allowed to

cool. A more convenient method, however, which Abney suggested in 1882 is to make two solutions as follows:—

No. 1.

Potassium citrate	700 grs.
Potassium oxalate	200 „
Distilled water	3½ ozs.

No. 2.

Ferrous sulphate	300 grs.
Distilled water	3½ ozs.

The solutions are mixed in equal proportions just before using. The citro-oxalate developer does not require any addition of bromide as restrainer, its action not being quite so energetic as the ordinary oxalate, but it gives a fine velvety black deposit with most papers. Further notes on modifications and additions to the oxalate developer will be found in the APPENDIX.

Pyrogallol Developers. Alkaline pyrogallol, having a great tendency to the production of unpleasant brown tones, and also to give rise to stains, has never yet found much favour for enlarging purposes, and therefore no formula will be given for this, although a few workers have advised its use.

Quinol Developers. Hydroquinone, or quinol, has been used with great success by many operators, but there is again with this developer a tendency to brown in the deposit, which is extremely unpleasing to some. We can recommend the following for black tones:—

No. 1.

Quinol	154 grs.
Sodium sulphite (recryst.)	437 „
Sulphurous acid	20 minims.
Distilled water, to make	10 ozs.

No. 2.

Sodium carbonate	1,300 grs.
Potassium hydrate	154 „
Potassium bromide	20 „
Distilled water, to make	10 ozs.

Mix in equal parts, and dilute with three times the quantity of water.

Eikonogen. We have found the following formula satisfactory :—

No. 1.

Eikonogen	50 grs.
Sodium sulphite	50 ,,
Distilled water, to make	10 ozs.

No. 2.

Sodium carbonate	437 grs.
Potassium hydrate	56 ,,
Distilled water, to make	10 ozs.

For use mix in equal parts, and add an equal quantity of water.

Eikonogen and Hydroquinone. The most satisfactory formula we have yet used is one suggested by Mr. J. T. Chapman, of Manchester.

No. 1.

Quinol	40 grs.
Eikonogen	120 ,,
Sodium sulphite	480 ,,
Citric acid	20 ,,
Distilled water, to make	20 ozs.

No. 2.

Potassium bromide	5 grs.
Sodium carbonate pur.	60 ,,
Sodium hydrate	30 ,,
Distilled water, to make	20 ozs.

Mix in equal proportions, and add an equal quantity of water.

Clearing and Fixing. The paper having been exposed, and our developer made, we are now ready for the all-important operation of development; but before giving directions for this procedure there are one or two little points which it will be well to explain. It is advisable to have four or five dishes, and the most convenient are the deep porcelain kind. *Dishes used for ferrous oxalate development must be used for no other purpose; dishes which have been used for pyro, quinol, eikonogen, or fixing, must not be used, or stains will probably occur.* The dishes must be absolutely clean, and so must the measures and

hands. Hypo must not be touched till the whole developing has been done and the developer and developing dish put away. *Distilled or clean rain water should be used for all operations prior to clearing, as otherwise a precipitate of oxalate of lime may cloud the prints.* After these important points have been observed, the operator may reasonably expect good results, provided the exposure and development are correctly carried out. It is advisable to have four or five dishes, but shift may be made with a less number, or home-made dishes may be constructed. Keep one dish solely for the developing, and mark it in some way that it may not be used for any other purpose. Mark the bottom or side of the dish with black enamel with OX, so as to distinguish it easily. Arrange three or four dishes side by side. Into the first pour distilled water till about one inch in depth; into the second, third and fourth a clearing solution is poured to the depth of one and a half inches. The clearing solution is made as follows:—

Acetic acid	1 dr.
Distilled water	32 ozs.

A considerable bulk of this solution should be made, so that the prints can be moved about in it quite freely. The hypo or fixing bath should not be touched or measured out till the whole of the developing is completed. Now take an exposed piece of paper and lay it face downwards on the distilled water, and as soon as the edges begin to curl up lift the sheet of paper, turn it over and immerse it bodily in the water, and allow it to soak till limp; then pour the distilled water off into a jug or other convenient vessel, and flood the paper with the developer in one even sweep; rock the dish till the image begins to appear. Allow the development to continue till the picture appears dense or black enough in the shadows, when by this time, if correctly exposed, the half tones and high lights will be full of detail. At this point, then, the print is raised from the developer and immersed at once, *without draining or washing*, into the first dish containing the clearing solution, and this is then rocked once or twice, and allowed to remain quiet. The developer is now poured back into the measure, and the developing dish rinsed out with a little distilled water, and drained, again filled with distilled water, and another exposed sheet of paper treated just

like the one as described above; but while the paper is soaking in the developer, the already developed print is raised from the first clearing bath, drained slightly, and immersed in the second clearing bath. Attention is now turned to our developing print, and when this is developed sufficiently it is placed in the first clearing bath, like the first print, *without draining and washing*. We now proceed to treat our third print in like manner to the first two; and as soon as placed in the developer the first print is removed from the second clearing bath and placed in the third, the second print is placed in the second bath, and this leaves the first bath ready for the third print. When three prints have been cleared in the first bath, it is poured away, and the second bath put in its place, the third in the place of the second, the first dish now being in the third place, and filled with fresh clearing solution. The second and third baths, which have now become the first and second, are treated in a similar manner. It is always as well to use a good quantity of developer, as it can be used for two or three prints, or even more, without any loss of detail, if the developer is used for too many prints, however, the latter gradually become lacking in detail or too full of contrast. The used developer need not be thrown away, but placed on one side and regenerated. Having finished our development, the developing dish is washed, dried, and put away. The prints still in the clearing baths are placed in one dish and flooded twice with fresh clearing solution, the solution being allowed to act for one minute each time, and then well washed for at least half an hour in five or six changes of water, preferably one hour in ten changes of water. The print is then ready for fixing, which may be effected by immersing for ten minutes in

Hyposulphite of soda	3 parts.
Water	20 ,,

The print should be then taken out, and preferably placed in a second fixing bath of the same strength as the above, where it should remain for ten minutes. The time required for thorough fixation varies much according to the texture of the paper and the hardness of the film; but if the sheet is held up to the light the disappearance of the opalescent bromide can generally be traced in the white parts. At least double the time required for the apparent solution of the bromide should be given. For

washing the prints any of the usual washing tanks may be utilised, or the prints may be placed in a dish and washed by changing the water every ten minutes for at least two hours.

Drying, mounting, and finishing the prints. To dry the washed prints it is advisable to hang them over a rod or cords. They should not be dried between blotting-paper. We have successfully used thin laths nailed across a room, on which the prints are laid. Artificial heat should not be used, unless it is warm air. The most usual method of mounting enlargements is on cloth or canvas, and the directions given by the Eastman Company for this purpose will be found quite satisfactory. For mounting upon cards it is best to allow the print to dry thoroughly, then place it face downwards upon a sheet of clean paper, and apply freshly made starch paste, not too stiff, with a brush, and rub into contact with a soft cloth, or use a roller squeegee. Enlargements should always be mounted behind a cut-out mount, and a small gold edging of from $\frac{1}{4}$ to $\frac{1}{2}$ inch or more, according to the size, adds to the appearance; and toned, grey, or buff mounts show up well. The smoother varieties of bromide paper may be both rolled and burnished, but the rough-surfaced papers, which are the more artistic, should not be either rolled or burnished. For burnishing, dry Castile soap should be used, or else an alcoholic solution of soap made as follows; but care must be exercised in the use of the latter, or stains may ensue:—

Curd soap	1 oz.
Glycerine soap	$\frac{1}{2}$ oz.

Shave the soap finely, rub up with a little water, and heat till dissolved, adding only as much water as is absolutely necessary to dissolve the soap. This solution is then added gradually to 32 ozs. of methylated spirit, well shaken and filtered. A pad of linen or cotton wool is soaked with the solution and rubbed over the dry print, which is ready for burnishing when the alcohol has evaporated. Retouching may be effected by means of a lead pencil, or preferably by a mixture of powdered graphite and crayon, a suitable kind of the latter being Conte-crayon No. 1, the touches being afterwards worked up with a stump. For the shadows Conte-crayon No. 3 should be used, whilst for the high lights and half tones a harder crayon, such as No. 0 or No. 1, will be found useful. Special pencils are made

for retouching bromide prints and enlargements, which will be found to answer every requirement. Small defects, such as produced by pinholes in the negative, if they occur in a high light or otherwise white place, may be eradicated by scratching out with a lancet or other sharp-pointed knife, or a needle mounted in a penholder. Enlargements on rough-surface paper are specially suitable for colouring with pastels or crayons, water colours, and oil colours, by means of the air brush, etc.; but this department would need more space than can well be devoted to the subject. Colouring with pastels or crayons is, however, extremely easy, the rough surface of the paper taking the colour well. For water colours it is advisable to gently rub the surface of the enlargement with a pad of fine linen or cotton wool dipped in weak ammonia water, so as to make the colours take; or diluted solution of ox-gall may be used for the same purpose. The enlargement must be absolutely dry before any colour is applied, or blisters and running of the colours will ensue. For finishing in oils, the enlargement is treated as follows. We must first apologise for the rough-and-ready formula, but it was obtained from a professional colourist, who had used nothing else for over fifteen years. Obtain one pennyworth of clear size and dissolve in a pint of warm water, and flow over the enlargement just as if one were coating a dry plate. The film must not be touched with the fingers. When quite evenly covered, set the canvas up about four feet from the fire to drain and dry, when it will be found that the oil colours will take well, and yet not sink in and stain the paper or canvas. Mr. William Brooks, in the "Year Book of Photography," 1885, proposes the following plan for the greater preservation of enlargements:—Good white shellac is dissolved in alcohol, to which solution an equal quantity of a saturated solution of borax in water is added in small quantities, and shaken. The liquid should be quite clear, or else it must be filtered, and it should remain clear when diluted with from five to ten times the quantity of water. The enlargement is laid flat on a table face upwards, and the dilute solution is sprayed evenly over the whole surface by means of a spray diffuser. When the print is entirely covered and damp, it is allowed to dry, and shows no trace of the last treatment.

Collodionising and Waxing Bromide Prints. Bromide prints may be given a slight glaze by squeegeeing the print whilst wet

down to waxed plate glass, or sheets of ebonite, or ferrotype iron. A still higher glaze may be obtained by waxing a sheet of plate glass, and then coating it with enamel collodion,

Pyroxyline	6 grs.
Methylated alcohol	1 oz.
Ether	1 ,,

As soon as the collodion has set it should be immersed in a dish of distilled water till it no longer shows a greasy appearance, and the print, previously soaked in water till limp, placed in contact with the collodionised glass under water; and both should be carefully lifted out, the print well squeegeed down till no air bubbles are visible, and then the whole set up to dry. When thoroughly dry, the edges should be cut round with a sharp knife and the print stripped. The print may also be polished with encaustic paste, which improves the appearance and detail in the shadows without conferring too high a gloss.

Reducing and Intensifying Bromide Prints. Sometimes by an error of judgment a bromide print or enlargement may be over-developed and too dark and heavy, in which case our only remedy is to resort to reduction; and most of the methods adopted for landscape work may here be applied. The most suitable, however, are Howard Farmer's red prussiate of potash reducer, hypochlorite of soda, or Belitzski's reducer.

Howard Farmer's Reducer. The print or enlargement is soaked in water till soft, and then some fresh saturated solution of hyposulphite of soda is added, and the dish well rocked; then a few drops of a 10 per cent. solution of potassium ferricyanide or red prussiate of potash are added to the solution, and this again applied to the print. Reduction will visibly take place, the intensity of the action being controlled by the amount of solution of red prussiate used. The print should be removed before the exact stage of reduction is reached, as this action continues slightly during the process of washing.

Hypochlorite of Soda Reducer. For this reducer two solutions are necessary, one the so-called Labarraque's solution, made as follows :—

Chloride of lime	50 parts.
Carbonate of soda	100 ,,
Water	250 ,,

Mix the chloride of lime with 150 parts of water and the carbonate of soda with the remainder; mix the two solutions and filter, and make the filtrate measure 250 parts by washing the filter with distilled water. The second solution is a solution of chrome alum made by dissolving

Chrome alum	10 parts.
In water	250 ,,

To make the actual reducer, 15 parts of each solution are mixed together and diluted with 120 parts of water. This mixture is first thick and green, but gradually becomes clear yellow, in which condition it should be flooded over the print, previously moistened with water. The action of the reducer is to convert the image, or part of it, into chloride of silver, which must of necessity be dissolved by ordinary hypo. Care must be exercised that reduction is not carried too far.

Belitzski's Reducer. This is the method which in our hands has given the best results, and from the improved formula lately recommended by Herr Belitzski it is still more useful, as it may be kept in the form of a stock solution. The formula is as follows:—

Water	300 parts.
Potassium ferric-oxalate	15 ,,
Sodium sulphite	15 ,,

Dissolve, and add to the blood-red solution

Oxalic acid	5 parts,

and shake till the solution turns green; pour off from any undissolved oxalic acid, and add

Hyposulphite of soda	75 parts.

When dissolved it is ready for use. To reduce the print, as soon as removed from the fixing bath, rinse with water, flood with the above solution, and remove as soon as reduced sufficiently. The intensification of bromide prints is by no means a satisfactory process; it can rarely be effected without altering the colour of the deposit. There are one or two methods applicable.

Intensifying with Mercury and Re-development. This is perhaps the most satisfactory of all processes, and may be

effected by bleaching the print in a solution of mercuric chloride, and then re-developing with an old, used ferrous-oxalate developer.

Intensifying with Monckhoven's Silver Cyanide. The objection to the use of this formula is that one cannot make sure of obtaining a black tone in the intensified print, the colour of the image tending towards a brown.

Intensifying with Silver. It may be quite possible to intensify bromide prints with an acid silver and iron, or acid silver and pyrogallol intensifier; but we, so far, have been unable to obtain results free from stains.

Intensifying with Uranium. The application of Selle's process of uranium intensification, first suggested for collodion negatives in 1865, has been suggested as a toning process for bromide paper, but it is purely an intensification process. The following formula, which is a modification of the original one, acts well:—

Potassium ferridcyanide	1 part.
Uranyl nitrate	1 ,,
Acetic acid	20 parts.
Distilled water	200 ,,

The print, when perfectly free from hypo, should be soaked in water till limp, and then the above solution applied. When the intensification has proceeded far enough, wash thoroughly for half an hour in water acidulated with acetic acid.

Conversion of the Image into Platinum. The silver image of the bromide print may be converted into platinum by the following process, first suggested by Vidal in 1887. The well-washed print is immersed in the following bath:—

Platinum perchloride	1 part.
Distilled water	2000 parts.
Hydrochloric acid	25 ,,

till the desired tone is obtained. E. Vogel, junior, recommends the following—

Chloroplatinite of potash	1 part.
Distilled water	1000 parts.
Hydrochloric acid	10 ,,

The print is placed in this for about twenty minutes, and is then thoroughly washed and fixed. To prove the substitution of

platinum for silver, place the print in a solution of cupric chloride made as follows:—

No. 1.

Calcium chloride, crystal	10 parts.
Distilled water	50 ,,

No. 2.

Sulphate of copper, crystal	15 parts.
Distilled water	100 ,,

When the salts are dissolved, mix the two solutions and pour on to a filter paper, and allow the filtrate to drain through, and wash the filter paper with 50 parts of distilled water. The print, or a portion of it, is soaked in the filtrate, when any silver remaining in the image will be converted into chloride, and may, after washing, be removed by the use of the ordinary fixing bath; or if the image appear pale and wanting in intensity, it may be redeposited in the shape of metallic silver by applying an old ferrous oxalate developer. If the print, after being treated with the cupric chloride solution, be exposed to actinic light, the image can be developed in shades varying in colour according to the duration of the second exposure.

Failures.

The exposure has been over-estimated; in other words, the enlargement is over-exposed. This is at once recognised by the resulting print being flat, wanting in contrast, or sunken in. The whites even may not be pure, but show signs of reduced silver; the image is also a dull grey, and contains no rich blacks. The obvious remedy is to shorten the exposure, but the over-exposed print may also be improved by a process of intensification.

The exposure has been under-estimated, or the enlargement is under-exposed. An under-exposed bromide print is full of extreme contrast, the shadows black and heavy, and the high lights wanting in detail, and showing bare patches of paper. Increasing the exposure is the only remedy, and an under-exposed print had better be consigned to the residue box rather than shown.

The print is flat, and wanting in contrasts, and does not even show white paper under the pins or bands which hold it on the easel. This is probably due to stray actinic light. The room in which the enlargement is made, and the lantern, if such be used, should be examined for stray leakage. Such a print may be

improved by slightly reducing, washing, thoroughly converting the image into chloride of silver, and redeveloping.

Faults due to the Developer.

The print during development becomes covered with a sandy yellow deposit. This may be caused, first, by too much acid in the developer; second, by want of acid in the developer; third, by using too much ferrous sulphate; fourth, by using too little oxalate solution. The remedy for the second cause is the addition of some acid to the developer, both to the oxalate and iron solutions. Ferrous oxalate, formed by the addition of ferrous sulphate solution, is soluble only in excess of oxalate of potash; therefore, if too much iron solution be added, some of the ferrous oxalate will be precipitated. In such a case pour off the developer, and add more oxalate solution and a grain or two of oxalic acid. If the oxalate solution is allowed to sink to too low a temperature some of the oxalate will crystallise out, and the solution thus be weakened. The remedy is obvious.

The print during development becomes covered with a white chalky deposit. This deposit, which is oxalate of lime, is caused by using ordinary tap or hard water for soaking the print or for diluting the developer. The remedy is obviously the use of distilled water or clean rain water. When, however, such a deposit occurs, the only plan is to continue the development till the print is done enough, and then remove the deposit by a weak hydrochloric acid or sulphuric acid bath.

The print is under-developed. This is known by the print being full of gradation and detail, but not sufficiently dense or black enough in the shadows. The addition of a little more ferrous sulphate solution and longer development is, of course, the remedy. In the case of a finished print intensification is the only remedy.

The print is over-developed. This is known by the print being too dark and heavy. The use of less iron or shortened duration of development, or, in the case of a finished print, reducing the same.

Faults due to the After-Operations of Clearing, Fixing, Washing, etc.

The print is yellow. This must not be confounded with the yellow deposit of ferrous oxalate, this yellowness being caused,

first, by washing the print between development and clearing, or leaving it too long a time before immersing in the clearing bath; second, insufficient acid, or too little clearing bath; third, insufficient washing between clearing and fixing; fourth, insufficient washing after fixing. (1) The cause of this yellow stain is the action of the air upon the iron salt, or by the action of the alkaline and earthy salts in common water, when the print is washed between development and clearing. The sole action of the clearing solution is to eliminate the soluble iron salt, and prevent the precipitation of any insoluble iron compound. (2) Insufficient acid or insufficient use of the clearing-bath tends to exactly the same results as given under No. 1. (3) Insufficient washing between clearing and fixing produces not exactly the same kind of yellow stain. With the two former cases the stain is generally more or less defined, and tends to an orange hue, whilst the third fault in manipulation is generally characterised by a faint general yellow or lemon tint all over the print; and it arises, in this case, from the decomposition of the hypo by the acid of the clearing-bath, and consequent deposition of sulphur in the film and paper. (4) Insufficient elimination of hypo or imperfect fixation tends to subsequent yellowing of the paper consequent on the decomposition of the hyposulphites of silver. Using a fixing-bath too long or too weak also gives rise to the same result, or not allowing the prints to stay sufficiently long in the hypo will also cause the same effect. The prevention of these faults is obvious. The cure of the same, when existent, depends solely upon the nature of the fault. Thus, if the yellow coloration be due to a compound of iron it may frequently be removed by using a bath of

Sulphuric acid	25 parts.
Water	500 „

or

Neutral oxalate of potash	25 parts.
Oxalic acid	5 „
Sulphuric acid	5 „
Distilled water	500 „

The prints should be allowed to soak in either of these baths for about ten minutes, and then thoroughly washed. If the stain is still persistent, it may be assumed to be sulphur deposited in the

paper. We have found, however, that many a yellow stain on bromide paper will yield to the following treatment, although it may refuse to budge by treatment with either of the above baths. The print is thoroughly well wetted and laid at the bottom of a dish, with just sufficient water to make it adhere flat to the bottom without floating about. The following powder is then sifted over the print; it may also be applied in the form of a paste. When sifted over the wet print it should form a damp, sticky mass; and this may be allowed to remain on the print for half an hour, and then well washed and dried.

Salt of sorrel, or acid oxalate of potash ...	15 parts.
Cream of tartar	5 „

Blisters. These pests sometimes make their appearance when using bromide paper, usually in the first washing water after fixing, and they may be partially prevented by adding a handful of salt to the first washing water after fixing, or preferably by using the following bath just after clearing :—

Chrome alum	25 parts.
Sulphuric acid	6 „
Water	250 „

It is absolutely necessary that the print should be well washed to eliminate the alum, or yellow stains would ensue from the decomposition of hypo by the alum, and consequent deposition of sulphur. See FORMALIN, for another preventive of blisters.

It seems almost unnecessary to give any explanatory notes as to the cause for the desire for warm tones on bromide paper. The Eastman Company first suggested, we believe, the application of uranium to the finished print on their transferrotype paper, to give a warmth and colour which could not be obtained by ordinary development, but they pointed out that it was essentially a process of intensification; and one cannot help feeling very strongly that it is so, and that it has a tendency to strengthen up the distance so as to destroy to some extent the atmospheric effect. In Anthony's *International Annual*, 1889, p. 266, I stated that experiments had been commenced, which would enable any one to obtain warm tones even to purple shades on bromide tints; and in the succeeding volume, 1890, p. 340, I suggested bleaching the image with a chlorising agent, and then reducing with sulphantimonite of soda or a weak developer. Senier

recommended the chlorising of the image and redevelopment and A. R. Dresser suggested bleaching with mercury and redevelopment with quinol. In his excellent book, "Leitfaden für den Positiv-Entwicklungs-process auf Gelatine-Emulsions Papier," etc., Dr. E. A. Just suggests the use of the alkaline developers for obtaining warm tones; and Dr. Stolze ("Photo-Nachrichten," 1891, p. 4) gives a summary of his experiments to obtain warm tones by various developers, and finally suggests giving a long exposure, and developing with the following:—

A.

Sodium sulphite	20 parts.
Eikonogen	4 ,,
Water	300 ,,

B.

Potash carbonate	50 parts.
Water	300 ,,

To obtain brownish tones, the actual developer must be compounded as follows:—

Solution A	50 parts.
,, B	20 ,,
Water	150-180 ,,

To every 100 parts of this add

Solution of bromide of potash (1 : 10) ... 5-10 parts.

Brown or blackish brown tones only are to be thus obtained. Dr. Stolze also suggests bleaching the image with a solution of bromide of copper, stating that this is preferable to chlorising the image, as stains are less likely to appear. The bromide of copper solution can be made by dissolving:—

A.

Copper sulphate ... ... 1 part
in
Distilled water ... ... 100 parts;

B.

Potassium bromide ... ... 1 part
in
Distilled water ... ... 100 parts,

and mixing the two solutions; the thus bromised image should be well washed, and then exposed to daylight and redeveloped with the above eikonogen developer mixed in the following proportions:—

Solution A	...	...	...	...	...	50 parts,
„ B	...	...	...	...	...	20 „
Water	...	...	...	...	...	5000 „

Bromide Pencils. Special pencils for retouching, spotting out and working up bromide prints and enlargements.

Bromides. These are salts formed by the union of bromine with a metal or pseudo-metal. The alkaline bromides, potassium and ammonium, are used as restrainers, or for emulsion making. The question often arises as to whether these two are of equal efficiency as restrainers, but has not been satisfactorily answered. If Abney's view of their action be accepted, then the ammonium salt should be the stronger. He says: "In the formulæ with pyrogallic acid, it will be noticed that a soluble bromide is recommended to be added to the solution of pyrogallic acid and ammonia. This is to check the reduction of the unaltered silver bromide, the soluble bromide seemingly forming a compound with it, which is much less attackable by the developer."

Bromine (Ger., *Brom;* Fr., *Brome;* Ital., *Bromo*). Br = 80. A non-metallic element obtained as a deep orange-red liquid from sea-water. It is used to form the bromides.

Bronzing. A peculiar metallic lustre seen on looking at the shadows of some prints at a certain angle. It only makes its appearance on paper sensitised in a very strong bath, and with negatives showing very bold contrast. It usually disappears in the fixing bath. If it should still show after fixing and drying, the use of a little Encaustic Paste (*q.v.*) will remove it.

Buckle Brush. A convenient little instrument, made by drawing a piece of silver wire bent in half through a piece of small glass tubing, a tuft of cotton-wool being caught in the arch of the wire; the great advantage of this being that, when dirty, the cotton-wool can easily be replaced. It is convenient to turn

one end of the tube out like the mouth of a cornet, as shown by fig. 14, as this shape gives firmness and stability to the tuft

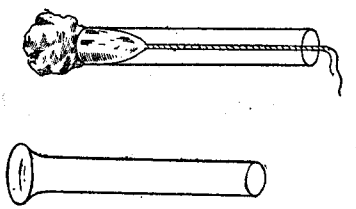


Fig. 14.

of wool; a very easy matter to one who will study our remarks under GLASS WORKING. A small piece of sponge is often more convenient than cotton-wool, and a piece of string than a wire.

Burned-in Photographs. See ENAMEL AND CERAMIC PHOTOGRAPHS.

Burnishing is the operation of *drawing* prints over the surface of a heated roller, the print being brushed over with a lubricator made by dissolving five grains of Castile soap in an ounce of methylated spirit. This should be rubbed over the face of the print with a piece of flannel, and allowed to dry before burnishing. The hot bar of burnisher should be just hot enough to be comfortably held in the hand. No stoppage must occur in the movement of the print whilst on the burnisher, or a line will be caused across the finished print. Should the bar of the burnisher become scratched at any time, it should be repolished with the finest emery ground into a paste with oil. (See AGATE BURNISHER.)

Cabinet. A special size of the commercial photograph, which measures about 6 by 4 ins.

Cadmium. A metal which accompanies zinc, the compounds of which are much used in photography.

Cadmium and Ammonium Bromide (Ger., *Einfach-ammonium-cadmiumbromid;* Fr., *Bromure double de cadmium et d'ammonium;* Ital., *Bromuro doppio di cadmio e d'ammonia*).

$2CdBr_2 2NH_4BrH_2O = 758$. This salt is formed by dissolving 344 parts of cadmium bromide and 98 parts of ammonium bromide in water, evaporating and crystallising: 130 parts are soluble in 100 parts of cold water, and 1 part in 5·3 parts of absolute alcohol, and 1 part in 24 parts of alcohol and ether (1 : 1). This salt is preferred to the simple bromide for collodion work on account of its greater solubility.

Cadmium and Ammonium Iodide (Ger., *Zweifach ammonium-cadmiumiodid;* Fr., *Iodure double de cadmium et d'ammonium;* Ital., *Ioduro doppio di cadmio et d'ammonio*). CdI_2, $2NH_4I$, $2H_2O = 565$. This salt is formed in a similar manner to the double bromide by dissolving 183 parts of cadmium iodide and 145 parts of ammonium iodide, evaporating and crystallising. One part is soluble in 0·7 parts of absolute alcohol and in 1·8 parts of alcohol and ether (1 : 1). It is used in the collodion process, and is preferred to the single salt on account of its greater stability and greater solubility.

Cadmium Bromide (Ger., *Cadmiumbromid*, or *Bromcadmium;* Fr., *Bromure de cadmium;* Ital., *Bromuro di cadmio*). $CdBr_2 4H_2O = 344$. One part by weight is soluble in 0·94 part of cold and 1 part of hot water, in 3·4 parts of absolute alcohol, in 250 parts of ether, and 16 parts of alcohol and ether (1 : 1). It crystallises in small efflorescent needles, and may be formed by direct combination between bromine and cadmium. At 100° C. the crystals lose two molecules of water and all the water at 200° C. It is used in the manufacture of bromised collodion.

Cadmium Iodide (Ger., *Cadmiumiodid*, or *Iodcadmium;* Fr. *Iodure de cadmium;* Ital., *Ioduro di cadmio*). $CdI_2 = 366$. This salt is formed in a similar manner to the bromide, and it is the most stable of all iodide salts. One part dissolves in 1·13 parts of water, in 0·98 parts of absolute alcohol, in 3·6 parts of ether, and in 2 parts of alcohol and ether. It is used in the collodion process.

Calcium Carbonate (Ger., *Calciumcarbonat, Kohlensäures Kalk, Kreide;* Fr., *Carbonate de chaux;* Ital., *Carbonate di calce*). $CaCO_3 = 100$. This occurs native in various forms, such as Iceland spar, marble, chalk, etc. It is almost insoluble in water, 0·007 per cent. being taken up by cold and 0·005 per

cent. by hot water; insoluble in alcohol and ether; it is soluble in water containing carbonic acid, a soluble salt, $Ca(HCO)_7$, being formed. It is used for cleaning glass, in toning-baths, and for preparing other calcium salts.

Calcium, Chloride of (Ger., *Calciumchlorid;* Fr., *Chlorure de calcium;* Ital., *Cloruro di calcio*). $CaCl_2 = 111$. Made by dissolving chalk in hydrochloric acid, and evaporating the solution. One part is soluble in ·25 parts of cold water and ·15 of hot, in 7 parts of absolute alcohol. The salt is met with in two forms—as a crystalline substance and also in the form of white agglutinated masses. The latter form is used for the preservation of platinotype and other paper, and acts by absorption of the aqueous vapour from the air; and it will be found in time to become very moist, and, if left long enough, quite liquid. In either case it should be collected in a common jar or vessel, and placed in a hot oven, when the water absorbed will be driven off and the salt will be as good as new so far as its hygroscopic qualities go. The form of preservative box now most used is commonly called a Calcium Tube (*q.v.*).

Calcium Hydrate (Ger., *Calciumhydroxid;* Fr., *Hydrate de chaux;* Ital., *Calce spenta*). $Ca(OH)_2 = 74$. Synonyms. Calcium Hydroxide, Hydrate of Lime, Slaked Lime. Prepared by moistening quicklime with water. It is a white powder, and is soluble in 760 parts of cold water, less soluble in hot water; its solution is called lime-water.

Calcium Oxide. See LIME, QUICK.

Calcium Tube. This is usually a metal tube with, at one end, a separate chamber to contain Calcium Chloride (*q.v.*), and is used to prevent the action of moisture on certain papers, such as platinotype, etc. Another pattern, in the form of a box, was much used in the early days of photography under the name of Marion's Preservative Case. Carbon tissue, or sensitised albumenised paper, may be kept for a long time in a perfectly dry atmosphere.

Calculations and Constants. Sufficient data for the most important photographic calculations will be found distributed under various headings, as EQUIVALENCE, CHEMICAL; HY-

DROMETERS AND HYDROMETRY, ANGLE OF VIEW, LENSES, THERMOMETERS, WEIGHTS AND MEASURES, EXPOSURE, FOCUS AND ITS BEARING ON RAPIDITY, SHUTTERS, and SOLUBILITIES, but in this place a few tables are given which do not come under these and other headings:—

CONSTANTS TO FACILITATE RAPID CALCULATION, MOSTLY GIVEN AS MULTIPLIERS.

Area of circle	= diameter squared × ·7854.	
Avoirdupois pounds	× ·009	= cwts.
,, ,,	× ·000455	= tons.
Cubic inches	× ·00058	= cubic feet.
,, ,,	× ·01638	= litres.
,, feet	× ·03705	= cubic yards.
,, ,,	× 6·232	= imperial gallons.
,, inches	× ·003607	= ,, ,,
Circumference of circle		= diameter × 3·1416.
,, ,,	× ·2251	= side of inscribed square.
,, ,,	× ·2821	= ,, equal square.
,, ,,	× ·31831	= diameter.
Diameter of circle	× 3·1416	= circumference.
,, ,,	× ·7071	= side of inscribed square.
,, ,,	× ·8862	= ,, equal square.
,, squared	× ·7854	= area of circle.
Radius	× 6·28318	= circumference.
Circumference	÷ 3·1416	= diameter.
Diameter	= 1·128 $\sqrt{\text{area of circle.}}$	
Length of arc	= number of degrees × ·017453 radius.	
Arc of 1° to radius 1	= 0·01745329.	
,, 1′ ,, 1	= 0·00029088.	
,, 1″ ,, 1	= 0·000004848.	
Volume of prism and cylinder	= base × height.	
,, cone	= $\frac{1}{3}$,, × ,,	
French tonnes	× ·984	= English tons.
,, metres	× 3·281	= ,, feet.
,, litres	× ·2202	= imperial gallons.
,, hectolitres	× 2·7512	= English bushels.
,, grammes	× ·002205	= lbs. avoidupois.
,, kilogrammes	× 2·205	= ,, ,,
Feet per second	× ·682	= miles per hour.

Calculations and Constants

Gallons	× 4·541	= French litres.
Grains	× ·001429	= lbs. avoirdupois.
Miles per hour	× ·1467	= feet per second.
Pounds avoirdupois	× 7000	= grains.
,, ,,	× ·82286	= lbs. troy.
,, troy	× 1·2153	= lbs. avoirdupois.
,, avoirdupois	× ·009	= cwts.
,, ,,	× ·00045	= tons.
,, on sq. inch	× 144	= lbs. per sq. foot.
,, ,, foot	× ·007	= ,, ,, inch.
Square root of area	× 1·12837	= diameter of equal circle.
,, of diam. of sphere	× 3·1416	= convex surface.
Carcels	× 9·5	= candles (English).
German candles	× 1·25	= English candles.
Carcels per sq. metre	× ·86	= Candles per sq. foot.

TABLE OF CIRCUMFERENCES, CIRCLES, SQUARES, CUBES, SQUARE ROOTS, AND CUBE ROOTS.

n.	Circumference of diameter n.	Surface of circle of diameter n.	Squares n^2.	Cubes n^3.	Square roots $\sqrt{n}$.	Cube roots $\sqrt[3]{n}$.
1	3·14	0·79	1	1	1·000	1·000
2	6·28	3·14	4	8	1·414	1·259
3	9·42	7·07	9	27	1·732	1·442
4	12·57	12·57	16	64	2·000	1·587
5	15·71	19·63	25	125	2·336	1·709
6	18·85	28·27	36	216	2·449	1·817
7	21·99	38·48	49	343	2·635	1·912
8	25·13	50·27	64	512	2·828	2·000
9	28·27	63·62	81	729	3·000	2·080
10	31·42	78·54	100	1,000	3·162	2·154
11	34·56	95·03	121	1,331	3·316	2·223
12	37·70	113·10	144	1,728	3·464	2·289
13	40·84	132·73	169	2,179	3·605	2·351
14	43·98	153·94	196	2,744	3·741	2·410
15	47·12	176·71	225	3,375	3·872	2·466
16	50·27	201·06	256	4,096	4·000	2·519
17	53·41	226·98	289	4,913	4·123	2·571
18	56·55	254·47	324	5,832	4·242	2·620
19	59·69	283·53	361	6,859	4·358	2·668
20	62·83	314·16	400	8,000	4·472	2·714

TABLE OF CIRCUMFERENCES, CIRCLES, SQUARES, CUBES, SQUARE ROOTS, AND CUBE ROOTS—*Continued.*

n.	Circumference of diameter n.	Surface of circle of diameter n.	Squares n^2.	Cubes n^3.	Square root $\sqrt{n}$.	Cube roots $\sqrt[3]{n}$.
21	65·97	346·36	441	9,261	4·582	2·758
22	69·11	380·13	484	10,648	4·690	2·802
23	72·26	415·48	529	12,167	4·795	2·843
24	75·40	452·39	576	13,824	4·898	2·884
25	78·54	490·87	625	15,625	5·000	2·924
26	81·68	530·93	676	17,576	5·099	2·962
27	84·82	572·56	729	19,683	5·196	3·000
28	87·96	615·75	784	21,952	5·291	3·036
29	91·11	660·52	841	24,389	5·381	3·072
30	94·25	706·86	900	27,000	5·477	3·107
31	97·39	754·77	961	29,791	5·567	3·141
32	100·53	804·25	1,024	32,768	5·656	3·174
33	103·67	855·30	1,089	35,937	5 744	3·207
34	106·81	907·92	1,156	39,304	5·830	3·239
35	109·96	962·11	1,225	42,875	5·916	3·271
36	113·10	1017·88	1,296	46,656	6·000	3·301
37	116·24	1075·21	1,369	50,653	6·082	3·332
38	119·38	1134·11	1,444	54,872	6·164	3·361
39	122·52	1194·59	1,521	59,319	6·244	3·391
40	125·66	1256·64	1,600	64.000	6·324	3·419
41	128·80	1320·25	1,681	68,921	6·403	3 448
42	131·95	1385·44	1,764	74,088	6·480	3·476
43	135·09	1452·20	1,849	79,507	6·557	3·503
44	138·23	1520·53	1,936	85,184	6·633	3·530
45	141·37	1590·43	2,025	91,125	6·708	3·556
46	144·51	1661·90	2,116	97,336	6·782	3·583
47	147·65	1734·94	2,209	103,823	6·855	3·608
48	150·80	1809·56	2,304	110,592	6·928	3·634
49	153·94	1885·74	2,401	117,649	7·000	3·659
50	157 08	1963·49	2,500	125,000	7·071	3·684
51	160·22	2042·82	2,601	132,651	7·141	3·708
52	163·36	2123·72	2,704	140,608	7·211	3·732
53	166·50	2206·18	2,809	148,877	7·280	3·756
54	169·65	2290·21	2,916	157,464	7·348	3·779
55	172·79	2375·83	3,025	166,375	7·416	3·802
56	175·93	2463·01	3,136	175,616	7·483	3·825
57	179·07	2551·76	3,249	185,193	7·549	3·848
58	182·21	2642·08	3,364	195,112	7·615	3·870
59	185·35	2733·97	3,481	205,379	7·681	3·892
60	188·50	2827·43	3,600	216,000	7·745	3·914

TABLE OF CIRCUMFERENCES, CIRCLES, SQUARES, CUBES, SQUARE ROOTS, AND CUBE ROOTS—*Continued.*

n.	Circumference of diameter n.	Surface of circle of diameter n.	Squares n^2.	Cubes n^3.	Square roots $\sqrt{n}$.	Cube roots $\sqrt[3]{n}$.
61	191·64	2922·47	3,721	226,981	7·810	3·936
62	194·78	3019·07	3,844	238,328	7·874	3·957
63	197·92	3117·24	3,969	250,047	7·937	3·979
64	201·06	3216·99	4,096	262,144	8·000	4·000
65	204·20	3318·31	4,225	274,625	8·062	4·020
66	207·34	3421·19	4,356	287,496	8·124	4·041
67	210·49	3525·65	4,489	300,763	8·185	4·061
68	213·63	3631·68	4,624	314,432	8·246	4 081
69	216·77	3739·28	4,761	328,509	8·306	4 101
70	219·91	3848·45	4,900	343,000	8 366	4·121
71	233·05	3959·19	5,041	357,911	8·426	4·140
72	226·19	4071 50	5,184	373,248	8·485	4·160
73	229·34	4185·39	5,329	389,017	8·544	4·179
74	232·48	4300·84	5,476	405,224	8·602	4·198
75	235·62	4417·86	5,625	421,875	8·660	4·217
76	238·76	4536·46	5,776	438,976	8·717	4·235
77	241·90	4656·62	5,929	456,533	8·774	4·254
78	245·04	4778·36	6,084	474,552	8·831	4·272
79	248·19	4901·67	6,241	493,039	8·888	4·290
80	251·33	5026·55	6,400	512,000	8·944	4·308
81	254·47	5153·00	6,561	531,441	9·000	4·326
82	257·61	5281·02	6,724	551,368	9·055	4·344
83	260·75	5410·61	6,889	571,787	9·110	4·362
84	263·89	5541·77	7,056	592,704	9.165	4·379
85	267·03	5674·50	7,225	614,125	9·219	4·396
86	270·18	5808·80	7,396	636,056	9·273	4·414
87	273·32	5944·68	7,569	656,503	9·327	4·431
88	276·46	6082·12	7,744	681,472	9·386	4·447
89	279·60	6221·14	7,921	704,969	9·433	4·464
90	282·74	6361·72	8,100	729,000	9·486	4·481
91	235·88	6503·88	8,281	753,371	9·539	4·497
92	289·03	6647·61	8,464	778,688	9·591	4·514
93	292·17	6792·91	8,649	804,357	9·643	4·530
94	295·31	6939·78	8,836	830,584	9·695	4·546
95	298·45	7088·22	9,025	857,375	9·746	4·562
96	301·59	7238·23	9,216	884,736	9·797	4·578
97	304·73	7389·81	9,409	912,673	9·848	4·594
98	307·88	7542·96	9,604	941,192	9·899	4·610
99	311·02	7697·69	9,801	970,229	9·949	4·626
100	314·16	7853·98	10,000	1,000,000	10·000	4·642

LOGARITHMS.

N.	0	1	2	3	4	5	6	7	8	9	D.
10	0 000	043	086	128	170	212	253	294	334	374	40
1	414	453	492	531	569	607	645	682	719	755	37
2	792	828	864	899	934	969	004	038	072	106	33
3	1 139	173	206	239	271	303	335	367	399	430	31
4	461	492	523	553	584	614	644	673	703	732	29
5	761	790	818	847	875	903	931	959	987	014	27
6	2 041	068	095	122	148	175	201	227	253	279	25
7	304	330	355	380	405	430	455	480	504	529	24
8	553	577	601	625	648	672	695	718	742	765	23
9	788	810	833	856	878	900	923	945	967	989	21
20	3 010	032	054	075	096	118	139	160	181	201	21
1	222	243	263	284	304	324	345	365	385	404	20
2	424	444	464	483	502	522	541	560	579	598	19
3	617	636	655	674	692	711	729	747	766	784	18
4	802	820	838	856	874	892	909	927	945	962	17
5	979	997	014	031	048	065	082	099	116	133	17
6	4 150	166	183	200	216	232	249	265	281	298	16
7	314	330	346	362	378	393	409	425	440	456	16
8	472	487	502	518	533	548	564	579	594	609	15
9	624	639	654	669	683	698	713	728	742	757	14
30	771	786	800	814	829	843	857	871	886	900	14
1	914	928	942	955	969	983	997	011	024	038	13
2	5 051	065	079	092	105	119	132	145	159	172	13
3	185	198	211	224	237	250	263	276	289	302	13
4	315	328	340	353	366	378	391	403	416	428	13
5	441	453	465	478	490	502	514	527	539	551	12
6	563	575	587	599	611	623	635	647	658	670	12
7	682	694	705	717	729	740	752	763	775	786	12
8	798	809	821	832	843	855	866	877	888	899	12
9	911	922	933	944	955	966	977	988	999	010	11
N.	0	1	2	3	4	5	6	7	8	9	

Logarithms facilitate many calculations, especially the extraction of roots, and even the above short table may be very useful in some cases, although for higher numbers a more extended

table will be required. The following short explanation gives sufficient information for using the above table :—

The logarithm of a number is the power to which 10 must be raised in order to produce that number, thus :—

10 to the 1st	or	10^1	=	10,	and the Log. of	10	= 1
10 „ 2nd	„	10^2	=	100	„ „	100	= 2
10 „ 3rd	„	10^3	=	1000	„ „	1000	= 3

Without giving further explanation, the following table—capable of indefinite extension in either direction—may be given of such logarithms as are whole numbers :—

Number.					Logarithm.
·001	...	...	...	...	− 3
·01	...	...	...	...	− 2
·1	...	...	...	...	− 1
1·	...	...	...	...	0
10·	...	...	...	...	+ 1
100	...	...	...	...	+ 2
1000	...	...	...	...	+ 3
10000	...	...	...	...	+ 4

The fractional part of the logarithm (called the mantissa) is alone given in the ordinary table of logarithms, and is naturally a constituent of logarithms of numbers intermediate between the above. The integer number (called the characteristic) is added by the user of the table according to the following rules :—The characteristic is one less than the number of figures to the left of the decimal point; but if the number is wholly decimal, the characteristic is minus, and is one more than the number of cyphers which precede the first significant figure.

Example : What is the logarithm of 279? Reference to the table of logarithms gives ·4456 as the mantissa or fractional part, while the characteristic will, according to the rule above given, be 2; so the complete logarithm will be 2·4456. If the number instead of being 279 were ·0000279, the mantissa would still be ·4456; but the characteristic would be − 5, making the complete logarithm − 5·4456.

Multiplication by Logarithms. Add the logarithms of the

factors, and the sum will be the logarithm of the number required.

Division by Logarithms. From logarithm of dividend subtract logarithm of divisor. The remainder will be the logarithm of the quotient.

Extraction of Roots by Logarithms. Divide the logarithms by the exponent of the root to be extracted. The quotient will be the logarithm of the required root.

The last column of the table, headed D, gives differences between successive logarithms, and may be used to further extend the table by interpolation. Let, for example, the logarithm of 2795 be required, half the difference is added to the logarithm previously obtained, and we get ·4464. Obviously the last figure thus obtained cannot always be relied upon as being accurate to a unit.

Calomel. An old name for the insoluble mercurous chloride. When digested with dilute hydrochloric acid in a water bath—say, a jam jar set in a saucepan—it is rapidly converted into mercuric chloride, but the *free access of air* is essential to this reaction. Some persons who require mercuric chloride solution (corrosive sublimate) for the purpose of intensification, prefer to prepare the solution as above, as calomel can be bought without trouble, while mercuric chloride comes within the Poisons Act. An ounce of calomel requires about ½ a fluid ounce of the strong commercial hydrochloric acid and 12 ozs. of water. Any excess can be neutralised with ammonia.

Calorific Rays of the Spectrum. Those rays of the spectrum which produce or emit heat. They are found at the red end of the spectrum, the most powerful being situated beyond the visual rays. This can be proved in the following manner:—The rays of the spectrum are conducted through a solution of iodine in carbon bisulphide, which absorbs visual rays, but allows heat rays to pass; these can be brought to a focus by certain means, and in this focus magnesium ribbon will catch fire, and platinum be brought to a white heat. Taking 100 as the maximum intensity of the heat rays, the following table will give the values of the colours of the spectrum as heat-producers:—

Violet	0
Green	2
Yellow	14
Red	21
End of visual spectrum	45
Ultra red, or invisible rays	100

Bodies which have the power of transmitting heat rays are said to be *diathermanous*, those which do not possess this power, *athermanous*, or adiathermanous. Glass being highly adiathermanous, photographic lenses, unless they are pointed at the sun, allow but few heat rays to pass to the sensitive film. Rock salt, on the other hand, allows the heat rays to pass very freely, and lenses or prisms of this material are required in making experiments on the calorific rays, or radiant heat.

Calotype, or Talbotype. A process commonly named after its inventor, Fox Talbot, but called by him calotype (*καλός*, beautiful). It is but little used now, excepting in a modified form for making enlargements, but interesting from its being the first paper negative process used. The following is a short *résumé* of the process:—Stout paper, of an even surface and as grainless as possible, is brushed over with a solution of iodide of silver in iodide of potassium. It is, when partially dry, washed twice or three times in distilled water to remove the iodide of potassium and dried, and it can be kept for some little time in this state, as it is but faintly sensitive to light. When required for exposure it is brushed over with a solution of gallo-nitrate of silver or aceto-gallo-nitrate, and exposed wet; the exposure required for an open view is about six minutes. In all cases a faint image of sky-line should be apparent. The image is developed with a solution of gallo-nitrate of silver in excess of gallic acid. The negative is well washed, fixed in hypo, and washed and dried in the usual way, then waxed or oiled to render it translucent.

Cameo. Photographs to which, by means of dies and press, a slight convexity is given.

Camera, Lucida. A reflecting device, a piece of flat glass being the simplest form, by which the reflection of a scene is made to appear as if superimposed on a sheet of paper. It

was much used as an aid in sketching before the invention of photography.

Camera Obscura is actually a dark chamber into which the image of external objects may be projected by means of a convex lens. In the pre-photographic days portable camera obscuras were made, by means of which the images of external objects were projected upon a sheet of white paper, and the outlines traced by means of a pencil. The first photographic camera of Nicephore Niepce, appears to have been constructed about the year A.D. 1816, and in a letter written during this year he describes it as "a sort of artificial eye consisting of a square box fitted with an adjustable tube containing a lens." The modern types of camera for ordinary use are too well known to require any description, but special cameras are described, under appropriate headings, as DETECTIVE OR HAND CAMERA, CYLINDROGRAPH, PANORAMIC CAMERA, and AUTOMATIC PHOTOGRAPHY; while matters of importance relating to the camera are similarly dealt with under suitable headings—as, for example, FOCUSSING SCREEN, LENS, or VIEW FINDER.

Camera Stand. See STAND.

Camphor (Ger., *Camphor;* Fr., *Camphre;* Ital., *Canfora*). This is obtained from several trees from Japan and Borneo. It is met with in solid, colourless, translucent, crystalline masses, usually covered with minute fissures; it is very tough, but can be powdered by moistening with water, alcohol, or ether. It has a peculiar smell and hot, bitter taste. It is soluble 0·1 per cent. in water, 120 per cent. in alcohol, and also in ether and most oils. It is used in the preparation of celluloid, varnishes, and as an antiseptic.

Canada Balsam (Ger., *Canadabalsam;* Fr., *Baume du Canada;* Ital., *Balsamo del Canadà*). Synonym: Canada Turpentine. A pale greenish and faintly yellow turpentine obtained from various species of pine trees. It has the consistence of honey, and a pleasant resinous odour. It slowly dries by exposure to the air into a transparent adhesive varnish. Insoluble in water, soluble in all proportions in alcohol. It is used for making varnishes, and for cementing lenses together. (See BALSAMING, RE-, OF LENSES.)

Canvas, Printing on. See SILK. For enlarging on canvas see ENLARGING.

Caoutchouc. See INDIA-RUBBER.

Cap. The cover used at the time of exposure to open and close the lens. It is also a protection against accidental injury. It is well to have a cap for each end of the lens for greater protection of the glasses. To prevent accidental losing or mislaying of the cap, it may be attached to the lens mount by a piece of string.

Caramel. When ordinary cane-sugar is heated to from 400° to 420° F., the molecule of sugar $C_{12}H_{22}O_{11}$ loses the elements of water, and caramel $C_{12}H_{18}O_9$ is formed. It is highly soluble in water, deliquescent, and has a deep orange-brown colour, which is highly nonactinic. It is used in photography in backing plates as a preventive of halation. The preparation of caramel is easy if sugar is heated in a saucepan over a slow fire and with constant stirring, a very little practical experience being sufficient to enable the operator to guard against over-heating and consequent carbonisation of the sugar.

Carbide of Calcium. See ACETYLENE.

Carbolic Acid (Ger., *Carbolsäure;* Fr. *Acide Phenique*). $C_6H_5HO=94$. Synonyms: Phenic Acid, Phenol, Phenylic Alcohol, Hydrate of Phenyl. A crystalline substance, which is not a true acid, obtained from coal tar by fractional distillation. It is a powerful antiseptic and preservative, for which purpose it is added to gelatine and certain mountants. Solubility: 1 in 15 of water, mixing with alcohol and ether.

Carbon. An elementary body which is met with in many forms; native as diamond and plumbago, also together with hydrogen in the coal deposits. The various forms of coke, retort scale, charcoal, and lamp black are nearly pure carbon. Carbon in this latter form is the chief or basic pigment used in the methods of printing known as carbon printing, and a curious process has been devised in which carbon itself (or possibly a metallic carbide), in contact with nitrate of silver, appears to be sensitive to light. (See CARBONISED PLATE METHOD.)

Carbon Processes. (Transfer and non-Transfer.) Carbon printing is a general term applied chiefly to those printing methods in which a pigment, which may be, and often is, carbon, is mixed with gelatine, gum, or albumen and applied as a coating on paper. The film being made sensitive by soaking in a solution of an alkaline bichromate—or in some cases the sensitising material is added to the organic mixture in the first instance—exposure to light makes the bichromated organic matter insoluble, while the unexposed portions can be washed away. In the most usual form of carbon or pigment printing—also frequently called autotype printing—the starting point for the amateur or occasional worker is a material sold as carbon tissue, or autotype tissue, and this consists of paper coated with a thick layer of gelatine, somewhat heavily coloured with suitable pigments. The preparation of this tissue on a small scale is seldom worth undertaking, but particulars will be found farther on. The tissue may be bought ready sensitive, the bichromate being added during manufacture; but as its keeping properties are very uncertain and variable, it is generally best to obtain the unsensitised tissue, which may be had in various colours, as black, engraving black, standard brown, standard purple, portrait brown, portrait purple, sepia, red chalk, and special transparency tissue for lantern slides. The paper, or tissue, is sensitised in the following bath :—

Bichromate of potash	1 oz.
Liq. ammon. fort. ·880	5 drops.
Distilled water	20 ozs.

The tissue is *immersed* in this for two minutes in hot weather or three minutes in cold. It must be dried, and kept protected from light, air, and damp. From the colour of the tissue it is evident but little, if any, image can be seen; therefore the duration of exposure is judged by means of an actinometer of ordinary chloride albumenised paper, and according to the density of the negative the tissue is exposed whilst the actinometer registers one, two, or three tints. The action of light continues in the dark. Allowance must, therefore, be made for this fact if the tissue is not to be developed at once. As the exposure to light renders the gelatine insoluble (and as the action of development is to remove the unacted-upon gelatine),

it is obvious that it will be useless to try and develop the picture upon the face, as the gelatine is insoluble there. It must, therefore, be transferred to some support, so as to enable the gelatine to be dissolved away from the back, for which purpose the paper must be removed; and as this transfer would reverse the print—*i.e.*, make the right hand of the picture the left—when a negative taken in the ordinary way is used, a temporary support is required, from which the developed print is again transferred to its correct position. This temporary support may be either a mulled zinc plate, glass, or a specially prepared paper, according to the surface desired. From the temporary support again the print may be transferred to paper, opal glass, porcelain, metals, ivory, terra-cotta, stone, wood, or other material. The special transfer paper or temporary support is a tough, smooth paper coated with shellac and rolled, and when required for use it is waxed to prevent the gelatine film from adhering permanently to it, the following solution being used for that purpose :—

Yellow resin	...	...	...	...	36 grs.
Yellow wax	...	...	...	...	12 ,,
Turpentine ...	...	...	...	...	2 ozs.

Melt the wax, add the resin and turpentine. The writer has found the substitution of ether for turpentine a decided advantage, as the temporary support can be used immediately; when turpentine is used some hours must elapse after the waxing solution has been applied to the paper, which is done with a tuft of cotton-wool, or flannel, and a fresh tuft of wool being used to polish. A piece of smooth indiarubber cloth or "macintosh," slightly waxed with the turpentine solution, is a very good temporary support. The printed tissue and the waxed temporary support, of whatever nature it may be, are immersed in cold water, till the tissue begins to uncurl and float flat; it is brought into contact, film side downwards, with the temporary support, and both raised together from the water, and then the squeegee is used to bring them into complete contact. They are then placed between blotting boards for five or ten minutes, and immersed in a bath of water at a temperature of 105° or 110° F. When the pigmented gelatine begins to ooze out at the edges of the paper, strip off the paper upon which the

gelatine was spread, and keep washing the print with the hot water by throwing the hot water on to it with the hand, or by means of a cup or soft broad brush, or a small sponge. As this is done it will be found that the gelatine unacted upon by light will be dissolved away and will carry with it the colouring pigment, leaving the print in all its beauty. As soon as development is complete it is plunged into a bath of cold water to set the gelatine, and then it is placed in a bath of the following:—

Powdered alum	1 oz.
Water	20 ozs.

This not only fixes the print by hardening the gelatine, but it also discharges the yellow colour of any remaining bichromate salt. It is allowed to remain in this bath for about ten minutes, or till the colour is entirely discharged from the whites of the picture, and finally rinsed twice or three times in clear water. The print is now ready for transferring to its final support, of whatever nature that may be; but before this transfer can take place it is necessary that the final support should be prepared to receive it, for which purpose it is coated with the following:—

Nelson's gelatine	1 oz.
Water	20 ozs.

Soak the gelatine in the water for an hour, or till soft, and then dissolve by the aid of a gentle heat. When dissolved, add to it gradually 12 grs. of chrome alum dissolved in 1 oz. of water. The commercial final support, which is a stout paper, is already prepared, and merely requires soaking in alum solution, ½ oz. to the pint, an hour before using. The print on its temporary support and the final support, whether freshly prepared or not, are brought into close contact under the surface of water, and complete contact obtained by means of a squeegee, and are then placed in blotting boards, or hung up till perfectly dry, when the temporary support can be stripped off, leaving the print in its proper position. It is advisable for any amateur who may wish to work in carbon to obtain Sawyer's "A B C Guide to Autotype Printing." The disadvantage of this form of the process is the necessity for the use of reversed or film negatives, or the employment of a temporary support; but the non-transfer methods (see below, and also ARTIGUE'S PROCESS) obviate the above disad-

vantage. The advantages of carbon are the absolute permanency of the pictures as regards fading, the easy manipulations of the process, and the fact that prints of almost any colour may be transferred to any material, and the resulting pictures can be retouched, spotted, or otherwise worked up by the brush in the same colour. The process is very easy and simple, and the materials so cheap, that every amateur should number this amongst his photographic processes. Directions have been given for double transfer only. Single transfer is easier, as the intermediate or temporary support is not required. Reversed negatives, however, must be used, and the print is developed in precisely the same manner as directed above. When the tissue has been exposed it is transferred at once to its final support, which may be prepared with solution of gelatine as directed for double transfer or albumenised paper, the film of which has been rendered insoluble by immersion in a bath of two volumes of methylated alcohol, and one volume of water may be used. The transferred print is then well washed in water and soaked in the alum bath, and reared up to dry after another washing. It is stated above that "the action of light continues in the dark." Some doubt has been thrown on this, but it is an acknowledged fact that the action of light is continued, at any rate, in a damp atmosphere. The following are some of the principal mixtures used in preparing carbon tissue. The jelly is first made as follows:—

Nelson's transparent sheet gelatine ...	10 parts.
White sugar	4 ,,
Water	25 ,,

Soak the gelatine in the water until soft, and dissolve by the aid of a gentle heat; add the sugar, and stir thoroughly. When set, turn the jelly out, and cut off the bottom part, so as to get rid of any grit that may have settled down. A good photographic purple brown is made as follows:—

Vegetable black	72 grs.
Alizarine lake	60 ,,
Indigo	13 ,,

Grind these with about 4 ozs. of melted jelly, using muller and slab, and add to 6 lbs. of the above-mentioned jelly.

Black Tissue.

Jelly	2 lbs.
Paris black pigment	50 grs.

Red Chalk or Bartolozzi.

Jelly	2 lbs.
Venetian red	3 ozs.
Indian ink	8 grs.

Transparency Tissue.

Jelly	2 lbs.
Indian ink	200 grs.

To make Double Transfer Paper.

Hard gelatine	1 lb.
Fine sulphate of baryta	2 oz.
Water	5 ,,

Soak the gelatine till soft, and dissolve by the aid of heat; mix the baryta, and add

Chrome alum	50 grs.

dissolved in

Water	4 ozs.

For Single Transfer Paper.

Hard gelatine	1 lb.
Water	5 pints.

Soak the gelatine, and dissolve by heat, and add a few drops at a time, sufficient of the following to slightly coagulate the mixture.

Chrome alum	300 grs.
Water	1 pint.

The mixture being now somewhat thick and ropy, sufficient acetic acid should be added to make it again liquid. The "new" carbon processes without transfer are, like many new things, in their main and essential features the oldest, and much attention has recently been given to them. The article in this Dictionary, ARTIGUE'S PROCESS, gives such working directions as should enable the reader either to obtain satisfactory results on the ready-prepared paper manufactured under the superin-

tendence of M. Artigue, or on home-made tissue; the instructions of Mr. Duchochois on this head, and there quoted, being a useful guide. The process now to be described is somewhat simpler in execution than the artigue method, and in its original form appears to be chiefly due to M. Poitevin, Mr. John Pouncy, Mr. Thomas Sutton, and Mr. J. C. Burnett, who worked between 1850 and 1860; but its revival is largely due to M. Demachy and M. Rouillé-Ladevèze. The most recent work on the subject is "The Gum-bichromate or Photo-aquatint Process," by Demachy and Maskell, published at the *Amateur Photographer* office. The method may be summarised as follows:—Ground pigments are mixed with a thin mucilage of gum-arabic, and a little soluble bichromate, this mixture being applied to the paper as a thin wash. When dry, the paper is exposed under a negative, and the picture is developed by soaking in water (cold, warm, or hot) until the unexposed portions of the pigmented gum are sufficiently washed away. The following working details are taken, in abstract, from an article in the *Amateur Photographer*, March 6th, 1896, and a subsequent note:—"A rather rough paper is desirable, quite apart from any esthetic considerations, as the roughness breaks up the continuity of the mucilaginous film, and assists in enabling the water to penetrate freely; the various drawing papers, and Dutch hand-made papers, affording a wide choice of texture. The sensitive preparation is made as follows:—

A.

Clear white gum	4 oz.
Water	6 ,,

Soak till dissolved, and squeeze the mucilage through fine muslin.

B.

Bichromate of potassium	1 oz.
Water	9 ozs.

In a room lighted by yellow light, equal volumes of A and B are mixed, and then such moist water colours are stirred in as will give the required tint; but the coloration should only be such that, when the preparation is laid on paper with a broad camel's-hair brush, as described below, the tint appears very faint, and far short of that required to form the shadows of a print. The

film should seem very thin and transparent when the paper is held up to a window, and the outline of a finger held the other side of the paper should be easily traceable. Indian ink or ground lamp black, with a little cobalt blue to modify the greenish tint, is a suitable pigment. Earth colours, like Indian red or the siennas, can be used, but a much larger quantity is required than when lamp black is the base. To coat the paper it must be sponged on both sides to stretch it; after which it is pinned down on a board by one corner, and rapidly brushed over with the sensitive mixture by means of a broad camel's-hair brush. It is best to work in one direction, and the coating must be thin—so thin that the gummy mixture must rather be rubbed over the surface of the paper than painted on, and the pigmenting must be adjusted for this kind of coating. Some practice is required in coating the paper thinly and uniformly. The best method of drying is to hang the paper up over-night in a room where there has been a fire during the day, but more rapid drying before a fire is quite allowable. Exposure should generally be longer than for a print on albumenised paper, and can be judged by the faint image of the exposed bichromated gum which is visible—or should be, if the paper is not too heavily pigmented—when the paper is viewed by transmitted light; the details or the shades being just traceable. The use of an actinometer is often more convenient, especially for those who are accustomed to one. The exposed print is now soaked in cold water, and if the colour soon begins to wash off the paper on rocking the dish, under exposure is indicated; and in this case cold water alone may perhaps finish the development. According to the behaviour of the print, warmer and warmer water may be used, and to increase the detergent power of the water a stream may be poured from a height on the surface of the print. When the development is complete, the print may be soaked in an alum bath, after which it is rinsed and allowed to dry. Dr. Mallmann suggests that a special preparation of gelatine made non-setting may advantageously replace the gum ordinarily used in the direct carbon or pigment process. This change gives, according to Dr. Mallmann, images of finer texture, and the material does not so dissolve from the whites as to produce an appearance of scaliness; moreover, the image is much more firmly adherent to the paper. Hydrate of chloral

is one of those substances which may be used to prevent the setting of gelatine, and this without interfering with its sensitiveness to light when bichromated; and the following is mentioned as a known receipt for preparing a strong gelatinous solution, which remains fluid on cooling:—

Water...	... 1,000 parts.
Hydrate of chloral	... 250 „
Gelatine	... 400 „

Herr Watzek confirms Dr. Mallmann's results, and mentions that an addition of potash to the warm development water expedites the development when a long exposure has been given, while the use of sawdust (see ARTIGUE'S PROCESS) brightens the high lights."

Carbonates. A class of salts largely used in photography and industrial operations. After marble and chalk, which are carbonate of calcium, the most familiar carbonate, and most used in photography, is that of sodium (washing soda), Na_2CO_3, $10H_2O$. The white powder ordinarily sold as carbonate of soda by the pharmaceutical chemist is a bicarbonate, and is not used in ordinary photographic operations. It takes its name from a period when it was regarded as the normal carbonate, the salt now looked on as the normal carbonate being then called the subcarbonate.

Carbonised Plates. A plate of metal on which carbon has been deposited, or a plate of compact carbon such as is used for batteries, if moistened with nitrate of silver and exposed to light gives an image in white reduced silver.

Caricatures, Photographic. Among the most common methods of making these may be mentioned successive exposure against a black background, the use of painted or sketched screens in front of the sitter, and photographing the reflection from a curved mirror. (See POLYPOSE; also SPIRIT PHOTOGRAPHY.)

Carrier. A framework of wood used in the dark slide to enable the operator to use a smaller plate than the full size.

Carte de Visite. A once very popular size of the professional photograph, measuring about 4 by $2\frac{1}{2}$ ins.

Cartridge. Dry photographic chemicals are often put up in cartridge form for the use of tourists, and home-made cartridges,

made to a special size, are often convenient, and may be re-filled many times. Roll a sheet of pasted paper round a rod so as to form a tube, and when dry cut to suitable lengths and close with a cork at each end.

Caseine. The constituent of milk which, when coagulated, produces cheese. Skim cheese dissolved in weak ammonia yields a preparation which will coat paper like albumen, and in its relation to silver salts caseine is similar to albumen; but it is not much used in modern photography.

Castile Soap. A soap made from soda and olive oil, and used as a lubricant for burnishing. Castile soap is sometimes veined or marbled by the addition of sulphate of iron, and when freshly prepared is yellowish white, with bluish-green streaks. When old the iron salt turns red by oxidation. The white Castile soap is to be preferred.

Catalysotype. An old process invented by Dr. Woods, in which paper was impregnated with syrup of iodide of iron, and then painted with a solution of nitrate of silver. It was then exposed in the camera and the image gradually appeared.

Cathography. Synonymous with Radiography (*q.v.*).

Caustic. A term applied to corrosive or irritant chemicals. Thus nitrate of silver is known as lunar caustic, and the caustic alkalies are the hydrates of the alkaline metals.

Celluloid. A compact transparent material, the chief constituent of which is pyroxyline or dinitro-cellulose; camphor being the usual medium (or quasi solvent) for agglutination. Celluloid dissolved in amyl acetate, acetone, or other suitable solvent, forms a useful varnish. (For a method of repairing articles of celluloid, see note under ACETONE. See also CELLULOSE.)

Cellulose. A general term applied to the fibrous or hard constituent of plants. It contains $C_6H_{10}O_5$, and is the basis of the various kinds of paper, linen, and cotton. Treated with nitric acid, or mixtures of this acid with sulphuric acid, it yields a more or less completely nitrated product; that in which two of hydrogen are replaced by the group NO_2 being the soluble pyroxyline used in making collodion and celluloid. The acetic

and other derivatives of cellulose have been suggested for the making of transparent and flexible films to replace ordinary Celluloid (*q.v.*).

Centigrade. See THERMOMETER.

Centigramme, Centimetre. See WEIGHING AND MEASURING.

Centrifugal Separation. Plener, by rapidly rotating a metal vessel silvered inside, and containing gelatino-bromide emulsion, succeeded in separating the sensitive constituent which adhered as a cheese-like mass to the inner circumference of the vessel. It could then be stirred up with water and be again separated, and so washed any number of times, after which it could be incorporated with fresh gelatine. This method has since been largely employed as a means of getting rid of decomposed gelatine, which may cause frilling, or fog.

Ceramic Photography. See ENAMEL AND CERAMIC PHOTOGRAPHY.

Chemical Calculations, Reactions, and Equivalent Quantities. See EQUIVALENCE, CHEMICAL, and ANALYSIS.

Chemical Focus. See CHROMATIC ABERRATION.

Chemigraphy. Relief etching on metals, the resist being an original drawing on the metal, a transfer from another print, or a transfer obtained by photographic means. Zinc is the metal most used, and very weak nitric acid the mordant. As the etching progresses, the lines are loaded with fresh ink and resin powder. This mixture being heated on the plate, runs down on the sides of the relief and affords protection against undercutting.

Chlorates. A class of salts derived from chloric acid; the chlorate of potassium $KClO_3$ being used as a source of oxygen, which it readily yields when heated, especially if a small proportion of manganese dioxide is present.

Chlorides. A chloride is a compound of a metal or a quasi-metal with chlorine, the most common chloride being sodium chloride, or common salt, NaCl. The so-called chloride of lime and chloride of soda or potash come under a different category, containing as they do a hypochlorite as the active constituent. (See BLEACHING POWDER; also EAU DE JAVELLE.)

Chloroform (Ger., *Chloroform;* Fr., *Chloroforme;* Ital., *Chloroformio*). $CHCl_3$. Prepared by the action of Bleaching Powder (*q.v.*) and water on alcohol or methylated alcohol. It is a heavy, colourless liquid of pleasant smell and sweet, hot taste. It dissolves in alcohol and ether in all proportions, and 1 volume in 200 of water. It evaporates very quickly, and leaves no residue. It is used in some varnishes.

Chlorophyll (Ger., *Chlorophyll or Blattgrün;* Fr., *Chlorophylle;* Ital., *Clorofilla or Cromolo*). This is the green colouring matter of plants and leaves, and is stated to be composed of two substances, phylloxanthine, of a yellow colour, and phyllocyanine, which is blue. It is slightly soluble in water, but more so in alcohol and ether. It has been used for sensitising plates for ortho-chromatic work, and for this purpose either ivy, parsley or blue myrtle (periwinkle) should be used. The fresh leaves should be cut up small and rubbed in a mortar, and then allowed to macerate in alcohol for 24 hours. Chlorophyll solutions do not keep well.

Chromates. See CHROMIUM.

Chromatic Aberration. When light passes through a prism or a lens, which may be considered as formed of prisms, it is broken up or refracted into its constituent rays. If a beam of light, RR, strike a lens (Fig. 15) it is refracted and dispersed, and as the violet rays are bent out of their course more than the red, it is obvious that they will meet at a point nearer the lens than the red rays, as shown in the figure. Therefore, suppose we wish to get an image of the object from which RR proceeds, and place a screen at V, we shall see a violet image surrounded by rings of blue, green, orange, yellow and red. And by placing the screen at Y, we shall get a red image surrounded by orange, yellow, green, blue and violet rings, and this will be the case at each point where the different coloured rays cross the axis, though for the sake of clearness these are not shown. Now the brightest part of the spectrum to the human eye is in the yellow, whilst the rays which act most on the plate are in the blue and violet, so that if we obtain an image by the yellow rays, the plate would be affected by the blue and violet, and we should get no sharp picture, because at Y the blue rays would be a circle instead of a point. This is termed non-coincidence of the visual and

chemical foci, or the lenses are said to be uncorrected or non-achromatic. Now it is a fact that crown and flint glass have different dispersive powers, that is, they produce spectra which

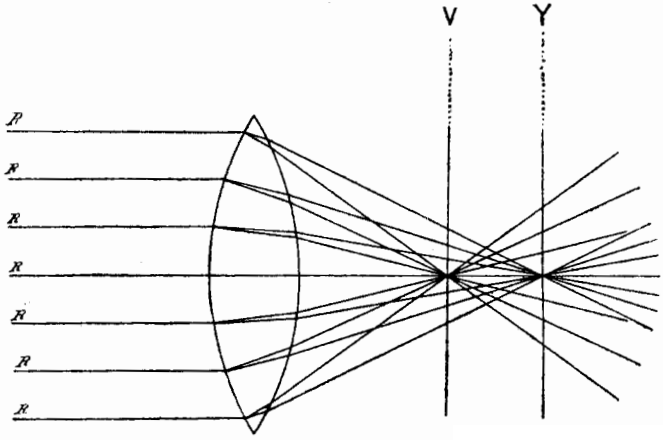


Fig. 15.

differ in the position of the Fraunhofer lines. With the crown glass the distances between A B and B C, in the red and orange, is greater than with the flint, whereas with the flint the distances

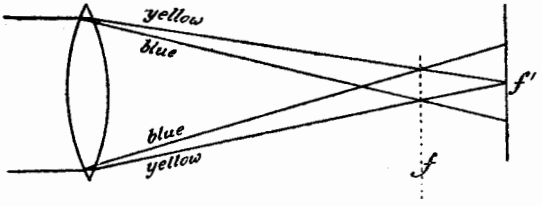


Fig. 16.

between F G and G H are greater than with the crown. Therefore we may assert that, with the crown glass, the red end or less refrangible rays are extended at the expense of the violet or more refrangible rays, whilst with the flint glass the opposite holds good. We have seen that we have a lens which is

practically a collection of prisms; we have also seen that the visual and chemical rays do not have the same focus, and it is essential they should possess this in common. Light is always refracted towards the base of a prism, and we have just pointed out that flint and crown glass act differently on the spectrum;

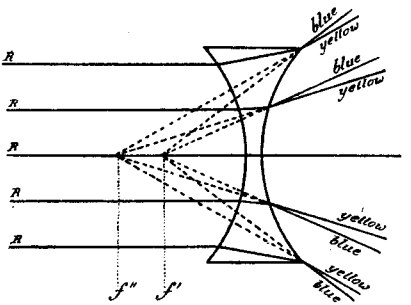


Fig. 17.

the one extends the blue, the other the red end more, so that it is not difficult to see from fig. 16, that what we want to do is to make f fall upon f'. This represents, exaggerated of course, the action of a convex crown-glass lens. Now, suppose we examine the action of a concave flint-glass lens. In this case,

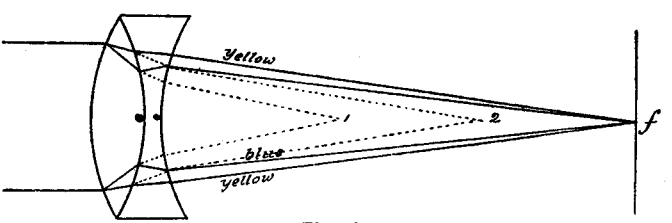


Fig. 18.

fig. 17, it is seen that the blue rays are bent out more than the yellow, so that, if we combine a flint concave with a crown convex, we shall get the blue rays extended more, and thus neutralise the effect of the crown to some extent. I endeavour to show this in fig. 18. The focus of the crown lens is shows at 2 for the yellow rays and at 1 for the blue; but by adding

a concave flint, the focus of both is lengthened to *f*. Now, there are more rays than the blue and yellow in the spectrum, and it naturally occurs to ask about the others; these are left outstanding, and at *f* form coloured rings round the central spot or sharp focus *f*, and form what is called the secondary spectrum. In the last figure we only used two lenses, but if we use three, three rays are combined and the lens is said to be apochromatic, and the faint outstanding rays of colour are called the residuary tertiary spectrum. The advantage of the more perfect achromatism of lenses at the present time is shown from the following statement. The ordinary gelatino-

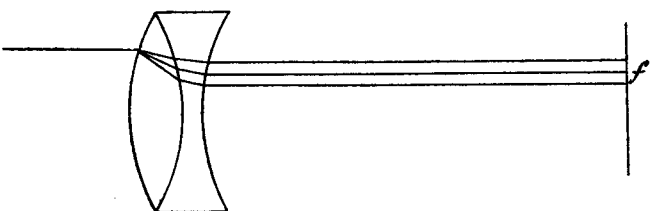


Fig. 19.

bromide plate is sensitive, not only to those particular portions of the spectrum designated by D and F, but also between D and F, and F and H; and if we use colour-sensitive plates, we find considerable increase of sensitiveness to the yellowish green about E, so that those rays for which the lens is not perfectly achromatised may act, and as these rays do not form an exact image at that point where D and F meet, they may affect the silver in such a manner as to enable the developer to reduce the same; and although such reduction would be hardly visible to the naked eye, yet, in enlarging, the points of confusion thus caused might become visible, and give indistinctness or fuzziness.

Chromatype, Chromotype. Names applied to certain bichromate processes; the former to an old method of Mr. Ponton's in which paper was sensitised with one dram of sulphate of copper in half an ounce of water, then mixed with half an ounce of saturated solution of bichromate of potassium. After exposure it yields a brown picture on washing with nitrate of silver solution, washing alone serving for fixation. Several variations were made. The latter name was applied by Mr.

Lambert to carbon points developed on collodionised glass, and stripped when dry with the full enamel lustre.

Chrome Alum. See ALUM.

Chromium. A metal unimportant in the separate state, but the compounds of which are much used in the industrial arts. The chromates M'_2CrO_4, and bichromates $M_2Cr_2O_7$, when soluble, make gelatine and similar substances highly sensitive to light, the gelatine becoming insoluble. (See CARBON PROCESSES and ARTIGUE'S PROCESS.)

Chromogramme. The assemblage of three monochrome positives which control the coloured lights in Mr. Ive's photochromoscope, now called by him Kromskop (*q.v.*).

Chromotype. See CHROMATYPE.

Chrono-Photography. The taking automatically of photographs at regular intervals for such devices as the lantern zoetrope. (See ZOETROPE.)

Chrysotype. An obsolete process: paper charged with the double citrate of iron and ammonia is exposed, and then immersed in a solution of chloride of gold, whereby a permanent purple print is obtained, which only needs washing.

Cinematograph. See ZOETROPE.

Circle of Least Confusion. An optical term to denote the nearest approach to an absolute focus of a pencil of light.

Citric Acid (Ger., *Citronensäure;* Fr., *Acide citrique;* Ital., *Acido Citrico*). $H_3C_6H_5O_7$. Occurs naturally in the juice of many fruits, and is obtained chiefly from the lime and lemon juice by heating and adding chalk, collecting the precipitate and decomposing with sulphuric acid, and evaporating the solution till crystals are obtained. Solubility: 133 per cent. in cold, 200 per cent. in hot water, soluble in alcohol and ether. It is used to make citrates, as an ingredient of clearing solutions, and as a preservative for sensitised paper.

Clearing Bath. Any solution used to clear or cleanse a negative or positive from the stains of development is thus termed. The following are those in most common use :—

Clearing Bath

Alum	... ...	2 ozs.
Citric acid	... ...	1 oz.
Water	... ...	20 ozs.

Or

Chrome alum	... ...	1 oz.
Citric acid	... ...	1 ,,
Water	... ...	20 ozs.

The latter is specially useful, the chrome alum having a special tanning action on the film much superior to ordinary alum. The addition of a little ferrous sulphate has been recommended, but without any notable benefit. When plates are developed by pyrogallol and soda, a very non-actinic yellow colour is given to the film, which protracts the operation of printing most inordinately. By use of the chrome alum bath this colour is changed to fine olive green, which scarcely effects the printing. In the case of ferrous-oxalate development the same bath is useful for clearing off the deposit of oxalate of lime due to the use of hard water, whether on negatives, positives, opals, or paper. Mr. B. J. Edwards has suggested the following, which, as it possesses one or two features distinct from the others, is here given :—

I.

Alum	... ...	1 oz.
Citric acid	... ...	1 ,,
Water	... ...	15 ,,

II.

Saturated solution of sulphate of iron	... 5 ozs.

For ordinary use one part No. II. is mixed with three parts of No. I. If the negative is a little too dense, the use of No. I. solution alone will reduce the same. If not quite dense enough, the use of No. II. alone will often give the slight effect required to produce a satisfactory negative. Mr. Edwards recommends the use of this clearing bath immediately after fixing, the plate being only just rinsed after being taken out of the fixing bath. The following solution has been specially recommended for removing pyro stains and is very effectual :—

Thiocarbamide	... ...	30 grs.
Citric acid	... ...	10 ,,
Water	... ...	5 ozs.

Cliché. A term applied to the negatives, positives, and moulds used in reproduction.

Cloud Negatives. There are few landscapes or seascapes taken by amateurs which would not be improved by the addition of clouds—in fact, in many instances an otherwise poor print may be made a picture by the judicious use of the same. It must, however, be borne in mind that clouds which are unsuitable to the landscape, or which are differently lighted, are worse than a blank sky. For taking cloud negatives it will be found that slow or medium plates, rich in silver and preferably coated with a bromo-iodide emulsion, will answer well; but the finest effects will be obtained by the use of isochromatic or orthochromatic plates, with a yellow screen interposed between the lens and plate. The majority of landscape photographs have the horizons from one-third to two-thirds up the plate; therefore it would not be advisable to point the lens to the zenith to obtain cloud negatives, as the lighting, as a rule, is different to that obtained nearer the horizon. It will be found that good cloud scenes may be obtained without much difficulty from any open space near London or any other city or town; and the author has obtained very fine negatives from the upper windows of an ordinary dwelling house, and in practice he makes it a rule, if possible, to include some of the housetops or distant landscape in the field of view, though this is totally disregarded in exposure and development. The lens used may be, of course, that usually employed, and it should be racked out to its equivalent focus, and a comparatively small diaphragm used—though this will depend upon the character of the clouds, as heavy, dark thunder-clouds will require a larger aperture than the fleecy clouds of bright weather. For dark masses, as a rule, *f*/22 will be large enough; whilst for bright sunlit masses on a blue sky as small as *f*/64 will be found ample. In any case, however, a shutter exposure will be required; generally from $\frac{1}{4}$ to $\frac{1}{10}$ sec. will be sufficient. For development of such plates it is advisable to keep down pyro, so as to obtain soft and delicate negatives rather than bold or vigorous contrasts, and the development should not be pushed too far. For sunrise and sunset effects isochromatic plates are a *sine quâ non;* these alone will in any way do but tardy justice to the sometimes beautiful effects to be

obtained at these times; but in every case it must not be forgotten that colour must be disregarded, shape and the relative massing of the clouds alone being of any use to the photographers. To print clouds into a negative it is advisable first to take a print on ordinary albumenised paper, and then the outline of the sky should be carefully cut with a sharp pair of fine-pointed scissors, and this mask, as it is termed, should be adjusted on the negative, and the sky printed in on the print after the landscape or seascape has been printed. For printing clouds in enlargements and lantern slides the same plan may be adopted, or with the latter the clouds may be printed on another plate, and the same, when developed, fixed, and washed, used as a covering glass. In the finished print clouds should, in almost every case, be subordinate to the landscape, and therefore they should not be so heavily printed—in fact, in some cases the merest suspicion of clouds is quite sufficient to produce an agreeable effect.

Coal-Tar Colours. See ANILINE COLOURS.

Collodio-Chloride Printing-out Paper. This was first proposed by Wharton Simpson in 1865, and for some considerable time it was a very favourite printing process. It gradually fell into disuse, but has lately been revived. Numerous formulæ have been suggested, but the three following will be found to yield good results:—

Monckhoven's Formula.

A. Plain Collodion.

Pyroxyline	5 parts.
Ether	100 ,,
Alcohol	100 ,,

B.

Magnesium chloride (cryst.)	1 part.
Alcohol	10 parts.

Filter.

C.

Silver nitrate	2 parts.
Boiling dist. water	3 ,,
Alcohol	7 ,,

Dissolve the silver, previously powdered, in the water, then add the alcohol.

D.

Citric acid	2 parts.
Boiling dist. water	2 „
Alcohol	16 „

To make the emulsion, take of

Solution A. ... ... 60 parts,

and add gradually, with constant shaking

Solution B. ... ... 5 parts.

Then in the same manner

Solution C. ... ... 6 parts,

and finally

Solution D. ... ... 4 parts.

The emulsion should be allowed to stand at least eight days, and it works, if anything, better in six months.

Liesegang's Formula.

A.

Silver nitrate	2 parts.
Alcohol	100 „

B.

Strontium chloride	2 parts.
Alcohol	100 „

C.

Citric acid	2 parts.
Alcohol	100 „

D.

Pyroxylin	4 parts.
Ether	100 „
Alcohol	100 „

To make the emulsion take of

Solution D.	100 parts,
„ C.	10
„ B.	10

Collodio-Chloride Printing out Paper

Mix well and add gradually, with constant shaking,

Solution A ... ... 5 parts.

The emulsion should be allowed to stand three days. The following is the one which has given us the best results.

Geldmacher's Formula (modified).

A.

Schering's Celloidin	20 parts.
Ether	400 ,,
Alcohol	400 ,,
Castor oil	4 ,,

B.

Silver nitrate	20 parts.
Distilled water	20 ,,
Alcohol	50 ,,

C.

Citric acid	5 parts.
Alcohol	70 ,,

D.

Lithium Chloride	25 parts.
Strontium Chloride	2.5 ,,
Alcohol	70 ,,

Mix solutions C and D and add gradually to the collodion, and then add B very gradually with constant shaking, and finally 5 parts of pure glycerine. The emulsion should now be allowed to stand for six hours. Baryta or enamel paper is always used as the support, and the edges of a sheet are turned up, the paper laid on a sheet of plate glass, and coated with the collodion just the same as though it were the glass itself. It is then allowed to set and dry. It is printed in just the same way as any ordinary gelatino-chloride paper, and may be treated and toned in the same way; but it will be found that the paper is very apt to curl up in the solutions. This may be avoided by laying the print on the bottom of an empty dry dish, and pouring very hot water on to the collodion film, allowing it to soak for a minute and then washing thoroughly, either in plain water or salt water, as suggested for gelatino-chloride paper. The best results are obtained with

the simple sulphocyanide bath. One important precaution to be observed in the use of this paper arises from the fact that, if bent sharply across, it will crack.

Collodion. The vehicle used in wet-plate processes for holding the haloid salts necessary for the formation of the sensitive film. It is prepared by dissolving Pyroxyline (*q.v.*) in a mixture of equal parts of alcohol and ether, and it is a transparent glutinous liquid, which, when poured upon any surface, leaves, by the evaporation of the solvents, an attenuated film of pyroxyline highly transparent and structureless, also well adapted for the purpose for which it is required. The usual strength is as follows :—

Pyroxyline	5 grs.
Alcohol, ·820 sp. gr.	½ oz.
Ether, ·725 sp. gr.	½ ,,

Methylated alcohol and methylated ether may be, and are, largely used on account of their cheapness. A special kind of collodion, called enamel or leather collodion, is used for Enamelling Prints (*q.v.*). (See also following article, COLLODION PROCESSES.)

Collodion Processes. A short account of the Wet Collodion Process will be found under the heading WET COLLODION PROCESS, but as this method is now scarcely used excepting in connection with negatives for photomechanical processes, the details given are hardly sufficient to serve as a complete guide to a beginner; and a clue to the various sources of failure—a modern handbook of the Wet Collodion Process—is Mr. Charles W. Gamble's "Wet Collodion Photography," published at the office of the *Amateur Photographer*. The older Dry Collodion methods may be dismissed in a few words. The plate as taken from the bath was washed to remove free nitrate of silver, and an organic liquid, as coffee, tannin solution, albumen, weak gelatine or gum was poured on, so as to prevent the collodion film becoming horny and impermeable on drying. Such plates may be preserved indefinitely under favourable conditions. Previously to development the plate was soaked in water to soften the film, and then development was performed with a wet collodion developer (see WET COLLODION PROCESS), to

which nitrate of silver had been added to replace that washed out of the film. The development of dry collodion plates with an alkaline developer and no free nitrate of silver, also the making of collodion emulsions by adding a silver solution to the collodion, were important steps in a long chain of experimental work which led to the evolution of the modern gelatine emulsion process. (See EMULSION.)

Collotype. Synonyms: Albertype, Artotype, Phototype, Lichtdruck. Collotype is a photomechanical process by which prints in greasy ink are obtained by means of a film of gelatine used as a printing surface. Briefly the process is summed up as follows: a film of gelatine containing a bichromate salt is exposed to light under a negative, washed, and inked with greasy ink, which adheres only to those places which have been affected by light. By using a suitable press many proofs can be obtained. Negatives for preparing the collotype plates, as they are called, must be reversed (see REVERSED NEGATIVES), and should be of a rather soft, delicate character, free from yellow stain. They should also be provided with a safe edge which is usually made of tin foil. It is customary to prepare several negatives of one subject when a large number of pulls or prints is required; as many as two, four, six, or eight, bring prepared at once, on sheets of plate glass, which should be about $\frac{3}{8}$ths inch thick; the edges and corners should be ground off. This glass is grained, and it is usual to grain two at once by placing some emery flour moistened with water on one, which should be laid absolutely flat on a table, and placing another plate on top, and working this about till both surfaces are evenly grained; care being exercised to keep the emery moist. As soon as the surfaces are ground, the emery is washed off and finer emery flour used in the same way till the surfaces look perfectly homogeneous and free from deep pits or scratches. The plates are then thoroughly washed, rinsed in distilled water, and set up to drain. To ensure adherence of the gelatine to the glass during the hard usage to which it is subjected in printing a substratum is required. This is usually a mixture of beer and silicate of soda or potash. The beer to be used is that known as "four ale," and it should be allowed to stand twenty-four hours to get perfectly flat. The mixture is

Four ale	200 parts.
Silicate of soda (syrupy)	10 ,,

This mixture is well stirred, allowed to stand for some time, and then filtered through nainsook, well washed previously, and it is ready for use. The plates are heated gently in a collotype drying oven, and then rinsed with a little weak ammonia water, and allowed to dry; or else, after being dusted, they are flowed over with the silicate mixture, the excess being allowed to run off into the sink, drained for a minute, and a second coating given them, when they are placed in the oven in which they very soon dry. Another substratum, lately recommended by Holzhausen and Wetherman, is

No. 1.

Dextrine	40 parts.
Sugar	5 ,,
Alcohol	5 ,,
Water	40 ,,

No. 2.

Silicate of potash (liquid)	1200 parts.
Tannin	2·5 ,,

Dissolve the dextrine and sugar in the water, and add the alcohol. Dissolve the tannin in a small quantity of water, mix with the silicate, allow to stand for twenty-four hours. Both solutions will keep some time separate. For use take

No. 1	1 part.
No. 2	2 parts.
Water	7 ,,

Filter through cloth. This must be used at once as it will not keep. The plate should be placed on a levelling stand, and after brushing, plenty of the solution should be poured on and spread evenly over, if necessary using a small piece of paper, then drain off and place in a rack to dry; when dry the plates should be well rinsed to get rid of the free silicate, and again dried, and the plates are then ready for coating. The plates may also be dried in the oven, being placed on edge, and leaving the door open, and regulating the heat to about 100° F. The sensitive coating is bichromated gelatine prepared as follows:—Special hard gelatine, 80 parts, are allowed to soak in water for a quarter of an hour, the water poured off and as much

as possible squeezed out; the gelatine is then placed in a graduated measure, and water added to 1000 parts. The gelatine is melted by the aid of a waterbath, and then 16 parts of bichromate of potash finely powdered are added and dissolved by careful stirring. The mixture is then filtered through fine muslin. The glass is now carefully levelled in the oven and heated, and the plate carefully and evenly coated, from 100 to 200 minims being allowed for about 4 ins. square of glass. The plate or plates having been coated, the oven is closed and the temperature allowed to attain about 115° F., and this temperature must be kept even during the whole time the plates are drying; and the oven should not be opened till the plates are quite dry, which at the above temperature will be in two or three hours. At the end of this time the gas under the oven should be turned out and the plates allowed to cool. The plates when cool are ready for exposure, and this is effected in a heavy printing frame with plate-glass front, and with screw-bars to obtain pressure. The duration of exposure is sometimes judged by examining the plates from the back, but the safest way is to use an actinometer, using, as the sensitive actinometer paper, a piece of paper coated with the same mixture as used for the plates. A little experience soon determines the number of tints required for the particular class of negative. After exposure the plate is removed, placed face downwards on a sheet of black cloth or paper, and the back exposed to the light; the reason for this being to cause perfect adherence to the glass, and to lessen the relief, which takes but a short time and may be determined by the photometer or by the plate assuming a faint brown colour. The plate is washed for some hours in running water, or till, on placing on a sheet of white paper, it has quite lost its yellow colour, and is then dried and ready for printing, or may be kept in this condition for a long time. For printing, the plate is set horizontally, and covered with a solution, which is called the etching solution.

Water	...	...	...	...	...	300 parts.
Glycerine	...	...	...	...	...	600 ,,
Ammonia	...	...	...	...	...	30 ,,
Salt ...	...	...	...	...	...	30 ,,

This is allowed to act till, on passing the finger gently over the plate, the film seems thoroughly penetrated. The solution is

then poured off, and the excess removed with a soft sponge, and the plate is then rather sharply dabbed with a cloth or fine blotting paper. The plate is now ready for fixing on the machine, which may be either the hand or steam press. A mask of stout waxed paper is cut and mounted, so as to cover the margins, and the plate is then inked and printed from. The inking is usually effected with two rollers—the one of leather which is used with a thick ink and heavy pressure to ink the shadows, and the other a gelatine roller with a thinner ink and lighter pressure for the half-tones. The paper on which the proofs are pulled may be of various kinds. It may be glazed or unglazed, rough or smooth surface, India, China, or Whatman's, according to the result desired, and the proofs may be allowed to dry without further treatment, or they may be glazed, which is usually effected by floating the prints on an aqueous solution of white lac, or by coating them with an ordinary label varnish, and drying by the heat of a gas stove, when they present the appearance of ordinary albumen prints. The lac varnish is made by boiling 60 parts of white lac with 1000 parts of water, and 60 parts of borax. The prints are floated for some seconds on this in exactly the same way as for sensitising albumen paper, and then allowed to dry. The label varnish is a commercial article, or may be prepared with

Mastic	30 parts.
Oil of Lavender	5 ,,
Alcohol	150 ,,
Benzine	40 ,,

this is allowed to stand for eight days with occasional agitation, and then decanted. This should only be applied to collotypes on chromo or baryta paper, and should be applied with a broad brush, and the prints dried in an oven or drying box. Grained copper, zinc and lead plates have also been used instead of glass for the support, but have not found much application commercially. Flexible supports have also been used, such as the so-called vegetable parchment.

Colour, Effect of, in Photography. See ISOCHROMATIC PHOTOGRAPHY.

Colour of the Film. This exercises a great effect upon the subsequent operation of printing. The yellow-stained film is the

most non-actinic and slowest, the olive-greenish black being the quickest and giving the most brilliant prints.

Colour Sensitising. See ISOCHROMATIC PHOTOGRAPHY.

Colouring Photographs. An operation that requires considerable artistic skill and ability. Water colours have a decided objection to adhere to the glossy surface of an albumenised print, but they may be made to do so by applying a weak solution of inspissated and purified ox-gall. Some useful details will be found in the article BROMIDE PAPER.

Colours, Photography in. See PHOTOGRAPHY IN NATURAL COLOURS.

Combination Printing. See PRINTING.

Compensator, Miethe's. In using a wide-angle lens the falling off of the light from the centre towards the edges is often a serious inconvenience; but a many-armed star cut out of black paper and supported a little distance from the lens, either behind or front, will often prove a remedy. Of course, a position must be found where no trace of a shadow of the star is traceable on the focussing screen, a matter easily ascertained by directing the camera to skywards. Between the two elements of the lens would be theoretically a better position. A neater device of a similar sort was suggested some years ago by Dr. Miethe. A plano-convex lens of tinted or "smoked" glass is cemented in a plano-concave lens, the combination being thus equivalent to a plain glass, the centre of which is more opaque than the edges.

Composite Portraiture. Mr. Francis Galton, by throwing faint images of a succession of accurately-adjusted prints (or negatives) on the same part of a single sensitised plate, has obtained resultant images which give a pictorial average of all the constituents. Racial characteristics are brought out in a remarkable way in the composite photograph. Particulars and examples of composite portraiture are to be found in Mr. Galton's "Inquiries into Human Faculty" (Macmillan), and in M. Arthur Batut's "La Photographie Appliqueé a la Production du Type" (Paris: Gauthier-Villars).

Composition. A term denoting the grouping of the materials of a picture so as to form a pleasing and harmonious whole. It can be well said of the majority of photographs taken by amateurs that there is but little composition in them; most being but a faithful portrayal of subjects as they are found naturally. But, whilst the photographer does not possess that wide power of composition which is characteristic of the artist's work, he can at least modify to some extent the scenes, etc., ready found to his hand. The amateur who desires rather to produce pictures than faithful photographs is recommended to obtain Robinson's "Pictorial Effect in Photography," and "Picture Making by Photography," in which the subject is most ably treated at great length. These two books should form part of the library of every one practising photography.

Concave. A term applied to lenses when the surfaces are hollowed out like the inside curve of a bowl.

Concave, Concavo-Concave, Concavo-Convex Lens. See LENS.

Concentrated Solution. A term often, but somewhat loosely, applied to a strong or saturated solution. (See SOLUTIONS and SOLUBILITIES).

Condensers. These are combinations of lenses of various forms, which have for their purpose the condensing or collecting

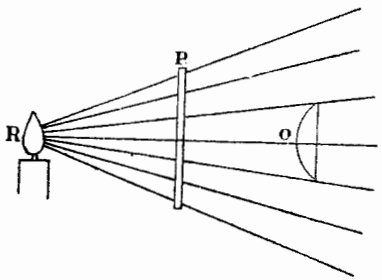


Fig. 20.

of rays of light which would otherwise be scattered or lost. They form a necessary part of every lantern, and take various forms. The action of a condenser is well shown in the following

diagrams. Let R be the light emitting rays which pass through the negative on slide P, and let O be the objective or projecting lens. It will be seen from this that practically very little light passing through the slide reaches the objective; but by placing

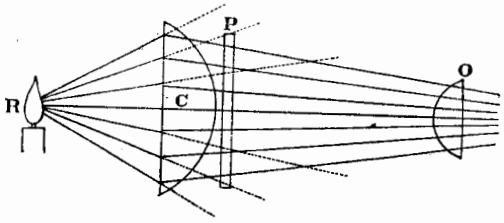


Fig. 21.

a condenser between the radiant and slide it will be seen that it refracts light which would otherwise be lost, as shown by the dotted lines, and condenses it, so that it is utilised by the projecting lens. Simple lenses could be used for condensers, but on

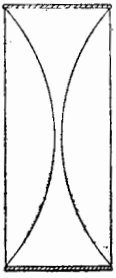


Fig. 22.

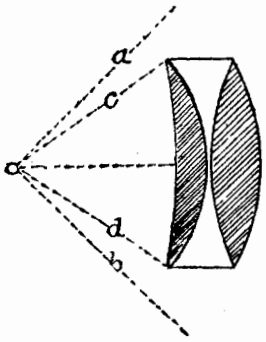


Fig. 23.

account of their great thickness they would be liable to crack, and there are other objections. It has been the custom, therefore, to split the single lenses, and mount the two lenses with their convex surfaces nearly touching as in fig. 22. A further improvement, suggested by Mr. Traill Taylor, was the form shown in fig. 23, which consists of a meniscus lens and a

double convex, preferably a crossed lens. It is essential with a lantern—very essential—that as much light as possible should be utilised, and assuming the dotted lines A and B to represent an angle of illumination of 90°, it is seen that unless the condenser is placed very close to the light, and is of short focus, it cannot grasp more than C D; therefore, by placing

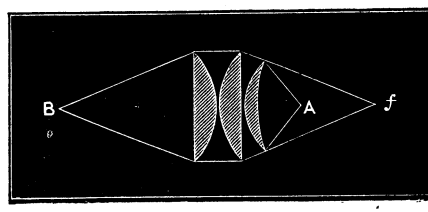


Fig. 24.

a small lens nearer the radiant, as in fig. 24, it is evident that more light will be collected, provided the third lens is thin and of long focus, when the light is brought to within two inches of the small lens, and, passing through it, diverges, and then is rendered parallel by the second lens and condensed by the third lens. Further than that, by using three lenses the spherical

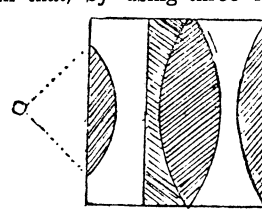


Fig. 25.

aberration is reduced to one-ninth of that of a single lens. Mr. Traill Taylor suggested many years ago the condenser shown in fig. 25, which consists of three plano-convex lenses, the centre being achromatised. This, however, is expensive. Grubb suggested the form shown in fig. 26, in which A is a piece of plain glass to absorb the heat, B a plano-convex lens which acts as a condenser, C a plano-convex, and D an over-corrected combination. From C to D the rays are practically parallel, and thence

diverge, and are condensed by the large lens beyond D. The best form when only two lenses are used, is that shown in fig. 27, according to Mr. Traill Taylor, whose notes on this subject we have condensed, and consists of a plano-convex lens with its flat side

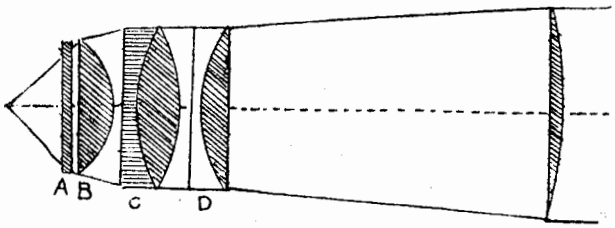


Fig. 26.

to the radiant, the second lens being a crossed lens. Most condensers are made of crown glass, and have a slightly greenish tinge. Colourless optical flint would be better, but the price would be higher. All condensers should be so loosely mounted

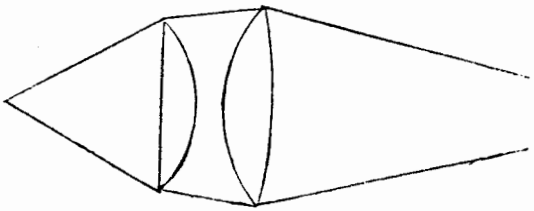


Fig. 27.

in thin cells that they can be turned round, otherwise the expansion by the heat may cause them to crack. Clock glasses filled with liquid have been suggested as condensers for enlarging, but are so long in focus as to be practically useless.

Conjugate Foci. See FOCUS.

Constants, Table of. See CALCULATIONS.

Contact, Optical. Any two substances brought into close union one with the other, so as to absolutely join, and made to present but two instead of four surfaces, are said to be in optical contact. A familiar example is the common mirror, where the amalgam and glass are in optical contact.

Contrast. The adjustment of the light and shade and objects in a photograph so that they may give due emphasis the one to the other.

Convex. The opposite to concave—*i.e.*, shaped on the exterior into a spherical or round form.

Cooling and Freezing. In warm weather it is often desirable to cool liquids, such as developers and washing waters, and to the carbon printer some means of cooling is occasionally almost essential. Bottles containing the liquids to be cooled—the half gallon bottles known as Winchester quarts are convenient—are wrapped round with two thicknesses of wet calico, this being tied on, and placed where there is a strong draught of air. The dampness of the covering must be maintained, which can conveniently be done by standing the bottles in a shallow tray containing a little water. When ice can be obtained, it is generally more convenient to cool water by leaving a few lumps of ice in it, and a similar course may be followed with other liquids, when the addition of a little water is no disadvantage; otherwise the plan of standing the bottle in a mixture of ice and water may be adopted. In special cases one of the following freezing mixtures may be used:—

No. 1.

Crushed ice or snow	2 parts.
Common salt	1 part.

Will reduce the temperature from about + 10° to − 17 or 18° C.

No. 2.

Crystallised sulphate of sodium	8 parts.
Commercial hydrochloric acid	5 „

Will give about the same reduction as the above.

No. 3.

Crystallised phosphate of soda	9 parts.
Dilute (1 to 3) nitric acid	4 „

Will reduce the temperature from about 0° to − 28 or 29° C.

Copal. A resinous substance obtained from Madagascar, China, Africa, and America, and the product of several widely differing trees, It is also found as a fossil. It occurs in pale

yellowish tears and masses, which are insoluble in water, slightly soluble in alcohol, more so in alcohol and camphor, freely soluble in chloroform, ether, and turpentine. It is used for making varnishes.

Copper, Bromide of (Ger., *Kupferbromid;* Fr., *Bromure de cuivre;* Ital., *Bromuro di rame).* $CuBr_2 = 223{\cdot}3$. Synonym: Cupric Bromide. It occurs as a blackish powder, or in light-blue needle-like crystals, and is formed by dissolving cupric oxide in hydrobromic acid, evaporating and crystallising, and by mixing solutions of cupric sulphate and bromide of potash, evaporating, and separating the sulphate of potash. It is a deliquescent salt, and slightly soluble in alcohol. It is used as a first step in the copper method of intensification, in which case the insoluble cuprous bromide Cu_2Br_2 is formed in the film.

Copper, Chloride of (Ger., *Kupferchlorid;* Fr., *Chlorure de cuivre;* Ital., *Cloruro di rame).* $CuCl_2 = 134{\cdot}3$. Synonym: Cupric Chloride. Formed in a similar manner to the bromide, with hydrochloric acid, or by mixing a solution of cupric sulphate and calcium chloride, filtering from the precipitate of calcium sulphate, evaporating, and drying. It forms brilliant emerald-green needles, which are very deliquescent and easily soluble in alcohol. It is used as a reducer, and in Obernetter's copper process. There is also a lower chloride, cuprous chloride CuCl or Cu_2Cl_2, which is sometimes used as a convenient absorbent of chlorine in the preparation of chloroplatinite of potash.

Copper, Sulphate of (Ger., *Kupfersulfat,* or *Kupfervitriol;* Fr., *Sulfate de cuivre,* or *Vitriol bleu;* Ital., *Sulfato di rame*). $CuSO_4,5H_2O = 249{\cdot}3$. Synonyms: Cupric Sulphate, Blue Copperas, Blue Vitriol. This is made by roasting copper pyrites with free access of air, lixiviation of the mass with water, evaporating, and crystallising. It occurs in beautiful blue crystals, some of very large size. Cupric sulphate has been used as an addition to the ferrous oxalate developer, its action being stated to be merely a retarding of oxidation of the ferrous sulphate.

Copying. This is an operation which is frequently necessary, and may be divided into three heads for convenience: (*a*) *copying black-and-white objects;* (*b*) *copying photographs;* (*c*) *copying coloured objects, like oil-paintings, missals, etc.*

(*a*) *Copying Black-and-White Work, such as Engravings, Line-Drawings, etc.* For the professional worker wet collodion undoubtedly still holds its own in this branch; but for the amateur, or when only one or two subjects have to be copied, dry plates may be used with satisfactory results. In copying a black-and-white object we want no gradation, no half-tones, no shadows; merely black and white. Should the paper show a grain it is necessary to light the subject in such a manner that no sign of this grain is visible, which can usually be effected by a full front lighting, and by even, all-round illumination as is obtained out of

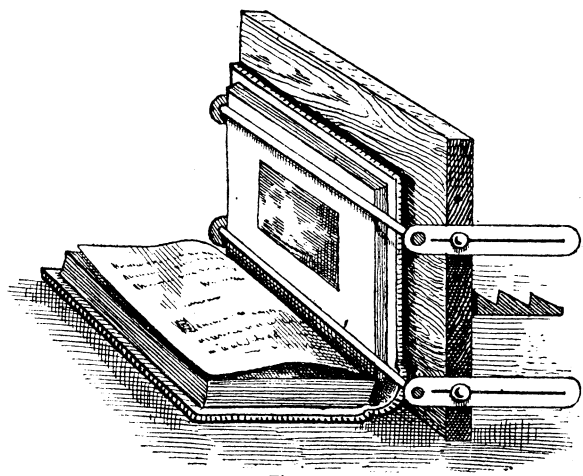


Fig. 28.

doors. Frequently it is necessary to use some support to retain the page of a book or print flat; this support may be either a piece of stout wood placed behind the leaf or print, which can then be held in position by a couple of stout india-rubber rings, if the print to be copied cannot be pinned flat by the aid of drawing-pins. A capital copying-stand, suggested by the "Kernel," the author of "Photography in a Nutshell," is shown in fig. 28. This is so obvious that we need hardly explain its action. The most suitable plates are those commercial brands, which are specially made for this work, and which are called

"photo-mechanical"; but, failing these, any ordinary slow lantern plate designed for giving black tones can be used. The lens should be a rapid rectilinear or doublet of not too long a focus, because it must be remembered that when copying at close quarters the focus is lengthened, and therefore a lens of such a focus must be chosen that the increased focus is not too long for the bellows of the camera. This increase in focus must be taken into account when estimating the factor of stop aperture for calculating exposure. The exposure of course will vary enormously with the subject; but, as some guide, I may say that copying a black-and-white line-drawing, such as one of the diagrams in this book, the same size, using *f*/22 diaphragm and a photo-mechanical plate at noon in an ordinary room, facing a north-light window on a bright, but not sunny day, the exposure given was 40 secs., and found to be correct. For development ferrous oxalate, eikonogen, amidol, and metol are perhaps less suitable than either hydroquinone or pyro; glycin also being of value, though for this work I have not obtained such successful results as with pyro. The main point in developing is to obtain clear glass in the lines representing the blacks of the print; density of the part representing the paper is of secondary consideration because it may be obtained afterwards by intensification, though with correct exposure good density combined with clear glass can be easily obtained. Continue development as far and as long as possible, but on the slightest sign of any deposit on the lines instantly drop the plate in an acid fixing-bath. After fixation wash thoroughly, and then examine the negative; should there be any deposit in the lines reduce by the aid of the ferri-cyanide and hyposulphite reducer, thoroughly wash, soak for 10 mins. in a hypo eliminator, again wash, and intensify with the potassio-silver cyanide intensifier.

(*b*) *Copying Photographs.* In copying photographs, photo-gravures, collotypes, or any prints in which there is half-tone, it is advisable to use a medium rapidity or ordinary plate, and with prints with a considerable amount of heavy shadow it is advisable even to use a more rapid plate. The developer should be the one usually recommended for the plates, or that which the operator is in the habit of using, and soft, full-of-detail negatives should be aimed at.

(*c*) *Copying Coloured Objects, Oil-Paintings, etc.* With all

coloured objects there is only one particular kind to use, and that is the colour-sensitive plate. When the object contains much red, then one sensitised for this colour must be used; if there is much blue or violet, then must also a yellow screen or filter be employed. In fact, it may be taken for granted that with all oil-paintings a yellow screen is advisable, as it prevents the reflections from the cracks and inequalities of the surface. The best light in which to copy oil-paintings is sunlight. In copying oil-paintings the question of lighting is an important one, as the thicknesses of the coats of paint will show with strong light from one particular direction; at the same time, it must be borne in mind that artists frequently desire to see these inequalities or brush marks, whilst for ordinary purposes the brush marks are objectionable. For the correct reproduction of colours it is necessary to use light filters, which will cut off the action of the blue and violet rays, whilst the red and yellow act. (The composition of these screens for this purpose is given under ISOCHROMATIC PHOTOGRAPHY.)

As regards the difficulty of mounting the object to be copied on a vertical position, this being more especially a trouble when a subject has to be copied from a book, it is often convenient to lay the original on the floor or a horizontal surface and to arrange for the camera to look downwards: a very easy matter to arrange if the necessary distance between object and camera is approximately determined beforehand. The camera can then be clamped to the edge of a table or some other piece of furniture; better still, in the upper angle of a step-ladder, in which case the adjustment as to distance can be made by supporting the book at the required height. Special stands for the camera, when looking downwards, have been designed, and these generally include an adjustable table or stage. (For a new and remarkable method of copying see PLAYERTYPE.)

Copyright. See REGISTRATION.

Cotton and Gun Cotton. See CELLULOSE, PYROXYLINE, and CELLULOID.

Crawling. A term applied to such shifting of the paper in the printing frame as makes a portion of the print unsharp. If the paper is not quite dry, the moisture will sometimes diffuse

into the backing pad, and the paper will contract; this contraction being sometimes as much as ⅛ of an inch to a sheet, even though the paper seemed quite dry to the touch.

Crescofylma. A name applied to a commercial preparation which probably contains either free hydrofluoric acid or an acidified fluoride, and used as a means of floating the negative film off the glass, in order that after becoming stretched it may be mounted on another plate, or otherwise used in its expanded form. (See NEGATIVES, STRIPPING OF.)

Critical Angle. When light passes from a dense medium to a rare medium under an increasing angle with the perpendicular, an angle will be reached at which the refracted ray should make an angle of 90° with the normal. This is called the critical angle, and then internal or total reflection sets in.

Crossed Lens. The form of single lens which has the least spherical aberration; double convex, and best with radius of posterior surface about six times that of anterior surface.

Crystal Varnish. This is specially designed for varnishing lantern-slides and transparencies, and is made by dissolving—

Gum dammar	25 grs.

in

Benzole	1 oz.

another formula being

Canada balsam	5 parts.
Shellac (yellow)	160 „
Sandarac	170 „
Alcohol	1000 „

Crystalotype. Photography on glass was so called when first introduced, and the term is sometimes applied to a special photographic decoration of glass. (See HYALOGRAPHY.)

Curvature of the Field, or the Aberration of Form. The image of a flat object should, to meet all the requirements of the photographer, be formed on a plane or flat surface; but, taking a single lens (fig. 29), we shall find that the focus for *b* is at *e*, whilst the focus for *a* is at *g*, for *c* at *f*. *h i* represents the plane of the sensitive plate, from which it is obvious that,

theoretically, only the point *e* would be in focus. A concave or negative lens has, as is well known (see also CHROMATIC

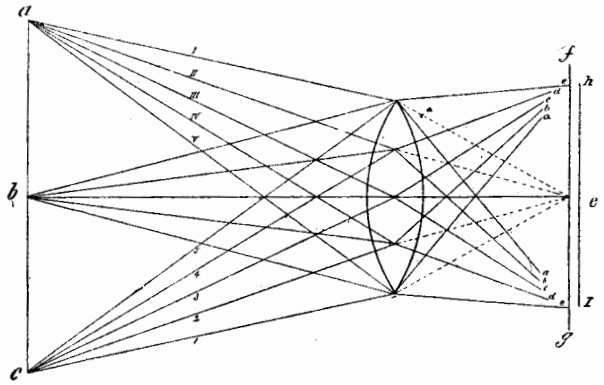


Fig. 29.

ABERRATION), no real focus, and the marginal rays are more refracted than the central, so that by combining a concave

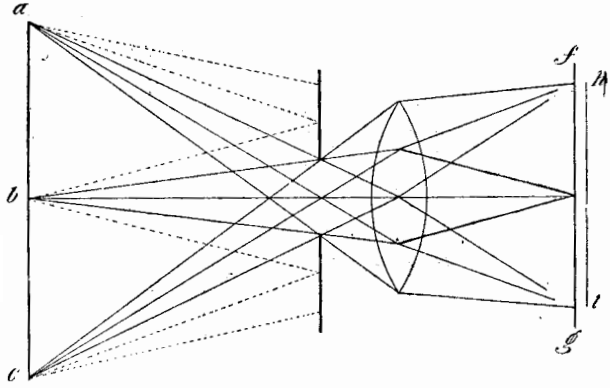


Fig. 30.

with a convex lens we lengthen the focus of the marginal rays, and thus flatten the field. The use of a stop also still further increases the flatness of field, as shown in fig. 30.

a b c is a plane object, next come diaphragm and lens; the rays from *b*—the point situated on the axis—will come to a focus on the line *f g*; but, those rays from *a* and from *c*, which are shown in fig. 29 as coming to a nearer focus, are cut off; while those that come to a focus on the line *f g* are allowed to pass; thus we shall practically have a sufficient approximation to a flat field.

Cutting Prints. This is trimming off the unnecessary part of the print till of the desired size. It should always be done prior to toning, to save the waste of gold in toning unnecessary matter, and it is best done whilst the print is dry. Plate-glass cut, with polished edges, to certain sizes can be obtained commercially, but any old negative glass or flat ruler will do as a guiding edge. Numerous and divers knives are sold for trimming; but the author has found a leather-cutter's knife, termed a clicker's knife, the most convenient, and the price is but a few pence. Too many amateurs consider that the finished print should be exactly the full size, when much more pleasing pictures can often be produced by trimming off certain portions of the print.

Cyanides. A class of salts containing Cyanogen (*q.v.*); the cyanide of potassium being the most important, and highly poisonous. Double cyanides, like the sulphocyanides and ferrocyanides, although apparently not actually poisonous themselves, should be regarded with extreme caution, as simple cyanides may be very readily produced from them under unexpected conditions.

Cyanine (Ger., *Cyanin*, or *Chinolinbleu;* Fr., *Cyanine*, or *Bleu de quinoléine;* Ital., *Cianina*). Synonyms: Cyanine, Cyanin Iodide, Quinolin, or Chinolin Blue. $C_{28}H_{35}N_2I = 525$. This is prepared by the action of iodide of amyl on chinoline; it occurs as a dark blue powder or prismatic crystals, with metallic lustre; it is not very soluble in water, but more so in alcohol. As cyanine is sensitive to light it must be kept in the dark. It is one of the best sensitisers for red, and for this purpose is used in orthochomatic work, the disadvantage being that the plates are very liable to fog, and therefore Dr. Eder suggests the use of chloro-cyanin, which has not this action, and gives the following

directions for making the same:—Powder the ordinary commercial iodo-cyanin; place in a porcelain or platinum dish, and cover with some water and hydrochloric acid; evaporate to dryness with constant stirring; the mass thus obtained is again wetted with hydrochloric acid, and again evaporated, when hydriodic acid is given off and chloro-cyanin is left behind. By weighing the capsule containing the cyanin before and after this treatment one may dissolve the mass at once in alcohol and keep in the dark for use.

Cyanogen, Cyanogen Soap. Cyanogen is a compound radical, CN or $(CN)_2$, entering into the composition of the cyanides. Cyanogen soap, a soap containing potassium cyanide, sold for removing silver stains from the hands.

Cyanotype. Synonyms: Negative Cyanotype, Ferroprussiate, or Blue Process. A process discovered in 1842 by Sir John Herschel. It is called negative cyanotype, because it produces copies of engineers' or architects' plans with white lines on a blue ground, the action being the reduction of a ferric salt by light to the ferrous state, and the precipitation of Prussian blue by the action of ferridcyanide of potassium. It is a very useful printing process for amateurs on tour as very little need be taken, and smooth writing-paper may be used as a basis. Herschel's formula was

A.

Potassium ferridcyanide	8 parts.
Water	50 ,,

B.

Ammonio-citrate of iron	10 parts.
Water	50 ,,

The solutions are mixed in equal parts, filtered, and kept in the dark, and will keep for some little time. The ferridcyanide should be just rinsed with water to clean it from any adherent powder, and the solution should be of a yellowish or orange-red colour, and not greenish blue; if the latter colour, it should be thrown away and fresh mixed up, or heated and a few drops of bromine water added. Latimer Clark suggested the following improved formula:—

Cyanotype

A.

Ammonio-citrate of iron	90 parts.
Water	300 ,,

B.

Potassium ferridcyanide	80 parts.
Liquor Ammonia	7 ,,
Water	300 ,,
Sat. Sol. oxalic acid	60 ,,

This is more sensitive. Ehrmann and Fries suggested the addition of bichromate of potash, the former stating that this addition kept the papers unchanged for from three to five months. Ehrmann's formula is

A.

Ammonio-citrate of iron	60 parts.
Water	256 ,,

B.

Potassium ferridcyanide	40 parts.
Water	256 ,,

Mix in equal parts, and to every 960 parts of the mixture add 1 part of bichromate of potash. Watt suggested the addition of boric acid for the same purpose.

A.

Ammonio-citrate of iron	96 parts.
Boric acid	1 part.
Water	190 parts.

B.

Potassium ferridcyanide	96 parts.
Water	196 ,,

Mix in equal parts. Rockwood suggested the addition of gum Arabic, or dextrin, as a preventive of the solution sinking into the paper.

A.

Potassium ferridcyanide	1 part.
Water	10 parts.

B.

Ammonio-citrate of iron	3 parts.
Water	10 „
Gum Arabic, or dextrin	½ part.

The sensitising solution is spread over well-sized paper with a pad or brush, working in one direction, and then across to even the marks out. The paper is then hung up to dry, and appears of a greenish-yellow colour; and where the light acts on it it turns blue. After exposure it is merely washed in water, when the image becomes bright blue, and the ground, or unexposed portion, should remain quite white. Over-printed proofs may be reduced, after thoroughly washing, by being dipped into a weak solution of ammonia or a 2 per cent. solution of sodium carbonate, well washing, and then dipping into weak hydrochloric or acetic acid and well washing. Under-printed proofs may be intensified by immersion in a solution of ferric chloride, or nitrate or sulphate of iron, 3·5 parts to 1000 parts of water, till the image appears darker in colour, and then well washing. Corrections, or taking out spots, etc., can be effected by touching the dry prints with a 4 per cent. solution of oxalate of potash, with which also titles may be written; and if red aniline ink be added to the above, or 4 parts of oxalate be dissolved in 100 parts of the red ink, the title will appear red on the blue ground. The blue images thus obtained can be converted into ink images, or blackish images, by soaking first in 5 per cent. carbonate of potash solution, washing, and then immersing in a similar strength of tannin solution; a good brownish-black colour is obtained by immersing them direct in a saturated solution of carbonate of soda, mixed with an equal quantity of water, to which has been added as much tannin as it will dissolve. It has also been suggested immersing the prints in weak hydrochloric acid to clear the whites, then in weak ammonia 1 : 15,000, and finally in a bath of

Alum	10 parts.
Tannin	1 part.
Water	130 parts.

exposing the prints to sunshine for ten minutes, and then bathing in dilute ammonia. Cyanotype, or Ferroprussiate prints, may also be converted into silver prints by immersing the prints in

a 2 per cent. solution of silver nitrate, washing well, and developing the pale yellow image with ferrous oxalate developer. Instead of using a mixture of ferridcyanide and ammonio-citrate as the sensitive mixture, the latter solution alone may be used for sensitising the paper, and the ferridcyanide solution used as a developer; or development may be with a chloride of gold solution. (See CHRYSOTYPE.)

Positive Cyanotype, or *Pellet's Process.* This process is the opposite to the last—that is, it gives blue lines on a white ground from a plan, or, in other words, where the light acts no image is formed; only on those parts where the light does not act is a precipitate of Berlin blue formed by the action of the ferrocyanide of potassium with a ferrous salt. This process was also suggested by Herschel, but no satisfactory progress was made till Pellet patented in 1877 his process of adding a viscous substance to the sensitising liquid. Pellet used

Oxalic acid	5 parts.
Ferric chloride	10 ,,
Water	100 ,,
Gum Arabic	9·5 ,,

In 1880 Collache patented a similar process, and used

Gum Arabic	7-10 parts.
Citric acid	2-3 ,,
Ferric chloride solution 45° Baumé ...	4-6 ,,
Water	81-87 ,,

Pizzighelli in 1881 gave good working formulæ for this process:—

I.

Gum Arabic	20 parts.
Water	100 ,,

II.

Ammonio-citrate of iron	50 parts.
Water	100 ,,

III.

Ferric chloride	50 parts.
Water	100 ,,

The two latter solutions will keep several weeks. The solutions are mixed in the following proportions and *order*:—

Solution	No. I.	20 parts.
„	No. II.	8 „
„	No. III.	5 „

As soon as mixed this solution is thin, then becomes thick and cloudy, and then clear and liquid again, when it is ready for use. Well-sized paper is evenly coated with this solution with a broad brush, and the coating evened out with another brush. It must be quickly dried in a warm room, and protected from damp and light. In printing, the image appears as yellow on a darker ground. The developer is

Potassium ferrocyanide	20 parts.
Water	100 „

which should be spread over the proof with a broad brush, care being taken that no solution touches the back of the paper or stains will be produced. As soon as the image appears of a deep blue colour, the print should be well washed, and then laid in dilute hydrochloric acid 1 : 10 till the ground appears white; and the print should then be well washed and dried. Waterhouse has suggested another process.

I.

Gum Arabic	170 parts.
Water	650 „

II.

Tartaric Acid	40 parts.
Water	150 „

III.

Sol. ferric chloride 45° Baumé	150-120 parts.

Mix solutions 1 and 2, and add gradually, with constant stirring, No. 3; allow the mixture to stand for twenty-four hours, and then dilute with water till the specific gravity is 1·100. The solution, and the paper sensitised with it, will keep for some considerable time. The exposure in direct sunlight is from 15 to 40 seconds, in diffused light from 10 to 30 minutes. As the image formed by light is only very faintly visible, it is advisable to use a strip of paper, either exposed under one corner of the plan or drawing, or under a similar and smaller one at the

same time; and when test slips from this develop a blue image on a yellow ground the exposure is sufficient. The developer is a 20 per cent. solution of ferrocyanide of potassium. The edges of the print are turned back so as to form a sort of dish, or protecting shield, so that no developer gets on the back of the paper. The print is then carefully floated on to the developer and left for about thirty minutes, and then examined at one corner till blue spots begin to appear, when the print should be immediately removed, floated carefully again on a dish of clean water and left for some minutes, and then immersed in dilute hydrochloric acid 1 : 100, and any blue spots removed by carefully brushing; and, finally, the print should be laid at the bottom of an empty dish and a vigorous stream of water from a rose or tap allowed to play on it. Corrections are made by the same solution previously mentioned, the spots being touched with a fine pencil and blotted off with clean blotting-paper.

Cyclograph. 1. A form of the Panoramic Camera (*q.v.*) due to M. Damoizeau. 2. A device of Mr. A. H. Smith.

Cylindrograph. A panoramic camera designed by Captain Moëssard, and which includes an angle of 170°. The sensitive

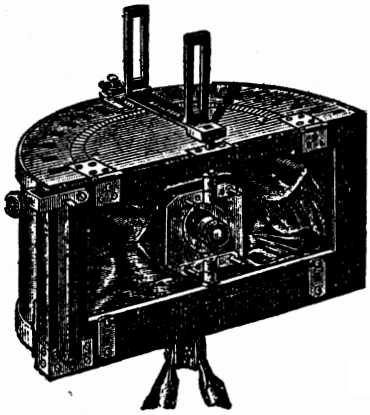


Fig. 31.

surface—generally gelatino-bromide on a celluloid base—is bent into a half circle, and during exposure the lens is made to rotate

on a vertical axis, which axis passes through what is virtually the optical centre of the lens. The sketch given (Fig. 31), together with a reference to the article PANORAMIC CAMERA, will make the nature of the cylindograph sufficiently clear. In order that views taken with the cylindograph may be seen as in correct perspective, the CYLINDROSCOPE (which see) is used. The cylindrograph has been used with much success as an aid in surveying by photography (see PHOTOGRAMMETRY), especially in connection with railway work in the United States, as if care is taken in producing the original the resulting print can be stamped or ruled with a scale of vertical lines, marking the angles subtended at the original point of sight—or it can be placed under a glass scale on which such lines are ruled. In the case of the panoramic picture an equal scale of parts will plot off the subject into equal horizontal angles, and if the actual radius of the camera is known, together with the aspect of one object, all the horizontal aspects are readily obtainable; whereas with an ordinary photograph such determinations are much more complex and require a datum mark on the print to show where the axis of the lens cuts the scene.

Cylindroscope. Captain Moëssard's apparatus for exhibiting panoramic views, the print being curved to a radius corresponding to the original radius of the panoramic camera which was used in obtaining the negative. The point of view is in the centre, where, if necessary, a suitable eye-lens is fixed. Another method of viewing cylindrographic or other panoramic pictures devised by Captain Moëssard is to attach the print to the outside of a cylinder and to make this rotate slowly in front of the observer, when the effect will be somewhat similar to that of the observer turning round at the position where the panoramic camera was originally stationed. (See PANORAMIC CAMERA and CYLINDROGRAPH.)

Daguerreotype. An early process for obtaining a camera picture; discovered by Daguerre. A sensitive surface of silver iodide and bromide was formed by exposing a silvered copper plate to the direct action of the metalloids. After exposure, which was inordinately prolonged, the development was effected by exposing the plate to the vapour of metallic mercury, which was deposited on the plate as an amalgam of silver and

mercury. The unacted-upon iodide and bromide were then dissolved by cyanide of potassium or hyposulphite of soda, and the image toned by sel d'or. (See GOLD HYPOSULPHITE.) The first intaglio photogravures were made by Mr. Justice Grove in 1840, by the electrolytic etching of the daguerreotype plate. The plates were too shallow to give good prints.

Daguerreotype, To Clean and Copy. Carefully remove the daguerreotype from its frame and separate from its covering glass, and place face upwards in a dish of cold water. Be extremely careful not to touch the front of the plate, as the slightest touch will leave a permanent mark. Lift the plate by the corners, and remove the paper from the back when sufficiently soaked; rinse the plate thoroughly, and, should the water be repelled as though the plate were greasy, flow over a little methylated spirit. If the tarnish on the edges be blue in colour, immersion in an ordinary fixing bath will remove the same; but if any bronzing is visible, make a solution of cyanide of potassium, ten grains to the ounce, and keep pouring this on and off till all tarnish is removed. Wash the plate thoroughly to free from cyanide, and rinse well with distilled water; then take hold of one corner of the plate with a pair of pliers, and dry evenly from a top corner downwards over a spirit lamp or Bunsen burner. If any stain or deposit is left by unequal drying, the plate must again be rinsed with distilled water, and dried in the same way. The chief point is not to touch the plate with anything but the liquids, or a mark will be made which nothing will eradicate. To copy a daguerreotype the best plan will be to place it inside a deep box, lined with velvet or black cloth, with a hole in the lid for the lens to peep through, and a piece cut out of one side only to illuminate the plate by—sunshine is best, though the light from an enlarging lantern is equally as effective. In most daguerreotypes the marks of the buffer are seen as fine horizontal lines. In copying, these should be placed vertically, and when in that position are barely visible.

Dallastint. A secret process of photo-blockmaking for the rendering of half-tone.

Dammar. A tasteless, odourless, whitish resin obtained from the Amboyna pine, whose habitat is the Malay Archipelago. It is

used in varnish-making, for which purpose it is usually dissolved in turpentine, or benzole.

Dark-Room. The room in which all operations requiring actual handling of the sensitive plate must be conducted. It is usually lighted by daylight filtered through some non-actinic glass or medium. It was the custom but a year or two back to utilise none but the deep ruby glass for this purpose, but now some equally non-actinic colours giving much more general illumination are used. A good, safe light can be obtained by using what is termed cathedral green glass, with one thickness of canary medium. The author invariably uses artificial light from a paraffin lamp, as by this light, which is constant, a much better idea of the progress of development can be obtained than by such a variable quantity as daylight. Whatever light is used it should always be tested by placing a sensitive plate upon the developing table with some opaque substance, such as a piece of black cardboard, upon it, and left for three or four minutes and then the plate carefully developed should show no image of the card. The general arrangements of the dark-room must be left entirely to the amateur, but the following may be considered to be some of the principal features:—A shelf or table on which to develop. This should be of a convenient height, to allow the operator to sit at his ease whilst developing. It should be covered with some non-absorbent material, such as sheet lead or zinc, and the edge of this should be turned up about a quarter of an inch to prevent any solution which might be spilt from running over. There should also be a sink, with a tap and a good supply of water. Shelves should be placed at convenient heights for the storing of bottles, printing frames, boxes, etc. The room and developing table should be kept scrupulously clean, and after operations, all solutions spilt and the trays, measures, etc., should be cleaned and put away.

Dark-Tent. A portable dark-room, little used now, but of absolute necessity for outdoor work in the old days of the wet process.

Decomposition of Light. White light on passing through a prism is decomposed or separated into its constituent rays. All lenses being formed on the principle of a prism, it is evident that light passing through a lens would be decomposed and give

rise to chromatic aberration, but this is obviated by combining a lens of different shape and glass, so as to recombine the scattered rays. (See CHROMATIC ABERRATION, and LENS.)

Definition is the accurate concentration by the lens of the light from a point in an object to the corresponding point in its image without spreading to adjacent parts. Perfection of definition depends chiefly on the characteristic curves of the lens, on the composition of the glass employed, the relative positions and forms of the surfaces and their proper grinding, the centring of the elements of a combination, and, in a doublet, the centring and due separation of the combinations. (See LENS.)

Deliquescence. The liquefaction of a highly soluble salt by the absorption of water from the atmosphere.

Density—literally opacity ; and in this sense correct density is an attribute of a good negative. It should be just sufficient to give due relation to the shadows, and yet allow the detail in the high-lights to print. Almost all plates differ in the value of the deposit of metallic silver, of which density or opacity is formed ; and the correctness of the judgment necessary in this particular is one of the best tests of a good worker—it can only be obtained by experiment with every brand of plate used. With some the development must be pushed till the high-lights just show on the back of the film, and the whole surface of the plate is becoming blackened ; whilst with others, especially those containing iodide or those having a film rich in silver, the test of the blackening of the surface of the plate will usually be sufficient. The colour of the deposit of silver affects the result in a great measure. If, when the negative has been fixed, the amateur finds that his judgment has not been correct, he has, fortunately, methods of increasing or decreasing the density, as described in the operations of Intensification and Reduction (*q.v.*).

Depth of Focus. See FOCUS.

Detail. The definition of each minute part or parts of the material of a picture, whether in the negative or print therefrom.

Detective or Hand Cameras. These are cameras of particular designs, so constructed as to be portable and unlikely to attract attention. Their name is legion ; their makes diversity

itself; and to attempt to include even a brief description of them would be beyond the limits of space at our command. Practically, however, hand cameras may be divided into two main classes: (*a*) those with automatic plate or film-changing apparatus; (*b*) those with dark slides. Each must decide for himself which pattern meets most nearly his requirements; but we can consider the individual parts of the camera.

The Lens. As one of the chief features of detective work is the portrayal of objects situated at varying distances from the camera, it is obvious that lenses with great depth of Focus (*q.v.*) are required; and as this property decreases with increase of focal length and aperture, we are limited in our choice to certain forms and apertures of lenses, although the great advance made lately in practical photographic optics has given us instruments which afford valuable assistance. It will be found that, generally, lenses of short focus—*i.e.*, which have a focus about equal to the longer base of the plate which they are intended to cover, thus for a quarter-plate a 4-in., 4½-in., or 5-in. focus lens —should be used. The doublet form of lens will, generally, be found the best, though single or landscape lenses, working at a large aperture, *f*/8 or *f*/10, will often serve.

The Diaphragms or Stops. The question of aperture is governed by two considerations—the first, that of depth of focus; and the second, the actinic power of the light. As the first increases with diminution of aperture, the smaller the diaphragm the greater the depth of focus; but as this is also governed by the second consideration, it is obvious that, except for brightly lit scenes, such as seascapes and river views, and work on the seashore in brilliant sunshine, it would be injudicious to use too small an aperture, as loss of detail in the heavy shadows would result. For ordinary work *f*/8 or *f*/10 will be found quite small enough, while for sea and river views *f*/16 will be found large enough. The form of diaphragm, whether Iris or Waterhouse, is not a vital question, as, unless the former is controlled from the outside of the case, there is no advantage in its use.

The Shutter. This should be capable of accurate adjustment for various speeds, from very rapid to slow. From $\frac{1}{1000}$ to $\frac{1}{10}$ sec. will be found quite range enough. The speed at which the shutter will be required to work is governed, of course, by the rapidity of movement and nearness of moving object to the

camera. Reference must be made to the tables and rules given under INSTANTANEOUS PHOTOGRAPHY for information upon this point; but as it would be impossible to make any calculation at the time of exposure, the operator must depend upon experience alone to teach him all that is required on this point, although the application of these rules in the formation of a set table of distances, rapidity of movement, and speed of shutter, would be useful. For example, supposing a 4-in. focus lens is used, by a little calculation we shall find that a shutter must work at the $\frac{1}{120}$ of a second to take a man, walking at the rate of four miles an hour, twenty yards off; and a horse at thirty yards' distance, going about twelve miles an hour, will require about $\frac{1}{300}$ of a second speed.

Plate Arrangement. For those who use spooled films, roller slides, of course, will be required; but for the general run the question as to which is the better, dark slides or automatic changing methods, will be an all-important one.

Focussing. In many hand cameras this is altogether dispensed with, the use of a so-called fixed-focus lens obviating the necessity of the same; but this we again object to on the same principle as the automatic changing arrangement is objected to—namely, the limitation of the use of the camera. The table of distances beyond which everything is in focus (see FIXED FOCUS) will be useful on this point, and the question of so-called fixed-focus Lenses (*q.v.*) will be treated of separately.

Finders. Many very successful workers in this branch of our art utterly pooh-pooh the necessity of finders; but, speaking from personal experience, these are an absolute necessity; nothing is more annoying than to find on development that only the half of a desired object is included on the plate. There is, however, one evil which is usually seen with most finders of the camera obscura model, the one usually employed, and that is, if the ground glass is not deeply sunk in the camera case, any bright light shining on the same effectually prevents the miniature image from being seen. This should be noted in the choice of a camera, or disappointment may ensue, unless the new style of clear view finder be used. (See VIEW FINDER.) Of the working of a detective or hand camera but little need be said; still it is just as well for the following points to be considered. In most cases comparatively wide-angle lenses are

used, and these tend to dwarf the distance and give exaggerated perspective. Do not be disappointed, therefore, if instantaneous pictures of distant mountains or other objects appear as insignificant in size; plates exposed indiscriminately on all sorts of subjects do not, as a rule, yield pictures, though they may produce perfect negatives. Subjects with very great contrasts of light and shade, such as street views, one side of which is generally in shadow, do not yield perfect results; and rapidly moving objects, such as horses or men, may be taken in too brief a period of time, and the results, though perhaps scientifically accurate, are not truthful as we see them, because the eye receives an impression of several movements combined in one. Of the plates to be used any good brand is suitable. There are several points in connection with hand-camera work which should be noted. First as to holding the camera. Some workers adhere to the method of holding the camera under the arm pressed close against the body, and use the small finder to judge of the position of the object; others hold the camera under the chin and sight along the top. The best position depends upon the position of the object to some extent. Suppose we wish to get a shot at a person or group about ten feet off, placing the camera under the chin will probably cut off his feet, whereas holding it under the arm may include all the figure. Then, again, supposing the object to be a distant scene, such as would be taken from a steamer going down the Thames; in this case holding the camera under the arm will include far too much foreground. A method for which I am indebted to a well-known optician has proved in my hands exceedingly useful. It is:—When the object is within about ten or fifteen feet, hold the camera close to the body, with both arms at full length; this places the camera low, includes much foreground, and obviates any chance of cutting off any one's feet. Supposing the object to be taken is about twenty feet distant, then the camera may be held against the chest; if the object is about thirty feet off the camera may be held up to the chin; but, supposing we are working from the deck of a steamer or from such a position that there is much of unnecessary foreground, then by raising the camera level with the eye and the arms at full length we cut off much foreground, and there is not the slightest difficulty in seeing whether the camera is level and whether we include the desired object. If

there is any difficulty on this point we may use one or two sights, like the back and fore sights of a rifle. I beg leave to enter a protest here against the craze for working shutters at unnecessarily high speeds. The idea with many workers seems to be how quickly the shutter may be driven, whereas how slowly it can be used should be the real aim, in order that full exposure to the shadows and darker portions of the picture may be given. A brief word of remonstrance may not be out of place at the absurd requirements of some workers. They expect for a few shillings to obtain a hand camera which will enable them to turn out the very finest work, to compete with that done by cameras costing as many guineas. I do not wish to decry cheapness, for I have myself done work with a twelve-shilling camera quite equal to anything done by a twelve-guinea one; but then it was only by recognising the capabilities of the camera, and not by expecting it to do impossible things, by recognising that the lens was working at a small aperture, that the shutter would not be suitable for the finish of a race or an express train at full speed, etc. Ignorance of the capabilities of the instrument is in many cases the cause of disappointment. For judging distances, always a difficult matter for a beginner, the simplest plan is to learn distances from his ordinary surroundings: for instance, take the street he lives in; find the width of it from his door, or window to the opposite pavement, to the centre of the road; measure the distances down the street; and by constantly counting these over in his mind whilst looking at them he soon learns to judge all distances by them. Finally, it should be remembered that a hand camera is not an instrument devised for the purpose of taking photographs in positions which are likely to cause derision of, or annoyance to, anybody; they are merely portable cameras which should be used to obtain mementos of rapidly moving scenes and persons, and not for universal picture-making.

Development and Developers. The production of a visible picture from an invisible or latent impression. A design traced on a window pane will often be invisible, but developable for weeks afterwards by breathing on the glass. Development may be divided into two distinct classes—physical and chemical. If we have a wet collodion plate which has been exposed on a subject, we shall have practically a film of silver salt, part of which

has been affected by light and which is covered with adherent solution of nitrate of silver. On adding a solution of ferrous sulphate to nitrate of silver we get a precipitate of metallic silver, this precipitation, however, being delayed by the presence of organic acid such as acetic or citric. If a piece of clean silver wire be placed in the acidified ferrous-sulphate and silver solution, the silver is slowly deposited from the solution on to the silver. In the case of the wet plate the sensitive salt of silver which has been affected by light acts precisely in the same way, and the nascent silver from the adherent nitrate solution is deposited on the light-affected places forming the image. At present there is no proof that the sensitive salt is itself reduced. This is called physical development. At the present time when dry gelatino-bromide plates are so much in use we have practically another state of things. In this case the sensitive salt affected by light is itself reduced to the metallic state by certain chemicals. We have no silver nitrate slowly depositing silver on the film, but the sensitive silver salt itself is reduced, hence this is called chemical development. In a developer there are four essential ingredients: (1) the developer proper; (2) the accelerator, which hastens the action of the developer; (3) the restrainer; and (4) the solvent or water. The developing agent may be pyrogallol, hydroquinone, eikonogen, amidol, metol, etc. The accelerator is usually an alkali, ammonia, or the hydrates or carbonates of potassium or sodium. The restrainers are the bromides of potassium or sodium, citrates, etc. If a developer of normal strength is applied to a plate which has never been exposed to light and allowed to act for a long time, it will be found that there is a general reduction of the silver salt; this general reducing action is, however, less, if some soluble bromide be added to it. Frequently a sulphite is added to a developer, and this is useful in that it prevents the too rapid oxidation and consequent discoloration of the developing agent, and thus prevents staining of the hands and the gelatine of the film. Having thus far considered the main points of development we may consider the chemical theory of the same to be as follows:—The latent image, which we will assume to be sub-bromide of silver, Ag_2Br, is split up into metallic silver and bromine; the bromine is at once absorbed to form bromide of the alkali or some more complex compound, the reducing agent or developer proper

being oxidised; but if the action were to cease at this point, the image would be very faint; the metallic silver and the unacted-on bromide of silver react and form more sub-bromide, which is again reduced by the developer to the metallic state. Some particular modifications of the various developers and methods of development applied to special purposes are to be found under various headings, as BROMIDE PAPER, WET COLLODION, ARTIGUE'S PROCESS, CARBON PRINTING, ENLARGING, GELATINO-CHLORIDE EMULSION PAPER, etc. As regards the development of ordinary dry plates, sufficient for the general guidance of the beginner, and hints for the advanced worker generally, will be found in this article; but some special matters relating to the development of gelatino-bromide dry plates will be found under such headings as HYDROQUINONE and EIKONOGEN. It is important

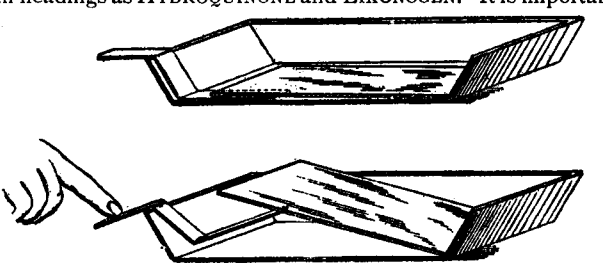


Fig. 32.

to remember that the influence of temperature on development is so great that the same chemicals will give very different results from day to day—or, at any rate, very different results, unless much more time is allowed when the weather is colder. Probably the most general first estimate as to the correctness of the exposure is based upon the time required for the first details to appear on the plate when in the developer. The slowness with which the developer acts in the winter would much surprise some of those whose work is confined to the summer months; but even during the summer it is easy to be so misled that not only are fairly well exposed plates cast aside, but one's judgment as to exposure generally is liable to be vitiated or at any rate confused. Speaking very generally, it may perhaps be estimated that development takes about twice as long in winter as in summer. A general notion of the chief desiderata to be arrived

at in arranging the developing apartment or dark-room will be found under the heading DARK-ROOM, and some kind of plate-lifter to the developing dish is a great convenience; the simple device of Mr. Charles Simpson, which consists of a strip of tin plate about an inch wide and bent twice, as shown by fig. 32, being one of the most convenient. A general instruction in development is never to expose the plate unnecessarily to light, and to use, at all possible moments, a cover for the dish—a thin sheet of ebonite answering the purpose admirably. No light, it should be remembered, is absolutely non-actinic or without action on the plate. The following general instructions for development, given by Mr. B. J. Edwards, may be taken as summarising the essentials of ordinary practice, not only for ordinary plates, but also for films and isochromatic plates:—When using Isochromatic films or plates great care must be taken to work with a deep ruby light only. Three thicknesses of good ruby glass or two of ruby fabric give a fairly safe working window for ordinary daylight. For lamplight the protection required is of course dependent on the strength of the light employed: two thicknesses of ruby glass or one of ruby fabric will generally be found sufficient, but it must not be supposed that the light in either case is sufficiently non-actinic to have no action. Care should be taken not to expose the film or plate more than is necessary even to this light, especially before and during the first part of the development. It is a good plan to cover over the developing dish or otherwise shield it from the light.

Development with Pyrogallic. Any of the following developers are suitable for these plates or films:—

PYRO AND AMMONIA DEVELOPER.

No. 1.

Pyrogallic acid	1 oz.
Citric acid	40 grs.
Water	7½ ozs.

No. 2.

Strong ammonia (·880)	1 oz.
Bromide of potassium	120 grs.
Distilled water	7 ozs.

The above will keep good for months if well corked. For use dilute 1 part No. 1 with 19 parts of water, and in another bottle

1 part No. 2 with 19 parts of water. The dilute solutions should be made fresh every day. To develop a correctly exposed plate or film, mix equal parts of these two solutions. In hot weather, when making up the dilute solutions for use, add 4 parts of No. 1 to 3 parts of No. 2, instead of equal parts of Nos. 1 and 2. In no case should the quantity of No. 2 exceed that of No. 1.

PYRO AND SODA DEVELOPER WITH METABISULPHITE.

No. 1.

Pyrogallic acid	1 oz.
Metabisulphite of soda	1 ,,
Water	80 ozs.

Dissolve the metabisulphite, and then add the pyro.

No. 2.

Carbonate of soda (washing soda)	12 ozs.
Water	80 ,,

No. 3.

Bromide of potassium	1 oz.
Water	9 ozs.

To develop, mix equal parts of Nos. 1 and 2. When working in the summer time in a good light, with full exposure, add 5 minims of No. 3 to each ounce of developer (or, to save the trouble of measuring small quantities, 1½ ozs. of No. 3 may be added to the 80 ozs. of No. 2); in winter the bromide may generally be omitted, and also for rapid shutter exposures, and portrait work in the studio. This developer gives exceedingly fine and delicate negatives, with full detail in the high lights, and of good colour for printing.

PYRO AND SODA DEVELOPER.

No. 1.

Pyrogallic acid	1 oz.
Nitric acid	20 drops.
Water	80 ozs.

No. 2.

Sulphite of soda	10 ozs.
Carbonate of soda (crystals)—washing soda	8 ,,
Water	80 ,,

No. 3.

Bromide of potassium	1 oz.
Water	9 ozs.

To develop mix equal parts of Nos. 1 and 2, and add 10 minims of No. 3 to each ounce of the mixed developer, or, instead, 3 ozs. of No. 3 may be added to the 80 ozs. of No. 2. For rapid shutter exposures omit the bromide. This developer gives bold vigorous negatives of a neutral grey colour. In either of the foregoing developers, the No. 1 solution may be mixed as a stock solution, if preferred, by using only 8 ozs. of water instead of 80, and diluting to above proportions, as required.

General Notes. Dust the face of the plate just before placing it in the dish for development, and, putting it face upwards, pour the mixed developer steadily over the *dry* plate, removing any air bubbles by passing a flat camel-hair brush (kept specially for this purpose) over it immediately; rock the dish gently, taking care to keep the film or plate well covered with the solution. When using pyro developer, where a plate is found to be under-exposed, the normal developer should be at once diluted by the addition of water; in some cases as much as three or four times its bulk of water may be added with advantage, the development proceeding proportionately slowly. By this means detail is brought out in the shadows without permitting the high lights to gain too much density. Under-exposure should always be avoided, as with these plates or films a considerable amount of over-exposure can be controlled in development, but if the light has not acted sufficiently on the plate no process of development can possibly make a good negative of it. For interiors and other subjects possessing great contrasts of light and shade, a weak developer should always be used. One of the best and most efficient methods of correcting over-exposure is that introduced by Mr. Edwards in 1888. This consists in using a separate strong but well-restrained developer as a redeveloper, which is substituted for the normal developer, as soon as over-exposure is recognised. When developing this redeveloper is kept ready mixed in a measure, and if the detail of the negative rushes up too quickly, indicating over-exposure, the normal developer is poured off and the redeveloper instantly substituted for it without waiting to wash the plate; by this means very considerable over-exposure

can be satisfactorily remedied, the redeveloper giving density without bringing out much more detail. This method of tentative development will be found exceedingly useful when developing a number of various or unknown exposures. The following is the formula for pyro. and ammonia redeveloper; separate formulæ are given for redevelopers to be used with pyro and soda, and hydrokinone or eikonogen:—

PYRO AND AMMONIA REDEVELOPER.

No. 1.

Pyro	1 oz.
Citric acid	2 drs.
Distilled water	32 ozs.

No. 2.

Ammonia (·880)	2 ozs.
Bromide of ammonia	24 drs.
Distilled water	32 ozs.

For use mix equal parts of Nos. 1 and 2.

PYRO AND SODA REDEVELOPER.

No. 1.

Pyro	1 oz.
Metabisulphite of soda (Boake's)	1 „
Distilled water	28 ozs.

No. 2.

Carbonate of soda (crystals)	9 ozs.
Bromide of potassium	2 „
Distilled water	28 „

For use mix equal parts of Nos. 1 and 2.

DEVELOPMENT WITH HYDROKINONE AND EIKONOGEN.

HYDROKINONE DEVELOPER.

No. 1.

Hydrokinone	¼ oz.
Sulphite of soda	1 „
Bromide of potassium	7 grs.
Distilled boiling water to make	12 ozs.

No. 2.

Carbonate of potash	½ oz.
Distilled water to make	12 ozs.

Frst dissolve the hydrokinone, and then add the sulphite and bromide. For use mix equal parts of Nos. 1 and 2. In cases of slight over-exposure add a few drops or minims of a 10 per cent. solution of bromide of potassium to each ounce of developer more or less according to extent of over-exposure. For considerable over-exposure use the redeveloper. For under-exposure pour off the hydrokinone developer and finish development with the eikonogen developer given below.

EIKONOGEN DEVELOPER.

Eikonogen	½ oz.
Carbonate of potash	1 ,,
Sulphite of soda	2 ozs.
Distilled boiling water	20 ,,

First dissolve the eikonogen, then the sulphite, and lastly the carbonate of potash. This will be found a very useful developer for snapshot work and portraiture; for ordinary landscape work a mixture of this and the above-given hydrokinone developer is to be preferred to eikonogen alone. One part of the eikonogen to two parts of the mixed hydrokinone developer will be found to work well, but the proportions may be varied to produce a developer possessing the required characteristics, eikonogen tending to softness and fulness of detail, and hydrokinone to bright shadows and full density. Instead of mixing the developers, the development may be commenced with eikonogen, and when the detail is sufficiently out, hydrokinone substituted for it, without waiting to wash the negative, and the development finished with this, or in case of much over-exposure with the following hydrokinone redeveloper:—

REDEVELOPER FOR HYDROKINONE OR EIKONOGEN.

No. 1.

Hydrokinone	½ oz.
Sulphite of soda	2 ozs.
Bromide of potassium	¼ oz.
Distilled boiling water to make	12 ozs.

No. 2.

Carbonate of soda (crystals)	2 ozs.
Sulphite of soda	2 ,,
Distilled water to make	12 ,,

For use mix equal parts of Nos. 1 and 2.

Fixing.

After development well wash the negative under the tap, and immerse in the following :—

Fixing Bath.

Hyposulphite of soda	6 ozs.
Water	1 pt.

This is most conveniently used in a *deep* porcelain dish. The precaution should be taken when films are put into the fixing bath, of keeping them well under so that they are perfectly covered by the solution, otherwise stains may be caused. The negatives should remain in the fixing bath for 2 or 3 minutes after they are apparently fixed, so as to ensure perfect fixation. If an acid fixing bath is preferred, add 1 oz. of metabisulphite of soda (Boake's) to the 6 ozs. of hyposulphite of soda, the addition of the metabisulphite tends to keep the fixing bath clear, and prevents discoloration of the negative. (See Acid Sulphite.)

Clearing.

When fixed the negatives should be well rinsed under the tap, and if they have been developed with pyro, put into a dish containing the following clearing solution for about a minute. If developed with a developer other than pyro, the clearing bath is not necessary, and the negatives may be removed direct from the hypo to the washing tank.

Clearing Solution.

Alum	1 oz.
Citric acid	1 ,,
or Sulphuric acid	½ ,,
Sulphate of iron	3 ozs.
Water	20 ,,

Washing.

After treating with the clearing solution, the negatives should be again well rinsed, and placed in a grooved washing tank, in which they are to be washed for not less than 2 hours, the water running continuously through the tank or being frequently changed. In placing film negatives in the grooves it is best to put two films back to back in one groove, as they stand up better

in this way. When finished washing, hang the film negatives up to dry; spring clips are most convenient for this purpose, the films being suspended by one corner.

VARNISHING.

The negatives may be printed from as soon as perfectly dry, but if this be done without previously protecting them with a coat of varnish, there is always a danger of the silver from the sensitised paper staining the negatives.

Special Transparency Plates for Lantern Slides.—Instructions for Use. They are equally suitable for contact printing or reductions in the camera. For contact printing by gas-light, using the light of a good fish-tail burner at a distance of 12 inches from the flame, any time from 10 to 60 seconds' exposure may be required, according to the density of the negative, more exposure being necessary when it is intended to develop with pyro for brown tones, than for black tones with hydrokinone or amidol. Very thin negatives should be exposed at a greater distance from the light and very dense ones nearer to it. Exposure may also be made by diffused daylight in the dull light of an ordinary room; it is, however, far more difficult to judge the correct time of exposure, therefore it is preferable to use artificial light. It is important that as nearly as possible correct exposure be given; under-exposed plates when developed appear hard with black shadows, and want of detail in the half tones, while very much over-exposed pictures are usually thin and flat, without sufficient contrast. The colour obtained is also dependent on the length of exposure. The best indications of the correct timing, or otherwise, of the exposure are the time taken before the image begins to appear, and the time necessary to attain the required density. For lantern slides, at least some portion of the highest lights in the picture should be represented by absolutely clear glass, without a trace of fog or deposit of any kind, which would detract from the brilliancy of the image. These plates cannot be satisfactorily developed with any of the usual formulæ for negative work, but either of the following formulæ will give results perfect in every way. To develop, place the exposed plate in the developing tray, and pour over the developer without previously wetting the film: all danger of air bubbles may be avoided by passing

a brush over the surface of the plate immediately after pouring on the developer.

PYRO AND AMMONIA DEVELOPER FOR WARM TONES.

No. 1.

Pyrogallic acid	1 oz.
Sulphite of soda	4 ozs
Citric acid	¼ oz.
Water	16 ozs.

First dissolve the sulphite and citric acid, and then add the pyrogallic.

No. 2.

Bromide of ammonium	1 oz.
Liq. ammonia (·880)	5½ drs.
Water to make	16 ozs.

For use mix one part of No. 1 and three parts of No. 2, and dilute with water to double the quantity. The mixed developer may be used over again for several plates. For lantern slides and transparencies from very thin negatives dilute the stock solution with less water. For contact printing under the conditions given above, the exposure for negatives of medium printing densities will be from 20 to 60 seconds. If the correct time has been given the image should begin to appear in from 40 to 50 seconds, and the development be complete in about five minutes.

HYDROKINONE DEVELOPER FOR BLACK TONES.

Hydrokinone	60 grs.
Sulphite of soda	2 ozs.
Carbonate of soda (crystals)	4 „
Carbonate of potash	2 „
Bromide of potassium	40 grs.
Hot distilled water	20 ozs.

For black and white line subjects add 1 drachm of a 60-grain solution of bromide of potassium to each ounce of developer. Dissolve the hydrokinone in the water, and add the other ingredients in the order named. This developer will keep good for at least a month; it can be used over again for several plates. Exposure for contact printing as above, 10 to 30 seconds. The

image should begin to appear in about 40 seconds to a minute, and the development be completed in about 4 minutes.

AMIDOL DEVELOPER FOR BLACK TONES.

Amidol	80 grs.
Soda sulphite	2 ozs.
Bromide of potassium	½ oz.
Water	12 ozs.

This developer is to be used without dilution, except when working from a very strong negative, when it can be diluted with an equal amount of water. It may be used repeatedly without apparent loss of developing power. With correct exposure it yields slides of a very fine black colour. Exposure for contact printing the same as for hydrokinone. Time of development about 8 minutes. These plates may be developed in either yellow or ruby light; the plate should be examined by looking through it from time to time, taking care not to expose it too much to the light. With pyro developer the transparency appears of nearly the same density before fixing as when finished, but when using hydrokinone or amidol the image must be developed to look much denser, as there is considerable reduction in the fixing bath. As soon as the transparency is sufficiently dense in the shadows, place it direct in the fixing bath, without previous washing.

FIXING BATH.

Hyposulphite of soda	4 ozs.
Water	20 ,,

Leave in this for at least 5 minntes, and then wash thoroughly for an hour or more. To secure greater brilliancy and dissolve away any deposit caused by impurities in the washing waters, the transparency should be immersed for 2 or 3 minutes in some of the following clearing solution contained in a dish, using fresh for each plate. The transparency is afterwards to be well washed for ten minutes:—

Alum	1 oz.
Citric acid	1 ,,
Water	20 ozs.

If, from an error in the exposure or want of quality in the original negative, the lantern slide or transparency is still

wanting in sparkle, through the high lights being veiled, it may be effectually cleared either at this stage or after being dried, by using Mr. Howard Farmer's reducer, made as follows :—

No. 1.

Ferridcyanide of potassium	60 grs.
Water	20 ozs.

No. 2.

Hyposulphite of soda	1 oz.
Water	20 ozs.

For use mix No. 1 and No. 2 in equal proportions. Place the transparency in a dish and flood it with the solution ; the dish must be continually rocked and the transparency carefully watched, and removed instantly the highest lights are cleared, which will not usually take more than 1 or 2 minutes: it is then to be again well washed before being dried. This reducer is in practice very useful, but requires using with great care, as it is capable of dissolving away the whole of the image, should the transparency be left in too long. When thoroughly washed, the lantern slides or transparencies should be allowed to dry spontaneously, and are then ready for binding or mounting in the usual way. If desired, they may be previously varnished, using crystal varnish.

Gelatino-Chloride Plates.—Instructions for Use. EXPOSURE. These plates are chiefly intended for contact printing under a negative in an ordinary pressure frame ; when used in this way they are extremely sensitive to daylight, the time of exposure varying from 1 second to 15 or 20 seconds, according to the power of the light and the density of the negative. Full exposure in a dull light usually gives the best results. With thin or weak negatives it is better to cover the printing frame during exposure with a sheet of opal glass or white tissue paper, giving sufficient exposure to compensate for the loss of light. A convenient method of printing by artificial light consists in burning an inch or two of magnesium ribbon at a distance of 12 inches from the printing frame. These plates can also be used for making enlarged or reduced positives from negatives in the camera, but for this purpose a much longer exposure, probably 5 to 10 minutes, in a good light will be found necessary to ensure success.

DEVELOPMENT. Make two stock solutions as follows :—

No. 1.

Neutral oxalate of potash	2 ozs.
Chloride of ammonium	40 grs.
Distilled water	20 ozs.

No. 2.

Sulphate of iron	4 drms.
Citric acid	2 „
Alum	2 „
Distilled water	20 ozs.

The above solutions will keep indefinitely. When required for use mix equal portions of the above solutions, adding No. 2 to to No. 1 to form the developer, place the exposed plate film uppermost in a porcelain dish, and pour over rapidly and evenly the mixed developer, rock the dish during the progress of development (which may be examined from time to time by yellow or non-actinic light), when sufficient density is obtained, which will usually be in about 2 minutes, pour off the developer into a measure, and flood the plate with water and wash well under the tap. The above developer with moderate exposure will give positives of a warm black colour, still warmer tone may be easily obtained by simply diluting the mixed solutions with an equal quantity of distilled water, or by adding to each ounce 2 or 3 drops of a 20-grain solution of bromide of potassium, and proportionally increasing the time of exposure. Short exposure and rapid development will give black tones, while full exposure and slow development will give warm brown or red tones to the transparency. It will be found a good plan to make up two separate portions of developer, strong and weak, and commence with latter; should the plate prove to be under-exposed the developer must be poured off, and the more concentrated solution used to bring out the picture and complete development. This method will allow considerable latitude in the time of exposure. Several plates may be developed in the same solution, but the developer gradually loses its energy and will not keep long after being mixed.

FIXING.

Hyposulphite of soda	2 ozs.
Water	16 „

Pour sufficient of the above, when dissolved, into a porcelain dish and immerse the developed and washed plate for 2 or 3 minutes, or until fixed, then rinse thoroughly under the tap and apply the following :—

Sulphuric acid	1 oz.
Saturated solution of alum	20 ozs.

Pour a small quantity of the above repeatedly over the plate for about half a minute, or until the slight deposit of oxalate of lime (caused by the washing water) is dissolved away, and the picture becomes bright and clear. The high lights of the transparency should be perfectly bare glass without a trace of deposit of any kind ; as soon as cleared wash well in repeated changes of water, and allowed to dry spontaneously.

Caution. Great care must be taken that not the faintest trace of hyposulphite of soda comes into contact with the developing solution or with the plate before or during development. Separate dishes must be used for each solution. The dishes, as well as the hands of the operator, should be frequently washed and kept scrupulously clean during the various manipulations, otherwise the films are liable to become stained and discoloured. When quite dry the transparencies may be varnished with good clear negative varnish applied with heat in the usual way.

Bromide Opals.—Instructions for Use. EXPOSURE. Place the opal plate film-side next to the negative in an ordinary printing frame, and expose to the light of a paraffin lamp, or by preference, that of an ordinary fish-tail gasburner, at a distance of 2 feet from the flame, for from 12 to 24 seconds, according to the density of the negative.

DEVELOPMENT. The following formula will be found to give very satisfactory results.

STOCK SOLUTIONS.

No. 1.

Oxalate of potash	2 ozs.
Chloride of ammonium	40 grs.
Bromide of potassium	20 „
Distilled water	16 ozs.

No. 2.

Sulphate of iron	4 drms.
Citric acid	2 „
Alum	2 „
Distilled water	16 ozs.

Having mixed equal parts of the above solutions (adding always No. 2 to No. 1), place the exposed opal film uppermost in a developing dish and pour the mixture evenly over the plate, rock the dish during the development, and watch its progress by a ruby or deep yellow light. When the image appears to have acquired the detail and vigour desired in the finished picture, wash the plate well under a tap for 2 minutes and then immerse for 10 minutes in the

FIXING SOLUTION.

Hyposulphite of soda	4 ozs.
Water	16 „

The plate must now be well washed in running water for 1 hour to remove the hyposulphite of soda, when it will be ready for toning in the sulpho-gold toning bath to a rich velvety black.

STOCK SOLUTIONS FOR TONING.

No. 1.

Chloride of gold	15 grs.
Distilled water	8 ozs.

No. 2.

Acetate of soda	1 oz.
Sulphocyanide of ammonium	1 drm.
Distilled water to make	8 ozs.

When the desired shade has been obtained, the picture should be well rinsed under the tap, and it may now be cleared of the slight deposit of oxalate of lime (caused by the washing water) by pouring over or immersing it for half a minute in the following

CLEARING SOLUTION.

Sulphuric acid	½ oz.
Saturated solution of alum	20 ozs.

After which it should be thoroughly washed to complete the process. When quite dry the opal can be finished in monochrome or water colours as may be desired, or may be varnished with crystal varnish.

Caution. It is of the greatest importance that not the slightest trace of hyposulphite of soda be allowed to contaminate the dishes or measures employed in developing or toning the opals. Therefore great care should be exercised and the hands well washed between the various operations.

The above detailed instructions by Mr. Edwards comprise details of most matters connected with development. Various formulæ for ferrous-oxalate developer are given in the article on BROMIDE PAPER, and the following formula, recommended by Messrs. Mawson & Swan, is excellent for dry plates:—

A.

Neutral oxalate of potassium	1200 grs.
Bromide of potassium	5 ,,
Citric acid	15 ,,
Distilled water to make	10 fluid ozs.

B.

Ferrous sulphate	1600 grs.
Citric acid	120 ,,
Distilled water to make	10 fluid ozs.

Distilled water should be used, otherwise the lime in ordinary water will cause turbidity from formation of oxalate. A will keep indefinitely, but B should not be used after it turns brown or yellow. When required for use, pour four parts of A rapidly into one part of B. The resulting solution will be of a deep red colour. After development and fixing, the plate frequently exhibits an opalescent appearance; this is a deposit of oxalate of lime that forms in washing: to remove it, immerse the plate, after thorough washing in

Hydrochloric acid	1 oz.
Saturated sol. alum	19 ozs.

washing the plate again after the operation.

Messrs. Lumière & Seyewetz state that some of the inconveniences ordinarily experienced with the pyrogallic developer, such as the staining of the finger-nails and the occasional lifting of the film, are largely due to the use of caustic and carbonated

alkalies, and they have found it advantageous to use the alkaline salts of the tribasic acids—phosphoric and arsenic, for instance—not only in the case of pyrogallic acid, but also with hydroquinone, eikonogen, metol, or glycin. Their pyrogallic developer is prepared as follows :—

A.

Water	1 oz.
Pyrogallic acid	30 grains.
Anhydrous sulphite of soda	45 „

B.

Water	7 ozs.
Phosphate of soda	100 grains.
Anhydrous sulphite of soda	45 „

For use, mix 20 volumes of A with 140 volumes of B.

The Messrs. Lumière, in conjunction with M. Seyewetz, have made a more strikingly new departure, based on the observation that certain ketones and aldehydes may replace the alkali in developers made up with the usual phenolic reducing agents. Sulphite of soda, Acetone (*q.v.*), and hydroquinone, pyrogallic acid, or paramidophenol will give a practically useful developer; that with hydroquinone being slow, and with either pyrogallic acid or paramidophenol being rapid. That the reducing action is not due to the acetone is evidenced by the fact that acetone and sulphite alone—or rather, one should say, in water as a medium, will not act as a developer. The following formulæ are given :—

PYRO-ACETONE DEVELOPER (rapid).

Pyrogallic acid	1½ drs.
Water	10 ozs.
Dry sulphite of soda	280 grs.
Acetone	2 fl. drs.

HYDROQUINONE-ACETONE DEVELOPER (slow).

Hydroquinone	150 grs.
Dry sulphite of soda ...	500 „
Acetone	500 mins. (1 fl. oz. and 20 m.).
Water	10 ozs.

Formaldehyde (formalin) may be used in a similar way to acetone, but is not recommended.

Deviation. An optical term to denote the alteration of the course of a ray of light when it is refracted or reflected.

Dextrine (Ger., *Stärkegummi;* Fr., *Dextrine;* Ital., *Destrina*). Synonym: British Gum. $C_{12}H_{20}O_{10}$. Is made by heating starch until it loses its insolubility in cold water, or by heating it in the presence of a dilute acid. It is usually a pale buff powder, and is used as a substitute for gum. Tested with litmus paper it should not give an acid reaction. (See MOUNTANTS.)

Diactinic. A term applied to any medium through which the actinic rays of light can pass. Substances which allow only non-actinic rays to pass are termed *adiactinic.*

Dialyser. This is sometimes used in the washing of emulsions, and can be prepared as follows:—Take a hoop of gutta percha, and over it stretch a piece of parchment paper, this being tied on tightly. It is used by floating it in a vessel of distilled water, and the materials to be dialysed are placed in the hoop. All bodies which will crystallise will pass through the *septum* of parchment paper, leaving those which will not crystallise in the dialyser. In the case of emulsions the unnecessary salts, such as nitrate of potash, etc., pass through the *septum,* leaving the *colloid* gelatine holding the sensitive silver salt.

Diameter. Any straight line passing through the centre of a circle and touching the circumference at opposite points is thus termed. If the diameter of a circle is known, multiplying that by 3·14159 will give the circumference, and *vice versâ;* and the diameter squared and multiplied by ·7854 will give the area of the circle, and the cube of the diameter multiplied by ·5236 will give the solid contents of a sphere.

Diamidophenol. See AMIDOL.

Diamond. A hard crystalline form of carbon. Its high refractive power, 2·47 to 2·75, together with its comparatively low dispersive power, would render it valuable for use in the construction of lenses, were large clear stones available and easily workable. Andrew Pritchard, working early in this century, did actually construct lenses of diamond. The natural edge of a small crystal is the effective agent in the glass-cutter's diamond, in the use of which the most important matter is to maintain the

mounting of the instrument at the same angle with the surface of the glass when once the best angle for cutting is found. In cutting dry plates or negatives, it is convenient to cut on the film side if the diamond works satisfactorily in this way, otherwise the cut may be on the glass side. When the glass has separated, and the film is like a hinge, a sharp folding of the plate in the reverse way will generally disrupt the film without causing any stripping.

Diaphanoscope. A device for looking at a photograph somewhat similar to the Alethoscope, Pantoscope, or Lanternoscope.

Diaphragms (*διάφραγμα*, a partition) are either loose plates of metal, or rotating metal screens, both having apertures of certain diameters; or another form is composed of tongues of metal actuated by an external pin or ring, which can be closed and opened out to any desired size. The Iris diaphragm consists of thin flat tongues of metal fastened to a ring in the lens mount, by means of which the aperture of the diaphragm may be enlarged or diminished by turning the ring backwards or forwards, causing the tongues to contract or enlarge the opening, the use of which obviates all chance of losing or misplacing the diaphragms. The diaphragms of the ordinary or Waterhouse pattern can be pinned together by a brass rivet just by the tongue, on which the numbers are stamped, thus lessening the chance of losing them. The influence of the diaphragm on the picture is great and of considerable practical importance, not only on the character of the picture, but also on the duration of exposure, as we shall see when treating of that subject. The influence of the diaphragm on the character of the image transmitted by the lens is seen first in a reduction of the amount of light admitted by the lens; secondly, by increase of the marginal definition; and, thirdly, by increase of the depth of Focus (*q.v.*). Diaphragms are very often termed *stops;* but this is not quite correct, as a stop is placed *in contact* with the lens, and a diaphragm some distance from it. For single lenses the diaphragm is usually placed from $\frac{1}{4}$ to $\frac{1}{7}$ of the focal length in front of the lens, in which position it limits the diameter of the pencils of light, and causes them to cross the axis at the aperture of the diaphragm, before refraction. (See DISTORTION.) The distance of the diaphragm is in many

instances, when placed in front of the lens, the cause of Flare (*q.v.*). This can be obviated by altering the position, one-eighth of an inch either way being generally sufficient to obliterate it. In all symmetrical doublet lenses, the proper position of the diaphragm is equidistant between the two combinations; in unsymmetrical combinations, the position is proportionate to the foci of the combinations. For general use the following maxims should be remembered:—*A large diaphragm gives a bolder picture than a small one; focus with the largest aperture, then insert the smaller diaphragms till sharpness is obtained over the whole screen. The smaller the stop the longer the exposure, also the flatter the field of the lens, and the greater the depth of focus.* It is customary to give the apertures of diaphragms definite diameters; that is to say, the diameter of the diaphragm apertures should be a definite fraction of the focal length of the lens. There are several methods adopted, the one in general use being the ratio aperture, or *f*/*x* system. To find this number divide the focal length of the lens by the diameter of diaphragm—*e.g.*, focal length of lens, $8\frac{1}{2}$ ins.; diameter of diaphragm, $\frac{3}{4}$ in.; $8\frac{1}{2} \div \frac{3}{4} = 11{\cdot}3$; number of diaphragm, *f*/11·3. The Royal Photographic Society number the diaphragms, however, in rather a different way, taking *f*/4 as the standard, which they call No. 1. This system is termed the "Uniform Standard," or U. S. No., and the U. S. number for any diaphragm marked on the *f*/*x* system may be found by the following rule:—Divide the focal length of lens by diameter of the diaphragm, and then square the result, divide by sixteen, and the quotient will be the U. S. No. Ex.: Find U. S. No. of diaphragm marked *f*/11·3. $11{\cdot}3 \times 11{\cdot}3 = 127{\cdot}69$; $127{\cdot}69 \div 16 = 7{\cdot}98$, or practically 8, U. S. No. In 1882 Dr. Stolze suggested a system of diaphragm numbering which was found by squaring the focal length and dividing this by the diameter of the diaphragm squared; thus, taking as an example, a lens of $8\frac{1}{2}$-in. focus and diaphragm apertures of $1\frac{1}{16}$, $\frac{3}{4}$ and $\frac{17}{32}$ in., we should find the numbers as follows:—

$$(8\tfrac{1}{2} \times 8\tfrac{1}{2}) \div (1\tfrac{1}{16} \times 1\tfrac{1}{16}) = 64.$$
$$(8\tfrac{1}{2} \times 8\tfrac{1}{2}) \div (\tfrac{3}{4} \times \tfrac{3}{4}) = 128.$$
$$(8\tfrac{1}{2} \times 8\tfrac{1}{2}) \div (\tfrac{17}{32} \times \tfrac{17}{32}) = 256.$$

In 1886 Dr. Stolze suggested, as an improvement on this, the marking of the stops with numbers, obtained by dividing the

square of the focal length by one hundred times the square of the aperture, *e.g.*:—

$$(8\tfrac{1}{2} \times 8\tfrac{1}{2}) \div (1\tfrac{1}{16} \times 1\ 1) \ 100 = \cdot 64$$
$$(8\tfrac{1}{2} \times 8\tfrac{1}{2}) \div (\tfrac{8}{4} \times \tfrac{3}{4}) \ 100 = 1.28$$
$$(8\tfrac{1}{2} \times 8\tfrac{1}{2}) \div (\tfrac{17}{32} \times \tfrac{17}{32}) \ 100 = 2.56$$

This practically means taking $f/10$ as the unit, which aperture was also adopted by the International Congress on Photography, held at Paris in 1889. Mr. T. R. Dallmeyer recommended the marking of the diaphragms on a system which takes as its unit $\frac{1}{\sqrt{10}} = \frac{1}{3 \cdot 16}$. The diaphragms, numbered on this system, would then be as follows:—

$$8\tfrac{1}{2} \div 1\tfrac{1}{16} = 8 \times 8 = 64 \div 10 = 6 \cdot 4.$$
$$8\tfrac{1}{2} \div \tfrac{8}{4} = 11 \cdot 3 \times 11 \cdot 3 = 127 \cdot 69 \div 10 = 12 \cdot 769.$$
$$8\tfrac{1}{2} \div \tfrac{17}{32} = 16 \times 16 = 256 \div 10 = 25 \cdot 6.$$

It will be seen from this that the system is practically a modification of Stolze's. Zeiss, the famous Jena optician, has adopted yet another system, which takes as its unit $f/100$, as suggested by Dr. Rudolph, and the actual working aperture of the lenses is taken as the diaphragm aperture. The following table gives, therefore, the connexion between the relative or ratio aperture and the stops:—

No. of Stop.	Relative Aperture.	No. of Stop.	Relative Aperture.
1	1/100	32	1/18
2	1/71	64	1/12·5
4	1/50	128	1/8
8	1/36	256	1/6·3
16	1/25	512	1/4·5

The photographic exposure corresponding, *cæteris paribus*, to the different stops, is, therefore, in the *inverse* ratio of those numbers. Goerz, the optician of Berlin-Schöneberg, has adopted yet another system of marking the diaphragms; this is the relative time of exposure (t) calculated from the formula $t = \frac{1}{10}\left(\frac{f}{d}\right)^2$, when f = the focus, d = effective aperture. This is really Dallmeyer's system of $\frac{1}{\sqrt{10}}$, but the diaphragms are num-

bered differently. The following table shows the f/x number for each diaphragm, as marked by Goerz :—

4 = $f/6{\cdot}3$	48 = $f/21{\cdot}9$
6 = $f/7{\cdot}7$	96 = $f/31$
12 = $f/11$	192 = $f/43{\cdot}8$
24 = $f/15{\cdot}5$	384 = $f/62$.

We have stated above that to determine the value of the diaphragms it is necessary to find the focal length and divide this by the aperture of the diaphragm. Burton gives a very convenient table in his useful little handbook, "Modern Photography," which gives the diameter of the stop aperture for lenses of any focus from 6 to 11 in., and the diameter of any aperture for lenses of less or longer focus may be found by multiplying or dividing, as the case may be. We here insert this useful table :—

	Focal Length.										
Standard No.	6 in.	6½ in.	7 in.	7½ in.	8 in.	8½ in.	9 in.	9½ in.	10 in.	11 in.	f/x or Ratio No.
·25	3·0	3·25	3·5	3·75	4·0	4·25	4·5	4·75	5·0	5·5	$f/2$
·5	2·12	2·3	2·47	2·65	2·82	3·01	3·18	3·36	3·53	3·89	$f/2{\cdot}828$
1	1·5	1·62	1·75	1·87	2·0	2·12	2·25	2·37	2·5	2·75	$f/4$
2	1·06	1·15	1·23	1·32	1·41	1·50	1·59	1·68	1·77	1·94	$f/5{\cdot}656$
4	·75	·81	·87	·93	1·0	1·06	1·12	1·18	1·25	1·37	$f/8$
8	·53	·57	·62	·66	·71	·75	·80	·84	·88	·97	$f/11{\cdot}31$
16	·37	·40	·44	·47	·5	·53	·56	·59	·62	·69	$f/16$
32	·26	·28	·31	·33	·35	·38	·40	·42	·44	·49	$f/22{\cdot}62$
64	·188	·20	·22	·23	·25	·26	·28	·29	·31	·34	$f/32$
128	·132	·144	·155	·168	·177	·188	·20	·21	·22	·24	$f/45{\cdot}25$
256	·094	·101	·109	·117	·125	·133	·141	·148	·156	·172	$f/64$

Now for an example or two how to use this table. We have a lens of 5-in. focus, and want to cut our diaphragms for $f/8$, $f/11{\cdot}3$, $f/16$, $f/22$, and $f/32$. Turning to the table, we find no 5-in. lens included, but we find a 10-in. ; therefore we have the diameters there given. Carrying the eye down the column under 10-in., we find opposite $f/8$, 1·25, then ·88, ·62, ·44, ·31, so that we must cut our apertures to $1{\cdot}25 \div 2 = {\cdot}625$ in., $·88 \div 2 = ·44$ in., $·62 \div 2 = ·31$ in., and so on. Where the focus of the lens is given in the table we merely take the apertures there given. To some it may be difficult to accurately measure the diameters of apertures, and to facilitate this we include a diagram (fig. 32) taken from the "American Annual of Photography." Each cross

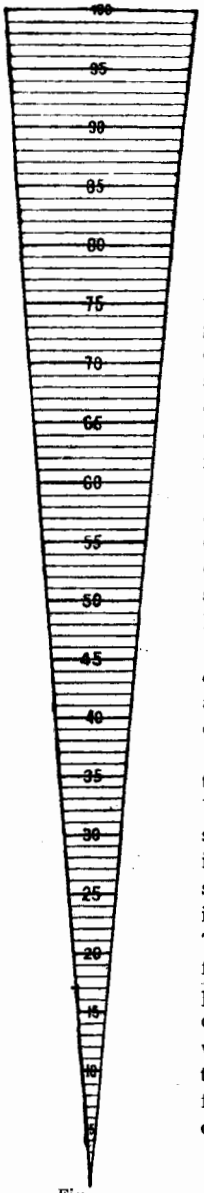


Fig. 33.

line varies in length from the adjacent one by $\frac{1}{100}$ of an inch. To use, lay the stop flat on this scale, and select a cross line which is of the same length as the greatest diameter of the opening; read this off by means of the figures, which will be the measurements in $\frac{1}{100}$ of an inch. The equivalent focal length of lens, divided by this measurement of the stop opening, will give the fraction expressing relative rapidity of lens—$f/4$, or whatever it may be. Personally I have had a piece of thin brass cut exactly to measurement, and thus ruled and continued till at its widest part it measures four inches. By inserting this in a stop, one is able at once to read off the diameter, and, dividing the focal length by it, to obtain the f/x number. The following convenient diagram and table were given some years back in the "British Journal of Photography Almanack":—

The Royal Photographic Society's Standard Diaphragms.—The annexed diagram and table are intended to facilitate the calculation of the proper number with which to mark the diaphragms according to the Royal Photographic Society's Uniform-System, which will be found described on another page. This number it is proposed to call the "U. S." (or uniform system number). The numbered circles in the diagram represent the sizes of stops. The photographer, knowing the equivalent focus of his lens, looks along the line opposite the number which represents the circle nearest inside to his diaphragm, and when he gets to the column headed by that equivalent focus the number there found is the U.S. number to be marked on the diaphragm. For example, a lens

of eight inches equivalent focus has a diaphragm in size about No. 5 on the diaphragm. Running the eye along the line opposite No. 5, we find in the column under "focus eight inches" the number 11, which is the U. S. number required.

No. of Circle.	4 focus.	5 focus.	6 focus.	7 focus.	8 focus.	9 focus.	10 focus.	12 focus.	14 focus.
1	25	39	56						
2	11	17	25	34	44	56	68		
3	6¼	10	14	19	25	31	40	56	
4	4	6¼	9	12	16	20	25	36	48
5	2⅞	4¼	6¼	8½	11	14	17	25	34
6	2	3⅛	4½	6¼	8	10	13	18	25
7	1½	2½	3½	4⅞	6	8	10	14	19
8	1¼	2	2⅞	3⅞	5	6¼	8	11	15
9	1	1½	2¼	3	4	5	6¼	9	12¼
10		1	1½	2⅛	2¾	3½	4⅓	6	8½
11			1¼	1½	2	2½	3⅛	5	6
12			⅞	1⅛	1½	2	2½	3½	4⅞
13				1	1¼	1⅝	1⅞	2⅞	4
14					1	1¼	1½	2¼	3
15						1	1⅛	1⅞	2½
16							1	1½	2
17								1⅓	1⅔
18								1⅛	1½
19								1	1⅓
20									1⅛
21									1

It has been stated above that the ratio aperture of diaphragms could be found by dividing the focal length by the diameter of the aperture. This is practically accurate, but not scientifically so. Where the diameter of either or both of the lens combinations is less than the fixed stop, the diameter of the combination is the actual aperture; where there is a fixed stop or a ring of metal in the interior of the lens mount, the diameter of this is the actual maximum aperture. These ratio apertures are strictly accurate when the lens is a single landscape lens; but with all doublet lenses the condensation of the light by the front combinations must be taken into account—especially when comparing,

either for scientific or lens-testing purposes, the actual ratio apertures; practically we are testing the *effective or working apertures* of the lens. This is by no means a difficult operation, and one of two plans may be adopted. The first is to rack the lens out to its equivalent focus, and to replace the ground-glass or focussing-screen by a piece of cardboard or thin metal plate,

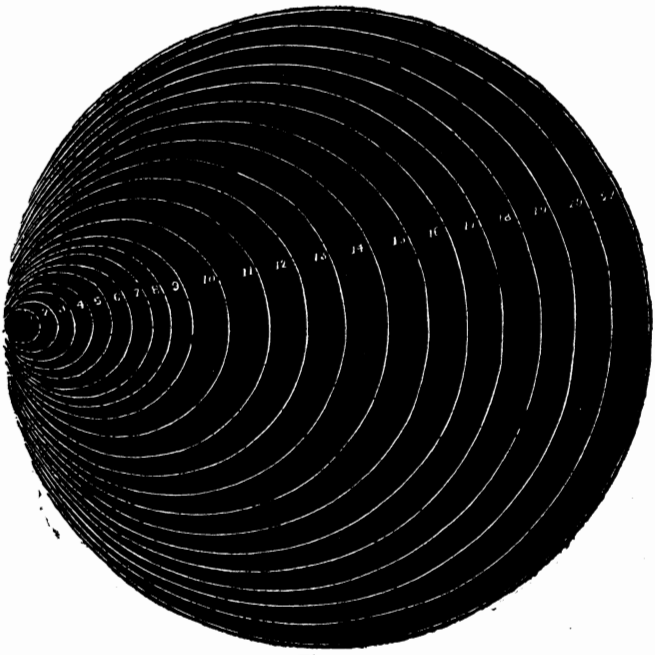


Fig. 34.

in the centre of which, and central with the axis of the lens, is punctured a minute pinhole. The camera should now be taken into a dark-room, and a lighted candle placed close to the pinhole in the cardboard. On examining the front lens, a circle of light will be faintly visible, or may be rendered still plainer by breathing on the lens or dusting it with a little French chalk or plain powder. A pair of dividers may be used for taking the

diameter, and this may be at once read off on applying the same to a foot rule, and the focal length divided by this will give at once the true aperture of the stop. The second plan is by the aid of a simple mathematical calculation as follows:—

Let D = the true aperture value.
d = actual diameter of diaphragm aperture.
f = the focus of front combination.
l = the distance between the plane of diaphragm and the centre of the front combination, which centre is situate midway between the front and back surfaces of such lens.

Then

$$\text{(I.)}\quad D = d \times \frac{f}{f-l}$$

$$\text{(II.)}\quad d = D \times \frac{f-l}{f}$$

To many doubtless this is unintelligible. An example may make it plainer. Let us suppose we have a Euryscope lens of 11-in. focus, the focus of the front combination is 21 in., the distance between the centre of combination and plane of diaphragm is $1\frac{1}{4}$ in.; we want to calculate the value of a diaphragm 1 in. in diameter; then, substituting the above values for the letters, we find

$$D = 1 \times \frac{21}{21-1\frac{1}{4}} = 1 \times \frac{21}{19\frac{3}{4}} = 1{\cdot}0632 = 1\tfrac{1}{16} \text{ in. nearly.}$$

Therefore our stop of 1-in. actual diameter has a true aperture value of $1\frac{1}{16}$ in.; not much difference, it is true, but still sufficient to render accurate scientific work an impossibility. It may happen that, by this calculation, we find this true aperture value greater than the diameter of the front lens; if this is the case, the diameter of the lens is the true value. Now suppose we have a lens of 16-in. focus, and wish to cut our diaphragms to have a value of $f/8$, $f/11{\cdot}31$, $f/16$, etc. We know that $f/8$ should be 2 in. if we disregard the condensing power of the front lens; the focus of front lens being 30, and the distance from the centre of this lens to diaphragm plane 1 in., we get then

$$d = 2 \times \frac{30\ 1}{30} = 2 \times \frac{29}{30} = 1\tfrac{14}{15}, \text{ actual diameter of } f/8.$$

Then for $f/11{\cdot}31$ we shall get

$$d = (16 \div 11{\cdot}31) \times \frac{30-1}{30} = 1{\cdot}41 \times \frac{29}{30} = 1{\cdot}363 = 1\tfrac{3}{8} \text{ in.}$$

It is true these measurements show but little difference to the actual diameter of stop, but in portrait lenses the difference is greater, and even in small diameter lenses the difference is sufficiently large to be taken into account when testing lenses. In practice it will be necessary to calculate out the true diameter of diaphragms for the first two only, the smaller diameters being obtained by dividing by 2, 4, etc. Another method of making the necessary allowance of the condensation of the light by the front lens is to cut the stops in fractions of a focus less than the true focus of the lens, and this may be found in the following manner:—

Let F = the equivalent focus.
f = the focus of front combination.
l = the distance between centre of front lens and plane of diaphragm.
A = the assumed focus.

Then

$$A = F \times \frac{f-l}{f}.$$

Or to take the example given above, viz., a lens of 16-in. focus, front lens focus 30 in., the distance from lens to diaphragm plane being 1 in., we get

$$A = 16 \times \frac{30-1}{30} = 16 \times \frac{21}{30} = 14{\cdot}13.$$

We therefore cut our apertures for a 14·13-in. focus instead of 16-in. focus. There is one point in connection with diaphragms which it is essential to note, and that is, the ratio aperture is calculated from the equivalent focus, but that in photographing near objects, such as portraits or line subjects, we have to rack out the camera considerably, and that therefore the ratio aperture of any given diaphragms decreases in proportion to the racking out. An example will make this plainer, perhaps—for reproducing a diagram full size with an $8\frac{1}{2}$-in. focus lens. The distance between the lens and focussing screen must be 17 in. We have found that a diaphragm marked $f/16$ will give the requisite sharpness, but this aperture is calculated from the equivalent

focus. Therefore, as the diameter of the aperture of the diaphragm remains constant, it is obvious that it cannot now be *f*/16; we must therefore calculate out afresh the ratio aperture:—
The stop is marked *f*/16 and is $\frac{1}{16}$ of the focal length = $8\frac{1}{2}$ in.
∴ Diameter = $8\frac{1}{2} \div 16 = \frac{17}{32}$.
The focus when copying diagram is 17 in.
∴ $17 \div \frac{17}{32}$, = 32, the new ratio aperture of stop.

Diazotype or Primuline Process. This is a process patented in 1891 by Messrs. Green, Cross, and Bevan, and is based upon the property which certain diazotised dyes possess of being so altered by light that they will not form colouring matters with certain anilines and phenols. As various colours can be obtained, and the process is applicable to paper material or gelatine on glass, it affords a ready means of obtaining decorative subjects, although the colours are not very brilliant, nor is the ground pure white. The solution of primuline is prepared as follows :—

Primuline	10 parts.
Distilled water	1,000 ,,

The water should be heated to near boiling-point, and kept at this temperature by means of a spirit lamp or Bunsen burner, and the primuline added, with constant stirring till dissolved. In this hot solution the linen, silk, plush, or velvet—the two former being deprived of their dressing by washing—should be immersed, and care taken that the dye is evenly distributed through the material by pressing with glass rods, etc., and stirring about. The material after about five minutes' immersion should be allowed to drain, rinsed once in cold water, and dried. In this stage it is not sensitive to light, and the dipping and drying may be effected in daylight. It will also keep well in this condition. The drying should be rather rapid, and therefore blotting off between blotting paper, or a free current of air, should be resorted to. The sensitising solution is composed of

Sodium nitrite	4 parts.
Oxalic acid	6 ,,
Distilled water	1,000 ,,

In this the material should be immersed and well saturated, then drained, rinsed, and superflous moisture removed by pressing between thick blotting paper. The material need not be absolutely

dry, and should be exposed at once, as it will not keep. The sensitising and drying must be done in a dark room or by weak gaslight. As this process is what is called a negative printing process—that is, it yields a negative from a negative—we require a positive to obtain a positive. The material is then exposed under a positive for about thirty seconds in sunlight, to ten minutes or more in diffused light. The process of printing can be gauged to some extent by examining the material in the ordinary way, the action of light bleaching the material, which assumes a dingy colour. It is advisable till practice is secured to use small test pieces of material, exposing them side by side with the printing frame till they no longer give colour with the developer. The developers are as follows:—

For Red Tones.

β-napthol	6 parts.
Sodium hydrate	8 ,,
Distilled water	1,000 ,,

For Yellow Tones.

Carbolic acid (crystal)	10 parts.
Distilled water	1,000 ,,

For Orange Tones.

Resorcin	6 parts.
Sodium hydrate	9 ,,
Distilled water	1,000 ,,

For Purple Tones.

α-Napthylamine	12 parts.
Oxalic acid	1·2 ,,
Distilled water	1,000 ,,

For Blue Tones.

Eikonogen	12 parts.
Distilled water	1,000 ,,

For Brown Tones.

Pyrogallol	12 parts.
Distilled water	1,000 ,,

As soon as the colour is sufficiently developed, the material should be well washed in water, and dried. Napthylamine has

an intense and characteristic smell which may be removed from hands and dishes by using the nitrite sensitising solution. For purple pictures the material should be rinsed in dilute solution of tartaric acid and dried without further washing. For obtaining prints on paper it is advisable to size the paper well first with a 2 per cent. solution of gelatine with a little chrome alum, and allow this to thoroughly dry, and then sensitise by floating on the hot nitrite solution, care being taken that none gets on the back. The after-treatment is the same as for materials. Transparencies and opals can be made by coating glass with

Primuline	80 parts.
Gelatine	480 ,,
Chrome alum	2 ,,
Distilled water	9,600 ,,

allowing to set and dry, and then sensitising by immersion in the nitrite solution. Prints produced by this process are permanent, unless exposed to brilliant sunshine. Designs in different colours can be made by thickening the developers with boiled starch and applying with a brush. Wool and silk require longer exposures than cotton or linen.

Diffraction or Inflection. An optical term used to denote the bending of the rays of light when such rays pass by the edges of an opaque body.

Diffused Light. Generally, in opposition to direct light. It is the only light which should be used for Portraiture (*q.v.*). Diffused light in the camera is generally taken to mean any actinic light other than that passing directly on the plate from the lens.

Dish. One of the most necessary articles of an amateur's outfit. It is made of various materials: glass, earthenware, vulcanite, metal, and wood are the most useful. It is only necessary to say dishes should be kept scrupulously clean, being occasionally scrubbed with a stiff brush and some strong acid. One dish should be kept specially for each operation, and used for that only.

Dispersion. An optical term used to denote the separation of a ray of heterogeneous light by refraction into its component

rays of different refrangibility. Different transparent media have different dispersing powers, or different powers of widening the angle between the red and violet rays, and it is owing to this difference of dispersive power in different kinds of glass that chromatic aberration can be eliminated.

Dissolving Views. See MAGIC-LANTERN.

Distance. The objects in a landscape farthest from the eye, forming a background to the scene; and, in an artistic sense, the representation of objects so as to give an idea of remoteness. (See AERIAL PERSPECTIVE.)

Distilled Water. $H_2O=18$. Pure water obtained by vaporisation in a still or retort, and subsequent condensation of the vapour. It should be used in many operations of photography, especially in the manufacture of emulsions and ferrous oxalate development.

Distortion. Images may suffer from no less than three kinds of distortion, (*a*) distortion of perspective, (*b*) distortion of parallel lines, and (*c*) distortion of marginal lines or the aberration of thickness of the lens.

(*a*) *Distortion of perspective.* This is frequently noticeable in

Fig. 35.

ordinary work, particularly in architectual studies where lenses of short focus, compared to the size of the plate have been used. In such a case near objects look exaggerated in dimension compared to others more distant, when the prints are examined at the distance of normal vision, whereas if the pictures are viewed from a distance equal to the focus of the lens this is not seen;

hence the distortion is rather relative to the point of sight than absolute.

(*b*) *Distortion of parallel lines.* Whilst this is strictly speaking a distortion of perspective, it is better to consider it as a separate subject, because it is solely due to a misuse of the camera. When a lofty object has to be taken and the camera is tilted upwards, unless the swing back be used, what should be vertical parallel lines in the print will appear to converge as in fig. 35.

(*c*) *Distortion of marginal lines or aberration of the thickness of lenses.* If a square ruled on paper be examined with an ordinary reading glass it will be found that the lines instead of being straight will be curved. When a landscape or single lens is used with a stop in front of it, lines falling near the margins will be curved outwards, as with the stop in this position the lower part of the lens forms the image of the upper part of the object; with the stop behind the lens, the reverse is the case, and the distortion is pincushion shape. From this it is obvious that by placing a lens on either side of a diaphragm we get the two distortions curing one another, and hence the rectilinear or doublet lenses.

Divergent Rays in optics are those which continually recede farther and farther from one another, being the opposite to convergent. (See LENS.)

Dodging Negatives. There are few negatives which will not be improved by some after treatment. Under the heads of Intensification and Reduction will be found instructions for these processes which have for their general purpose the increase of, or reduction of, density respectively, but in many cases it is found that one portion of a negative is so dense in proportion to the rest that it will not print: to improve such a negative we may use the method of Harmonising Harsh Negatives (*q.v.*), or we may locally reduce it or intensify it. To locally intensify a negative it should be thoroughly well washed free from hypo, or, if dried, soaked in water for an hour, then intensified by the use of the uranium intensifier (see INTENSIFICATION), then rinsed once or twice, and an alkaline solution such as 1 : 20 solution of carbonate of soda may be applied with a camel's hair brush to the dense parts of the negative; and this has the effect of dissolving

the uranium intensification and leaving the dense parts, therefore, in their original condition, so that the result will be a negative intensified in the shadows but not touched in the high lights. If necessary the negative may now be dried, and the high lights still further reduced by the local application of Farmer's ferridcyanide and hypo reducer. Vidal has suggested for local intensification or as we call it dodging, painting over the dense parts of a negative with asphalt dissolved in benzine, allowing this to dry, and then dipping the plate into a solution of some aniline dye, like aurantia, chrysoidine extra, Bordeaux red, etc., the strength of the solution and the stay of the negative in the same, being of course adapted to the degree of intensification required; the gelatine absorbs the colouring matter, and thus the thin parts are locally intensified. If afraid to treat the film in any way for fear of losing it, one may paste the back of the negative with starch paste, and lay it down on a flat sheet of tissue paper with slight pressure, allow to dry and trim the paper down. We have now a surface on which we may work with a crayon and stump, with retouching pencils or water colour. Another method is to coat the back of the negative with matt varnish which has been stained deep red by the addition of some aniline dye, or yellow by dissolving gamboge in it. When the varnish is quite dry, we may scrape it off with a sharp penknife over those parts we wish to print through more and thus get better results. Local reduction may of course be carried out by exactly reversing the directions for some of the above processes, but enough has been said to point out the method of procedure to any intelligent operator.

Doublet. This term is applied to lenses which have a glass or combination at each end of the lens tube. Various names have been given to these, or to slight modifications. (See LENS.)

Drachm or Dram. See WEIGHTS AND MEASURES.

Dragon's Blood. A red resinous substance which exudes from several plants, and is used as a resist in photographic etching processes.

Drop as Measure. See WEIGHING AND MEASURING.

Drop Shutter. See SHUTTER.

Dry Collodion methods. See COLLODION PROCESSES.

Dry Plates. Glass of particular size coated with a film of gelatine in which a sensitive salt of silver is emulsified. These are to be bought, commercially, so perfect in preparation that but few amateurs will be tempted to coat their own, but the formulæ given under Emulsion will be found all that can be desired, and the manufacture of emulsion is an education which all operators if time and circumstances permit, should undertake. It is advisable for all workers to examine the plates that they intend to use, especially when starting on a tour, to determine one or two points. Plates should be examined as to whether they are cut to size correctly or not, whether they are evenly coated, this being done by holding the plate or one or two plates in turn, before the dark-room light, and seeing whether one part lets through more light than another. Freedom from fog is another essential, and the best way to test this is to take out a plate from a freshly opened packet in a very dim red light, and place in a dish, and develop with freshly mixed ferrous oxalate or pyro-soda developers of normal strength for the normal time, and then see whether it be free from fog or not. With regard to the sensitiveness of the emulsion this is usually determined and marked by the maker. (Very full particulars as to the making of the modern dry plate are to be found under the heading EMULSION.)

Drying Box. A light-tight box used for drying plates, etc., coated with a sensitive film. There are many different kinds, but the following will answer well:—Make a box of half-inch deal, 2 ft. long by 1 ft. wide and 1 ft. deep, with a door opening at one side, with a deep fillet to prevent the ingress of light; at the bottom pierce about twelve holes, and have a second bottom made, but with openings at the side. In the centre of the top have a two-inch gas or zinc pipe fixed, with an elbow joint, and in the bend of the joint insert a small gas burner, so as to cause a draught of air when lit. Anhydrous chloride of calcium may also be placed upon the bottom of the box. The interior may be fitted with stout wire, or glass shelves, about three inches apart. See sketch and description, p. 221.

Drying Marks. These are generally irregular wavy marks seen near the margins of dry plates or sometimes as fairly regular patches which are of different density to other portions of the negative, and are caused by unequal drying of the coated plates,

those portions remaining moist longest being more sensitive and therefore appearing as over-exposed. Drying marks are also caused in an otherwise perfect negative if the same be allowed to dry unequally or at different temperatures. For instance, if a number of plates are placed in a drying-rack close together and left for some time the centres will not dry so quickly as the edges, and unequal density may be caused; or if part of the negative be allowed to dry spontaneously and the other part be dried by the heat of the fire, or by the aid of spirit.

Dusting-on Process. See POWDER PROCESS.

Eau de Javelle is used for eliminating the last traces of hypo from the film, and also for reducing over-dense negatives, its action being due to hypochlorous acid. It is a solution containing an alkaline hypochlorite, and can be made as follows :—

Chloride of lime	2 ozs.
Carbonate of potash	4 ,,
Water	40 ,,

Agitate the chloride of lime with 30 ozs. of water, dissolve the potash in the remainder, mix, and filter.

Ebonite. A modification of indiarubber made by heating it with sulphur under pressure. It is used for making dishes, instantaneous shutters, etc., and, though brittle and affected by heat, answers well, from its great lightness and hardness.

Edging. See SAFE EDGE.

Effective Aperture. The effective or working aperture of the lens is that portion which actually comes into use with the various

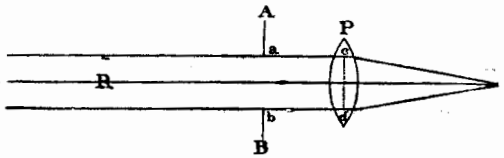


Fig. 36.

diaphragms, and the size of the working aperture is dependent not only on the size of the diaphragm, but also on the distance of the object; but for comparison of lenses, and in the ordinary

course of testing a lens, parallel rays only are considered in estimating the effective aperture. According to Dr. Stolze, "with any but parallel rays of light, such as those proceeding from near objects under otherwise equal conditions: (1) with single lenses, with diaphragm in front, the effective aperture increases as the distance of a luminous point decreases; (2) with doublets, with diaphragm between the lenses, the effective aperture increases

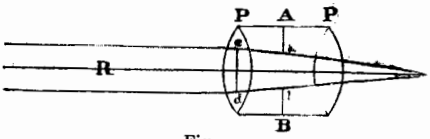


Fig. 37.

as the distance of a luminous point increases." The diagrams given show very clearly how the working aperture of single and doublet lenses is respectively equal to and greater than the diameter of the diaphragm aperture. In both figures F is the focus of parallel rays, R; P the lens; and the diameter, *c d*, in fig. 36 is equal to *a b*, the diaphragm aperture, but in fig. 37 *c d* is greater than *a b*. Directions for finding the correct working aperture have been given under DIAPHRAGM.

Efflorescence. The giving up of water of crystallisation to the air, whereby a salt falls to powder. The behaviour of crystals of wasting soda (crystallised sodium carbonate) in the air is an example.

Effluviography. A name applied by Tomassi (in 1886) to the production of images on a sensitive plate by radiations from the silent electric discharge. It was almost an anticipation of what is now understood by Radiography (*q.v.*).

Eikonogen, introduced by Dr. Andresen of Berlin in 1889, is the sodium salt of amido-β-naphthol-β-sulphonic acid, and has the formula $C_{10}H_{15}SO_3NaOHNH_2$. It was first discovered by Professor Meldola in 1881.

Developer No. 1.
For Portraits and Landscapes.
Solution A.

Sodium sulphite	...	...	...	...	4 parts.
Distilled water	...	...	...	...	60 „

To this solution add

Eikonogen ... ... 1 part,

which has been previously finely powdered by means of a mortar, and dissolve by shaking. Should a mortar be wanting, the solution can also be prepared by placing the salts into boiling water, and shaking till dissolved.

Solution B.

Washing soda	3 parts.
Distilled water	20 ,,

Immediately before developing mix the developer as follows:—

Solution A	3 parts.
Solution B	1 part.

No. 2.

For instantaneous work (about $\frac{1}{50}$-sec. exposure)

For this purpose formula No. 1 is to be used, with the exception that the crystallised carbonate of soda is replaced by the same quantity of carbonate of potash.

No 3.

For very short instantaneous exposure, or for increasing the power of Nos. 1 and 2 for under-exposed plates.

Sodium sulphite	5 parts.
Carbonate of potassium	2 ,,
Eikonogen	1 part.
Boiling distilled water	30 parts.

The following is the formula for the fixing baths recommended:—

Hyposulphite of soda	4 parts.
Bisulphite of soda	1 part.
Distilled water	20 parts.

Or

Hyposulphite of soda	20 parts.
Sulphite of soda (neutral)	5 ,,
Distilled water	100 ,,
Sulphuric acid (sp. gr. 1·845)	1 part.

For bromide paper it is advised to soak the paper after exposure in 40 parts of water, and when limp add 10 parts of No. 3

solution; if the image hangs fire add more of the solution. For over-exposure reduce the quantity of Solution 3. Bromide of potassium should not be used. After developing wash well, and place in an alum bath for several minutes, whereupon it is again fixed and washed. The author has used the following with good results :—

No. 1.

Eikonogen	40 grs.
Sodium sulphite	40 ,,
Distilled water	10 ozs.

No. 2.

Soda carbonate	400 grs.
Caustic potash	50 ,,
Distilled water	10 ozs.

For use mix equal parts; for instantaneous work add 5 grs. or ·3 grm. hypo to No. 2. Eikonogen is not easy to preserve in solution, or to get in solution, its solubility being low, only about seven grains per ounce of water; and, further, its avidity for oxygen is so great that it readily oxidises and turns brown, even in solution with a sulphite. The best preservative is acid sulphite of sodium or an acidulated solution of soda. A good formula for stock solution is Voight's, as follows :—

Acid Sulphite.

Sodium sulphite	170 grs.
Distilled water ... ... to make	1 oz.
Hydrochloric acid	40 minims.

Dissolve in the above order.

Stock Solution.

Eikonogen	125 gr.
Sodium sulphite	625 ,,
Distilled water ... ... to make	25 ozs.
Acid sulphite as above	1 oz.

Dissolve in the above order. Another convenient formula is :—

Eikonogen	125 grs.
Acid sulphite of sodium	½ oz.
Distilled water ... ... to make	25 ozs.

For accelerators we may use either caustic alkalies or the carbonates; and having this choice gives us far more control over our negatives than would otherwise be the case. For ordinary work it is not advisable to use the caustic alkalies, and carbonate of soda may be used where soft results are desired, whilst potash gives us a little more contrast and density. One of the most important points when using eikonogen as a developer is the temperature of the solutions. At 32° F. its developing power is practically none, and its power increases with the rise of temperature: the temperature of the developer should be about 65° F. to obtain the best results. Briefly formulating a method of development with eikonogen, we arrive at the following conclusions:—*Under-exposure and instantaneous shots:* Use either of the caustic alkalies; or with extreme under-exposure or very sharp snap-shots use a one-solution developer compounded on Warnerke's formula, which is as follows:—

Eikonogen	1 oz.
Caustic potash	1 „
Sodium sulphite	2 ozs.
Distilled water (boiling)	10 „

We have deprecated the use of one-solution developers, but as the addition of caustic alkali enables us to obtain a much greater concentration of solution, it is useful for instantaneous work. (For a useful device for keeping a one-solution developer, see the preservative bottle described under ATMOSPHERE.) The above solution should be diluted with from three to ten parts of water as required, more water giving softer results. Where only slight under-exposure exists the use of a mixed accelerator of caustic and carbonate will be found useful, and the caustic may be increased as desired or found necessary. *Normal exposure:* For portraiture, carbonate of soda should be used, as in all cases where softer effects are desired; for outdoor or landscape work, carbonate of potash should be used, and with a small addition of bromide of potash. *Over-exposure:* in cases where over-exposure is known to exist, practically the same method of development may be adopted as with pyro—viz., increase of bromide and reduction of accelerator, which should be carbonate of potash. We have given some formulæ for stock solutions of eikonogen; we now come to stock accelerators.

Carbonate of Soda Accelerator.

Carbonate of soda	300 grs.
Distilled water, to	10 ozs.

Carbonate of Potash Accelerator.

Carbonate of potash	150 grs.
Distilled water, to	10 ozs.

One part of these may be mixed with an equal quantity of eikonogen stock solution and applied to the plate. The caustic alkalies should only be used in cases where such are indicated as above, and stock solutions may be prepared either in 10 per cent. or 20 per cent. as desired, and they should be added, drop by drop, so as to avoid frilling and fogging of the film. A good all-round accelerator, which gives excellent results, and which can be modified with extreme ease, is the following :—

Carbonate of soda	400 grs.
Caustic potash	50 ,,
Distilled water, to	20 ozs.

One part of this may be mixed with an equal quantity of stock eikonogen. If development hangs fire at all, or the plate shows signs of under-exposure, add gradually, or drop by drop, watching the action after each addition—

Caustic potash	120 grs.
Distilled water, to	1 oz.

Of the application of eikonogen to lantern and bromide work we cannot speak at present, but in our opinion it is far superior to ferrous oxalate or hydroquinone for this purpose. It is advisable when using eikonogen to employ the acid fixing bath, as obviating all stains, and hardening the film and preventing frills and blisters, which are liable to occur when forcing plates with caustic alkalies. The superiority of eikonogen over pyro and hydroquinone is manifest, particularly in developing snap-shot and portrait work, as, no matter how dense the high lights and how weak the shadows, the resulting prints are far softer and more harmonious than would be the case with the other two reducing agents. It gives an image of a bluish black or grey colour, free from any brown tinge, as is the case with pyro, and development

has, therefore, to be carried rather farther than old pyro workers are accustomed to.

Electric Gas. A term popularly applied to Acetylene (*q.v.*).

Electric Light. The arc light is one of the best artificial lights for Portraiture (*q.v.*), and the incandescence light suitably protected with a red or orange covering is specially convenient for the dark-room.

Electric Radiations. See EFFLUVIOGRAPHY and RADIOGRAPHY.

Electric Telephotoscopy or **Telescopy.** A term applied to seeing or photographing at a distance, the connection being by means of one or several conducting wires. Most methods are based on the fact that selenium becomes more conductive under the action of light. Those wishing to study this problem should obtain Liesegang's "Beiträge zum Problem des Electrischen Fernsehen," published by the author at Düsseldorf, 1891.

Electrotyping. The formation of metal casts from a solution of the metal by electrolytic action, and largely employed in connection with the production of photomechanical printing plates. Useful information cannot be given in a few sentences, and the student should obtain Alexander Watts' "Electro-Metallurgy," 4*s.*, *Electrician* Office, Salisbury Court, Fleet Street.

Element. In chemistry a substance regarded as simple or non-decomposable. In optics often applied to one glass or lens of a complex system; occasionally to an achromatised group in a system.

Elemi. A concrete resinous exudation from *Canarium commune*, a plant of Malay. It is sometimes used in the preparation of Varnish (*q.v.*).

Eliminators, Hypo-. Any salt or solution of salt used to get rid of the last traces of hypo from the films or prints. Many so-called eliminators have been recommended, as peroxide of hydrogen, eau de javelle, alum, iodine, acetate of lead, hypochlorite of zinc; but opinions seem to be about equally divided as to the benefit of their action. The most recent introduction is the persulphate of potassium sold as anthion.

Emulsion. Photographically, a mechanical mixture of any sensitive salt of silver in extremely minute division, held in suspension in any viscous vehicle, such as gelatine or collodion, which, when spread upon any transparent medium, shall present a generally homogeneous appearance when viewed by transmitted light. It would be unnecessary and impossible to write a thoroughly comprehensive account of the emulsion processes; for such a work the amateur must consult Eder's "Handbook of Emulsion Photography," but a few well-proved formulæ will be given. The material upon which the emulsion may be spread may be either glass, paper, or any special substance desired. The emulsion may be either for the production of negatives, transparencies, positives, or lantern slides, for development or printing out. In this article that intended for negative work alone will be treated of. To summarise all the methods which have been suggested for emulsion making would be almost impossible, at least, within reasonable limits. Practically, however, we may consider that there are three methods in general practice, viz.—

(*a*) The ammonio-nitrate process.
(*b*) The acid-boiling process.
(*c*) The cold process.

The ammonio-nitrate process, which may be briefly described as the conversion of the nitrate of silver into the double salt by means of ammonia, and the addition of this to a bromised gelatine solution, and digestion of the emulsion at a moderate temperature for a given period, is simple and easy to carry out, and the one specially suitable for amateur emulsion makers. The acid-boiling process requires more apparatus than the previous one, and though clean working plates are obtained, the sensitiveness is not quite so great as with ammonia. The cold process is simple and easy, requires no heating, but it is far more difficult to obtain regular results.

(*a*) *The Ammonio-Nitrate Process.* Eder was the first to suggest this process, and the following is his latest formula. Two solutions are required.

A.

Potassium bromide	24 parts.
Solution of potassium iodide (10 per cent.)	3 to 8 ,,
Hard gelatine (Winterthur)	20 ,,
Distilled water	250 ,,

Allow the gelatine to soak for from 30 to 60 minutes in the water in a closed vessel, then place the vessel in a water bath and allow the gelatine to dissolve, and add the haloid salts. Now place the thermometer in the gelatine solution, and make the same register 40° C. (= 104° F.). Should the emulsion be too cool, raise the temperature of the water bath; if too hot, place the vessel in cold water for a little time till the emulsion reaches the desired temperature.

B.

Silver nitrate...	30 parts.
Distilled water	250 „

When dissolved, add cautiously liq. ammonia, ·880, till the brown precipitate first formed is redissolved. So far these operations may be performed in daylight, but it is now necessary to enter the dark-room, and the silver solution should be added to the bromised gelatine in small quantities at a time, vigorously shaking between each addition. The total time of mixing must not be long, as otherwise the temperature sinks too low. Eder states that the silver solution should be used at the ordinary temperature and not heated; but I have obtained equally good results by using hot water for dissolving the silver, and thus using the solution warm. As soon as the emulsion is mixed it should be placed in the water bath, the temperature of which should be 45° C. (= 113° F.). Eder now recommends wrapping the vessel in blankets, flannels, etc., to retain as far as possible an even temperature. By using a very faint spirit flame or gas flame, however, it is quite possible to keep the temperature the whole time at 45°, or just above. It will be noted in the above formula that the quantity of iodide solution is not definite—viz., 3 to 8 parts. According to Eder, increase of the iodide up to 8 parts gives rather more sensitive emulsions which are less liable to halation in landscape work. Many operators prefer to use, for portraiture, an emulsion which contains little or no iodide, and, therefore, the amateur plate-maker can take his choice. The duration of the digestion of the emulsion in the water bath has the most important influence on the final sensitiveness of the emulsion. When the above emulsion is digested for about 15 minutes, a slow landscape emulsion registering about 15° W. and working with great clearness and vigour will be obtained;

with 30 minutes' digestion the sensitiveness will be about 17 to 19° W.; with 45 minutes' digestion about 22 to 24° W. During the digestion the flask must be shaken two or three times so as to prevent any undue separation of the sensitive silver salts. When commencing to make the emulsion, take of hard gelatine 15 to 20 parts. Allow this to swell in distilled water, and as soon as the emulsion has been digested pour off the water from the gelatine, allowing it to drain slightly, and carefully let it melt in the water bath, which it should readily do, as in the course of an hour or so, which has passed in the above operations, it will have absorbed enough water to melt. This melted gelatine should then be added to the emulsion and the whole well shaken, then the froth should be allowed to subside a little, and the emulsion poured out into a flat glass or porcelain dish to set. The emulsion should be about three-quarters of an inch thick in the dish, and should be placed in absolute darkness to set, which takes, as a rule, about five to eight hours, according to the temperature. In the height of summer a little ice placed in the same box as the emulsion will be of assistance; in cold weather this is not necessary. The above process is suitable for plates of medium sensitiveness, and it is just as well to state here that very rapid plates are extremely difficult to make, and fog and all such incidental and minor troubles, such as frilling, blisters, spots, etc., are more likely to make their appearance when trying to make rapid plates. The simplest formula which the writer has tried, and the one in which success is more likely to attend a novice's efforts, is the following of Eder's, which gives a very good, clean working plate of about 15° W.:—

A.

Ammonium bromide	20 parts.
Solution of potassium iodide (10 per cent.)	3 ,,
Hard gelatine	45 ,,
Distilled water	300 ,,

Allow the gelatine to soak in the water for one hour; dissolve by the aid of a gentle heat; add the salts.

B.

Silver nitrate	30 parts.
Distilled water	300 ,,

Dissolve the silver, and convert into the ammonia-nitrate by the addition of ammonia as previously directed. Heat solution A to 35° C. (= 94° F.), and add solution B; digest for 30 minutes, and pour out to set. By digesting 10 minutes only a very fine-grain emulsion is obtained, which gives good lantern slides. The proportion of iodide solution may be increased from 3 to 8 parts with advantage when the plates are intended for landscape work; but in this, as in every formula where the iodide is increased, the bromide must be correspondingly reduced, which may easily be done by referring to the tables given at the end of this work. Very rapid plates are not easy to make, but in order to complete this note we may briefly indicate how to prepare the same. The formula for the emulsion may be precisely the same as that already given; but the iodide should be the full quantity of 8 parts, and the bromised gelatine be heated to 60° F. (= 140° F.), and the silver solution added to it, and after about 40 to 50 minutes' digestion, in the water bath, at a temperature of 40° C. (= 104° F.), a sensitiveness equal to about 23° W. will be easily obtained. When making such an emulsion, it is advisable to cool rapidly and wash rather quickly, as the digestion at such high temperatures has a tendency to give rise to frilling and blisters. Some manufacturers use chrome alum to prevent this frilling, and it is possibly due to this that some commercial plates require so long to develop and fix—not always a desirable feature. Chrome alum too is always faintly acid, and tends, therefore, to the lowering of the sensitiveness; this, however, may be avoided, I think, by neutralising it by the cautious addition of liq. ammonia, and, so far as I have been able to determine, this in no way affects the hardening action of the alum on the gelatine. On the other hand, if the chrome alum solution be rendered more than very faintly alkaline, there seems to be a greater tendency to fog. Practically, an addition of 20 parts of a 2 per cent. solution of chrome alum to every 1000 parts of emulsion will not be amiss, and it is advisable, if it is desired that the plates should keep long, to make an addition of 15 to 20 parts of a 1 per cent. solution of potassium bromide to every 1000 parts of emulsion; these additions must be made immediately before coating.

The Acid-Boiling Process. The disadvantage of not being able to obtain such a high sensitiveness, nor such great regularity

as with the ammonia process, rather places this *hors de combat*, one well-known writer even going so far as to say that it is impossible to obtain good plates by this process. Possibly the best answer to that is, that it is used by a well-known firm of plate makers to prepare excellent plates. The following is the process, devised by Mr. Wilson, which won a prize offered by Mr. Paget in 1880.

To make a pint of emulsion select a 20-ounce, narrow-mouthed stoppered bottle, with a well-fitting stopper and thin bottom Make it perfectly clean. Make a stock solution of

Hydrochloric acid (pure)	...	...	...	1 fl. drm.
Distilled water	...	...	...	12½ ozs.

Put into the 20-ounce bottle

20 minims of the above *dilute* acid.
3 fluid ounces distilled water.
210 grains ammonium bromide.
80 grains Nelson's No. 1 photo. gelatine.

Leave the gelatine to swell for, say, fifteen minutes or longer. In a clean glass vessel (beaker, measure, or flask) dissolve 330 grs. of nitrate of silver (re-crystallised) in 3 ozs. of distilled water. Pour out about 2 fluid drms. of this silver solution into another small vessel (say test tube), and dilute it to half strength with an equal quantity of distilled water. Take the 20-ounce bottle and the two lots of silver solution into the dark-room. Mr. Wilson prefers to use a large paraffin lamp, protected by one thickness of ruby and one of dark orange glass to two thicknesses of dark orange paper without any ruby. In the dark-room have a gas-boiling stove, and on it a tin pot or saucepan deep enough to contain the bottle when the lid is on. It should have a tin, perforated, false bottom to prevent the bottle resting immediately on the true bottom; or a piece of wire gauze will answer. Let the pot contain some 3 or 4 ins. in depth of *boiling* water. Turn out the gas of the stove, if alight, and plunge the bottle into the water two or three times, so as to avoid cracking it by too sudden heating; then leave it in for a few minutes until the gelatine is completely dissolved. Do *not* leave it in longer than necessary for complete solution. Take it out, shake up, remove the stopper, and set bottle down on the table near your lamp, so that you can

see what you are doing. Pour in, *all at once*, the 4 drms. of *dilute* silver solution. Put in the stopper, and shake up thoroughly, but not too violently, for about half a minute. Now pour in the strong silver solution in quantities of about half an ounce at a time, shaking as before after each addition, and, when all is added, give a final, thorough shaking for, say, a couple of minutes. Now put the bottle into the pot of hot water, see that the stopper is not jammed in, and put on the lid. Light the gas, and boil up as quickly as possible. If the water was previously boiling, and the gas only turned out for the mixing operations, it should boil up in less than 5 mins.; then keep boiling for 59 mins. At the end of this time turn out the gas, take off the lid, take out the bottle, and remove the stopper *at once*, or you will not get it out afterwards. The bottle must now be cooled down as quickly as is consistent with safety to the glass. In very cold weather it may stand on the table for 10 mins. or so, and then be cooled with water; or, in any weather, place it in a pan of nearly boiling water, and cool gradually by allowing cold water to trickle slowly in, shaking the bottle occasionally. Whatever method is adopted, it should be down to 90° F., or lower, in 15 or 20 mins. at the most. It cannot easily be made *too* cold, as the gelatine has lost its power of setting. In a glass beaker (about 12 or 14 ozs. size) put 1 oz. of Nelson's No. 1 Photographic or "X opaque" gelatine, and pour over it 10 ozs. of clean ordinary water. Leave it to soak until the gelatine has absorbed 4 ozs. of water, pour off the surplus 6 ozs., melt the swelled gelatine by immersing the beaker in hot water, and pour it into the 20-ounce bottle containing the cooled emulsion. Shake up well, and pour all back into the beaker, draining out the bottle thoroughly. Leave it to set in a cool place for 24 hrs. It has next to be washed. The *addition of the gelatine* after boiling should be made when the boiled emulsion and dissolved gelatine are *both* at as low a temperature as possible, and between the time of this addition and that of washing the emulsion it should be kept as cold as possible. For the washing clean ordinary water at a temperature cooled down to below 40 degs. by melting ice in it, should be used. In a glazed earthenware pan or other suitable vessel put about 3 pints of cold water, and add 3 ozs. of saturated solution of potassium bichromate (made by saturating clean ordinary water with the bichromate). Before squeezing the set emulsion

through the canvas it should be cooled down so as to be as firm as possible. The water into which it is squeezed will then remain almost clear, or but slightly milky. If the *emulsion be soft*, even though the *water* be ice cold, the water will be more milky, and the emulsion take up too much. Too much excess of acid bromide, too high a temperature at the time of adding the gelatine, or keeping at too high a temperature between adding and washing, will produce the same result. Having cooled the beaker of set emulsion down to 40° F., run a bone spatula or paper-knife round, and turn out the emulsion, or cut it out in lumps. If cold, it will come out almost quite clean from the glass. Place it on a piece of coarse "straining cloth" or canvas, and squeeze through the meshes into the water, the operation being performed under the surface of the water. Leave it so for an hour. Lay the straining cloth over the mouth of another pan or large jar, and pour the mixture of emulsion threads and liquid on to it so as to let the latter run through. Squeeze the emulsion a second time through the cloth into clean cold water, and immediately repeat the operation for a third time, leaving the emulsion in the last water for half an hour. When strained for the last time, place cloth and all in a large beaker, and put the latter into hot water until the emulsion is completely melted and warmed to about 115° F.—*i.e.*, not warmer than is pleasant to the hand. With a *clean* hand take out the cloth and squeeze it; very little will be lost. The emulsion should now measure about 16 or 17 ozs. Add 2 ozs. of alcohol, and mix thoroughly. The alcohol may be either pure ethylic alcohol, sp. gr. about ·830, or *good colourless* methylated spirit not containing petroleum. (See ALCOHOL, METHYLATED.) If the emulsion now measures less than 20 ozs., make it up to that by adding clean water. The emulsion is now ready for use. It should be filtered into the coating-cup through cotton-wool to free from bubbles, and plates coated in the usual way, dried and used as usual for rapid gelatine plates, using about an ounce of emulsion for a dozen quarter-plates.

Cold Emulsification.—This process is not very reliable, because the degree of sensitiveness depends solely, or to a great extent, upon the temperature of the air. Henderson's original process is as follows:—Allow 2 to 3 parts of gelatine to swell in 75 parts of distilled water, and then dissolve at a temperature of

50° C. (= 112° F.), and add 3 parts of pure carbonate of ammonia, then add 22 parts of bromide of ammonium and 3 parts of 10 per cent. solution of iodide of potassium. Finally add 200 parts of alcohol (92 per cent.) and 9 parts of solution of ammonia (sp. gr. = 0·91). Dissolve 30 parts of nitrate of silver in 150 parts of water, and now, in the dark-room, add the silver solution in small portions and with frequent shaking to the alcoholic bromide solution. The mixture should now be shaken frequently for two hours, the flask being closed by means of a cork, and the whole allowed to stand ten hours, or if made in the evening, till the next morning. Forty parts of Winterthur gelatine must now be covered with distilled water, allowed to soak for half an hour, and then, after pouring off the surplus water, it should be melted and added to the emulsion, which should be heated to 35° C. (= 95° F.). The whole must now be well shaken and poured out into a flat dish to set (and this should take place in an hour or two), and then broken up and washed. In the winter it will be difficult by this process to obtain a sensitiveness greater than about 15° W. after the emulsion has stood ten hours. In the summer, however, as high as 22° W. may be obtained, but there is a danger, if the emulsion is allowed to stand more than eight hours, of fog setting in, or of obtaining thin emulsions of no value in practical work. Henderson's original method was to pour the liquid emulsion into three or four times its quantity of alcohol, and stir with a glass rod ; when the emulsion adhered to the rod, it was removed, cut up, and well washed. Henderson has since suggested another process of making emulsion, which is somewhat similar to one proposed by Obernetter in 1882. We give the report of the lecture as printed in the *British Journal of Photography*, as some of the preliminary remarks are well worth reading :—

"Mr. Henderson then proceeded to give his promised demonstration of a perfect emulsion by a new method; but, before doing so, briefly dealt with some of the principal points in emulsion-making. It was important, he said, to have pure water ; he always experimented with distilled water, and recommended its use. A great many failures were due to impure water, and he read a list of the common impurities generally found in it, and pointed out that by employing ordinary water in

emulsion-making certain silver salts are liable to be formed in the emulsion, which are not amenable to some developers, and that, therefore, unequal results are produced. There were various way of making emulsion, and he enumerated and described some of them, among them the boiling processes, which, he considered, produced decomposition of the gelatine, and consequently fog in the image. Incidentally, on the question of the gelatine employed, he remarked that this substance often contained sulphurous acid, which would have an injurious action on the silver bromide. Then there was the precipitation process, in which no washing was required, as well as his own plan of emulsifying with ammonia, for which the late Dr. Van Monckhoven had often been given credit. He (Mr. Henderson) was the first to publish the method. The method he proposed to show them that evening consisted of the conversion of the silver nitrate into carbonate, and the introduction of the latter into a solution of bromised gelatine, or *vice versâ*. Thus the silver nitrate at no time came into contact with the gelatine. He then proceeded to convert a solution of silver nitrate into carbonate by means of a solution of carbonate of potassium, and, having dissolved the gelatine in a small quantity of water, added the bromide to it, and mixed the two solutions. The iodide, said Mr. Henderson, should be added after the bromide, as iodide of silver was formed quicker than the bromide. The emulsion was washed by being forced into shreds through a large mesh into a sieve placed in a jar of water, soluble salts being carried off by a metal pipe. He condemned the use of canvas, and said less washing was required by his method. Many failures were caused by impure rubber piping. He recommended the black kind; the red and grey varieties contain sulphur, which causes spots in the emulsion. He exhibited a small filter for water which he had found useful and effective; it was a tube about six inches long, with a piece of sponge at each end, and the centre filled with charcoal. By reversing the filter on the top it was self-cleansing. Mr. Henderson filtered his finished emulsion through wash-leather, hastening the process by pneumatic pressure. He then showed a coating mug, the emulsion passing through a piece of muslin; he usually had a piece of fine silver gauze. By this means he avoided bubbles. The action of the centrifugal separator in removing

the soluble salts was then shown. Concluding, Mr. Henderson said that, if he wanted an emulsion giving clear shadows and great density, he would convert the silver nitrate into acetate or citrate, instead of carbonate, and such an emulsion would do for line or lantern slide work. He strongly recommended that, in ripening by heat, uniform temperature and bulk of water be employed. He further said that impurities in chemicals must be guarded against, and mentioned the instance of a pupil of his whose bromide, when tested, was found to contain one-third of another substance, which the manufacturer subsequently admitted. Another pupil got spotty pictures, which he (Mr. Henderson) found to be due to the deliquescent iodide containing some sulphates. The formula he now recommended as a good base:—

Silver nitrate	120 grs.
Water	3 ozs.
Potassium carbonate	60 to 90 grs.
Water	3 ozs.
Gelatine	240 grs.
Potassium bromide	90 ,,
Potassium iodide	1 gr.

The gelatine to be dissolved in sufficient water, and the emulsion to be made up to fifteen ounces. He preferred to do without alcohol. A washed emulsion of this description, if treated with a solution containing two grains of potassium nitrate, one grain of potassium bromide, and half a grain of chrome alum in ten or fifteen ounces of emulsion, and allowed to stand at a temperature of from 80 to 90° for some hours, increased in rapidity, and also gave more density. If the salts are to be removed by the centrifugal separator, it would be necessary to have the bromide dissolved in a small quantity of gelatine, say fifteen grains, and then, when separation had taken place, the bulk of gelatine added; a still finer precipitate will ensue by the addition of gelatine to the formed carbonate of silver. In emulsions required for subjects of great contrast, more iodide and gelatine will be found advantageous."

There are several methods of washing emulsions but to the amateur emulsion-maker the simplest is to place the set emulsion

in the piece of canvas netting previously mentioned, to gather up the ends, and then twist the same and force the emulsion through the meshes, thus breaking it up into little nodules, or shreds, which, presenting a greater surface to the washing water, allow of a quicker extraction of the inert salts. The squeezing of the emulsion should always be done in distilled water, care being taken to wash both the hands and canvas well first, and rinsing the same in distilled water. In breaking up the emulsion in this way there is always some lost by adherence to the canvas, but not much; and where experimental batches of, say, 4 or 5 ounces only are made, the simplest plan is to cut the emulsion up, with a silver fruit-knife, into little dice, and then place these in a beaker of distilled water, stirring frequently during the course of an hour. If, however, it is inconvenient to give so much time to it, the simpler way is to collect all the dice on a piece of well-washed calico, gather up the loose ends and tie them together, and suspend the little bag thus made by the aid of a piece of string on to a glass rod; place this across the mouth of a decent-sized beaker or jar, fill the jar sufficiently full with distilled water to cover the bag, and leave it for an hour or two. The water filling the bag extracts the useless nitrates and excess of bromides, and being heavier than the pure water sinks to the bottom of the vessel, so that there is always a current of water less heavily charged, and the washing is mechanically performed. After about two hours of this soaking, the water should be changed, the bag being allowed to drain well before the vessel is refilled. Washing may thus be effected very thoroughly in from six to eight hours, or comfortably in a day. Twenty-four hours is not actually too much—in fact, very strongly recommended by Eder and other authorities. If a good supply of water is to be had, the washing may be performed by fixing the vessel under a tap, and allowing the same to run on it all night, but personally I think it is better to use distilled water even for washing the emulsion. There is one method of washing the emulsion which is, I believe, rarely used by commercial makers, and that is by the aid of alcohol, as was noted in speaking of Henderson's emulsion process. As soon as the cooking is finished, the still warm and liquid emulsion is poured into three or four times its quantity of alcohol, and well stirred round. The extraction of the unnecessary salts is not so complete and is more costly than when washing

is effected with water, but it is of advantage in saving time and there is less chance of frilling in the subsequent operations of developing, etc. After washing by this method, it is essential to allow the emulsion to soak in water for an hour, in order that it may absorb the necessary amount of water. When the emulsion has been sufficiently washed, it should be collected on a piece of clean and well-washed linen, allowed to drain, and gently squeezed so as to press out the superfluous water, then collected and melted by placing it in a beaker or other convenient vessel, which should be placed in a water bath. Care should be taken not to heat the emulsion too much, or else it will become fogged and useless, and the more rapid the emulsion the less heat it will bear in this second melting. However careful has been one's method of preparation and washing, one is never certain that the emulsion is free from mechanical impurities, such as little bits of fibre, hair, etc., and it is therefore advisable to filter the emulsion before use. For this purpose, flannel, felt, or wash-leather may be used, and whilst the flannel is the quickest to allow the emulsion to pass, leather is the most effectual. Personally, I always use a felt filtering bag, such as may be obtained from any chemist to order, about 2*s*. for a pint size, which will be too large for most amateur workers, as the bag absorbs too much emulsion, but the bag may easily be cut down to half its size. If wash-leather be used, it is necessary to wash it well in weak soda solution first, about 1 in 20, to free it from the natural grease, and then wash thoroughly to free from the soda. When the emulsion is perfectly fluid, it should be poured into the bag, presuming the felt bag be used, or into the wash-leather or flannel stretched on a filter. When the felt bag is used, it is only necessary to suspend it by its ring from a retort stand, or any convenient makeshift, and thus less emulsion is lost, and it does not get cold quite so quickly. Gentle pressure on the top of the bag soon forces the emulsion through. With wash-leather it is almost necessary to have some pumping arrangement, and this may be either the ordinary indiarubber balls as used for spray diffusers, or the more powerful brass force pump used for filling pneumatic cycle tyres or footballs. When leather or flannel is used, the most convenient filtering apparatus I have found to be a small glass percolator, a utensil known to every chemist, and this fitted with a cork to the upper part or body allows one to

affix the forcing arrangement. It is advisable before using the emulsion for coating, to add some bromide, and a little chrome alum to the emulsion, the latter especially when the process adopted has been the ammonia boiling process, as this addition prevents fog and frilling. A 1 per cent. solution of bromide of ammonium, and a 2 per cent. solution of chrome alum should be made, and 1 oz. of each should be added to every pint of emulsion. The addition of chrome alum lowers the sensitiveness slightly ; at least, so it is said, and certainly I think it does, but there are no ill effects if the chrome alum be rendered neutral by the cautious drop by drop addition of solution of ammonia. The addition of the chrome-alum solution should be made to the emulsion very gradually, with shaking between each addition, and this addition may be made either before or after filtration, preferably after. Many workers add a little alcohol to the emulsion, to make it flow over the plates ; and it is, I think, to be recommended when coating is to be done by hand. One part of pure rectified spirit of wine to every twenty parts of emulsion is the right proportion. The necessary utensils for coating plates may be either very simple, or more or less elaborate, according to the operator's ideas. The one absolute essential is a levelling stand, and if we are going to coat any quantity of plates, a good-sized sheet of plate glass and a level. All these may be bought from any photographic dealer, or the glass alone obtained from any glass warehouse. Sheets of glass of the necessary size, we need not say, are also essential. The glass on which the emulsion is to be spread should be well cleaned, and for this purpose tripoli made into a paste with methylated spirit may be used, or prepared chalk made into a thin cream with water. After rubbing the glass well with either, it should be rinsed in tepid water, then well rinsed again in hotter water, and given a final rinse in hot water, when it may be placed in a rack to drain, and, if thought necessary, polished with a soft wash-leather, which has been freed from grease by washing in soda. When the glass is cleaned, each piece should he taken up by means of a pneumatic holder, which may be obtained from any photographic warehouse, and examined for flaws and large bubbles ; all defective pieces being rejected. The glass should be piled together and heated by being placed in an oven or before the fire for a little time. It must not, however, be made too hot, only just pleasantly warm,

so as not to chill the emulsion when it is poured on. A measure may also be used by the amateur in his first trials to measure out the quantity of emulsion, but with a little practice one is soon accustomed to pouring out about the right quantity. The method of coating depends upon the size of plate; with small plates—for instance, half and quarter plates—it may be poured into the middle of the plate, which is supported by the pneumatic holder, and then the emulsion made to run to the four corners by tilting the plate as when coating a plate with collodion. This, however is not a very easy matter, and it is far simpler to pour the emulsion in a line right across the plate, and spread by means of the simple little distributor shown in fig. 39, which is a piece of glass rod, not tubing, bent to the above shape in a Bunsen flame; this is placed in hot water till quite hot, wiped dry, and then the emulsion is spread with it, the plate being on the plate of glass on the levelling stand. Mr. W. K. Burton, in his well-known and excellent little handbook "Modern Photography," describes a different method of coating, which I have used with success, and as I have also one of the drying boxes he describes, I give the extract from the book entire.

"There are several methods of coating plates in common use The best for those who have the skill is the method used for coating with collodion, and which we describe; but we imagine most of those who have not worked the wet process will find the plan which has been used for some time by the writer, and which is also described, the most convenient. For the ordinary method the apparatus necessary is as follows:—

"A small teapot. A large flat dish of the nature of a porcelain flat bath to catch spillings. A pneumatic holder. This is an india-rubber ball with sucker attached, the whole forming an apparatus whereby it is possible to pick up a plate.

"In coating by the ordinary method, it is advisable to have two ruby lamps, one placed at the back of the operating table, the other in front of the operator, and above the level of his head. He can thus see the emulsion on the plate, both by reflected and by transmitted light. The flat dish is placed between the lower light and the operator; the teapot full of emulsion, melted, and at a temperature of 120° F., or thereabout, may be placed on this dish, and the plates, *polished side downwards*, are placed to the right of the flat dish.

"The pneumatic holder is taken in the left hand, which is stretched across the flat dish, to take hold of a plate. The plate is held level, and a pool of emulsion is poured on to it, and guided over it exactly as was described for varnishing a plate. The only difference is that more than half the plate is at first covered with emulsion, and that, instead of the plate being drained, it is only slightly tipped up, so as to let a little of the

Fig. 38.

emulsion return to the teapot. After this is done, the plate is gently rocked for a few seconds, till we see by looking through it that the coating has spread evenly. To tell whether the plate has had enough emulsion left on it, we look through it, after it has set, at one of the ruby lights. If we can see the form of the light through the film, there is not enough emulsion on the plate.

"The plates, as they are coated, are placed on the levelling

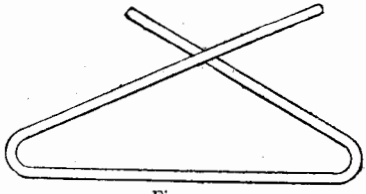


Fig. 39.

slab to set. Some emulsion is sure to be spilled into the flat dish. It is allowed to set, is then scraped up with a strip of glass, and remelted. For the method of coating which we recommend to those not skilled in the wet process the pneumatic holder is not required. It is necessary, however, to make a small tripod. This is done by gluing three somewhat large-sized shot on to a quarter-plate in the form of a triangle, (see fig. 38).

"There is also needed a glass rod about two inches longer

than the width of the plate to be coated, and a jam pot or glass measure in which to stand the rod. The dark-room lamp is placed within a few inches of the left-hand end of the levelling shelf, and to the back of it. There is to the left of the lamp room only for the pile of plates, which in this case have the polished side upwards. The rod standing in the jam-pot is to the right of the lamp. The teapot with emulsion in it, as before, is in front of the lamp, and farther forward still, near the front edge of the slab, is the small tripod mentioned. A plate is taken from the pile, and placed on the tripod.

"A pool of emulsion, about half covering the plate, is poured from the teapot. The glass rod is taken between the fingers and the thumb of each hand, and dipped into the pool of emulsion right across the plate. The emulsion will run between the rod and the plate to each edge of the latter. By a motion of the

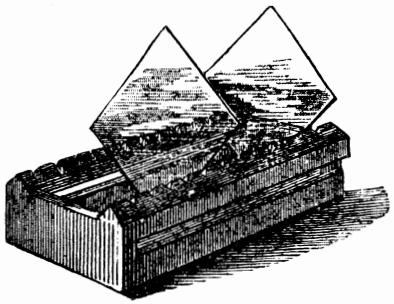


Fig. 40.

finger and thumb of each hand, the rod is lifted the smallest possible distance from the plate, and is rapidly moved first to one end, then to the other, the tips of the finger and thumb resting on the level table as a guide. This, if properly done, will cover the whole plate with emulsion; and if the plate be small—half-plate or under—it is sufficient to send it to the far end of the table to set. If the plate be large, the coating will not be evenly spread unless it is lifted, balanced on the tips of the fingers of the left hand, and rocked gently for a few seconds. By this method the plates may, after a little practice, be coated with great rapidity. There is no need to wipe the rod each time it is used.

"As no excess is poured off the plate nor spilled in this method, it is possible, by using a very small teapot, to keep a constant check on the quantity of emulsion going on to the plates. The covering power of the slow emulsion will be found somewhat greater than that of the rapid. With each ounce of the slow emulsion, eight quarters or four half-plates may be coated; with the rapid, only seven quarters or three halves.

"The plates will 'set' in a few minutes—that is to say, the emulsion will stiffen like a jelly, and will not run off the glass, whatever position it is placed in. They are now transferred to the drying box. When dry, they are ready for use.

"The drying box calls for some description. There are various forms in use. They all have in view the inducing of a current of air among the plates generally by the burning of a gas jet in a tube or chimney. The fault of most is that the air passages are far too contracted. In many, heat is applied to the incoming air. This is quite unnecessary if the air passages are sufficiently large and well arranged, and if the box can be placed in a fairly dry place. It is, moreover, the greatest mistake to use artificial heat in drying plates, if it can possibly be avoided, as they are rendered distinctly slower thereby.

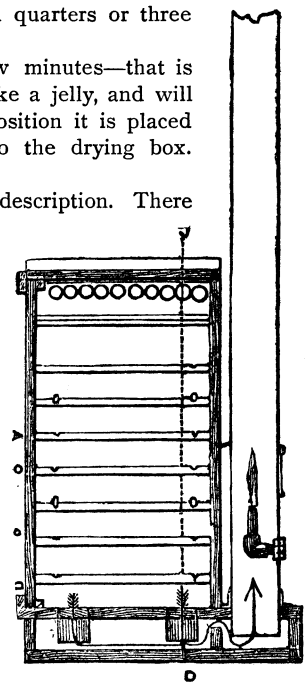


Fig. 41.

"We illustrate (fig. 40) a form of box which has been in use by the writer for several years, and has given complete satisfaction. It will be seen that the air enters at the top of the box. It is drawn into an air chamber at its lower portions, and hence passes up the large tube with a gas flame burning in it. This tube must be carried either into the open air or into a chimney. The plates are placed in racks, which were first designed by Mr. G. F. Williams. A sketch of one of these is given (fig. 41).

Two plates may be placed back to back in each pair of notches if desired. The racks may be placed on the cross rods shown in the box, the height of which may be adjusted to suit various-sized plates." As an alternative method of drying plates, the following may be adopted, and it is one which personally I prefer to that suggested by Mr. Burton. All that is required is an air-tight box and some anhydrous calcium chloride. The plates to be dried should be merely placed in racks in the box, and a porcelain dish, as large as the box will hold, in the bottom. In the dish place the anhydrous chloride of calcium, put the dish in the box, the racks containing the plates, and shut the door, or lid, and leave for three days, by which time the plates should be perfectly dry. In no case should the box be opened till a reasonable time has elapsed, or else peculiar markings will be caused, due to unequal drying. When the calcium choride has once been used, it should be heated in an oven till it swells up and becomes perfectly dry. The disadvantage of drying by air alone is that the rate of drying is proportionate to the amount of moisture in the air, and that the unequal drying caused by a fall in temperature may give rise to marks which are absolutely irremovable and show in the finished negative.

Enamel Ceramic Photographs. Photographic images may be vitrified on porcelain and coated with a porcelain glaze, which makes them permanent as against fading. Enamels are usually prepared on small copper plaques, which are coated with a special material, which may practically be considered to be very soft milk-white glass, and by no means so unalterable as a true porcelain. Metal plaques already prepared can be obtained commercially. On these an image is laid and fired. There are several processes—(*a*) the substitution process, (*b*) the powder process, (*c*) the pigment or carbon process, (*d*) the collotype process. For the substitution process a collodio-chloride printed-out positive is prepared and fixed. The image is toned with platinum, gold, palladium, iridium, or a selected mixture. The positive is then stripped, transferred to the plaque, and carefully smoothed out, and then fired, coated with glaze, and refired. The powder process is the preparation of a positive by the powder or dusting-on process on a sheet of glass, coating it with collodion, stripping, and transferring to the plaque, and firing. The pigment

process is merely a modification of the carbon process, gum arabic instead of gelatine being sometimes used as the material; it is transferred and fired. The collotype process is sometimes used for preparing the image, a special ink being used and the print being on litho-transfer paper, from which it is transferred to the plaque. It is impossible to enter fully into the subject, and enamel or ceramic processes are very little used at the present day. Recently Mr. Grundy, of Derby, has applied the principle of multiple impression to collotype work on tiles. The collotype plate is inked with a fatty ink containing an ordinary underglaze pottery colour, and impression after impression is made on the unglazed tile; suitable precautions being taken to keep exact register. The tile is then fired and glazed like an ordinary piece of pottery. (See COLLOTYPE.)

Enamel Collodion. See ENAMELLING PRINTS below.

Enameline. Method for process blocks (see FISH-GLUE PROCESS).

Enamelling Prints. This consists of coating the finished print with a film of collodion to give it a brilliant surface, which gives greater protection and more softness and depth. The following is the method of procedure:—Clean a glass plate—an old negative glass or a cutting shape will do—with French chalk, and polish thoroughly; now coat the plate with enamel collodion:—

Pyroxyline (tough)	10 grs.
Methylated Alcohol	1 oz.
Ether	1 ,,

Having made a solution of gelatine, 10 grs. to the ounce of distilled water, slip the collodionised plate and the print carefully into the solution of gelatine, avoiding air bubbles; bring the print face downwards into contact with the coated plate, remove from the solution, and squeeze into optical contact, and allow to dry. When thoroughly dry, raise one corner with a knife, and the print will strip from the glass, bearing the collodion film with it. (See also some instructions under BROMIDE PAPER.)

Encaustic Paste. A paste used to give a brilliant surface to the finished print without the use of hot rollers or of collodion.

There are several formulæ; but the following, proposed by Salomons, is excellent:—

Pure white wax	500 grs.
Gum elemi	10 ,,
Benzole	4 drms.
Essence of lavender	6 ,,
Oil of spike	1 drm.

Melt the wax and elemi, add the benzole and other ingredients, and allow to cool, stirring frequently. Smear a little of the paste over the face of the print with a tuft of cotton-wool, and polish with a clean piece till the surface is clean from markings. It increases the depth of shadow and general beauty to a large extent. A more simple paste can be made as follows:—

Dr. Eder's Cerate Paste.

Pure white wax	100 grs.
Dammar varnish	40 mins.
Pure oil of turpentine	100 ,,

Prepared and used as above described.

Endemann's Process. See ANILINE PROCESS.

Engraving Methods, Photographic. See PHOTOGRAVURE, FISH-GLUE PROCESS, GALVANOGRAPHY, DAGUERREOTYPE (etching of), OBERNETTER'S PROCESS, ELECTROTYPING, etc.

Engravings. Discoloured to bleach for copying. (See BLEACHING.)

Enlarging is the operation of obtaining a larger image of a negative or positive upon some sensitive surface. There are several methods of doing this, either by the use of daylight or artificial light, which will be severally described. But it is first necessary to make a few remarks upon the negative used for this purpose. Sharpness of focus is very necessary, for, supposing a quarter-plate negative taken in the ordinary way is to be enlarged—it may be considered that the discs of confusion appear as points of less than $\frac{1}{100}$ of an inch in diameter, a point inappreciable to the human eye; but if these said discs of confusion are enlarged, they will become of appreciable size—viz., enlarge a quarter-plate to 12 by 10, or three times, and these

discs of confusion will be enlarged in the same ratio; therefore they will be about $\frac{8}{100}$ of an inch in diameter, and will be easily seen. Again, the negative should be plucky, and with good, but not too great, contrasts, and of fair density; in fact, a good silver printing negative will give a good enlargement. For convenience sake we may divide our apparatus into two classes; first, that required for daylight enlarging; and, secondly, that required for artificial light. We may again subdivide our two classes into minor sub-classes: thus, daylight enlarging may include (1) Solar work, (2) Diffused light; and artificial light includes (1) Lantern work, including the use of condensers; (2) Work without condensers. Then, again, we may use petroleum, gas, enriched gas, limelight, or magnesium; these, however, will be described as we go on.

Daylight Enlarging.

(1) *Solar Work.* By this term we understand the use of the solar rays themselves, and not their light reflected from any card or white surface. Although this was one of the first processes employed before bromide paper was invented, and was used for printing on ordinary silver paper, carbon tissue, etc., we shall dismiss this in a few words, because the apparatus is costly, and sunlight, unfortunately, not always available in our climate. For this work Woodward invented his solar camera, and Monckhoven improved upon this with his dialytic apparatus, other instruments also being made for the same purpose. Large condensers are absolutely necessary, not less than nine inches in diameter, and the solar rays have either to be kept motionless by means of a heliostat, or mirror mounted equatorially and driven by clockwork, or else by careful and attentive work of an operator. As, however, equally good results can be obtained by using the apparatus described hereafter, no further description will be given; but, for the information of those desirous of spending their money, full and complete instructions will be found in Monckhoven's "Optics."

(2) *Enlarging by Diffused Daylight.* By many this will be found the most convenient and cheapest method of making enlargements; but as to whether it is the best is altogether another question, which we shall consider later on at the end of the instructions for both methods of illumination. We have here

also what may be practically considered as two distinct methods of working, the one using the actual light of the sky itself, and the other using reflected skylight. Before entering into particulars of either method, however, there are one or two details which it is advisable to elucidate. We may decide to use a darkened room or a special camera for the purpose of obtaining the enlargement, and the necessary arrangements will now be described. If we desire to use a darkened room, such as an ordinary sitting-room, it is obviously necessary that the light shall be prevented from having access to it by some means or other; therefore we will suppose that the room has one window, which, if possible, should face the north, and it is desired to

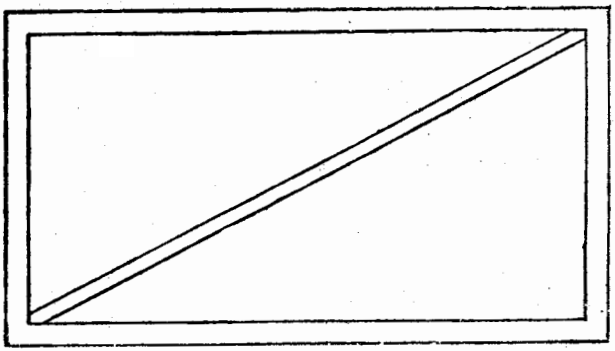


Fig. 42.

block out this window temporarily, so that the room may be afterwards used in the ordinary way. It is obvious that pasting brown or non-actinic paper on the panes of glass is not admissible; therefore we must have recourse to some other arrangement which can be temporarily applied and bodily removed when done with. A convenient contrivance, which can be very cheaply put together by any one possessing a little knowledge of carpentering, may be made, or a working carpenter may construct it in a few hours at a trifling charge. To make it still plainer we will take an actual example made for our own use. The window which it was requisite to block up measured six feet by four feet, and, like most windows, was divided across

the middle by a double sash. The sashes of the window measured at the sides one inch in breadth; at the top and bottom, two inches. Two frames were therefore made, one to fit into the upper part of the window, and one into the lower; the upper frame is shown in fig. 42, the lower in fig. 43. The frames were made of deal half an inch thick and two inches wide: the upper one, fig. 42, had a crosspiece to strengthen it, which was also convenient to lift it up by; the lower one, fig. 43, had two crossbars to strengthen it, and which were also used, as described hereafter, for the reception of the negative. We have now the skeleton, and it is only necessary to clothe it to make it a complete and useful piece of apparatus. For this purpose stout, dark-brown American cloth, which is a kind of coarse canvas covered with some coloured waterproof substance, was chosen, and this was tacked on to the upper frame, and the edges brought round to the back of the frame so as to exclude

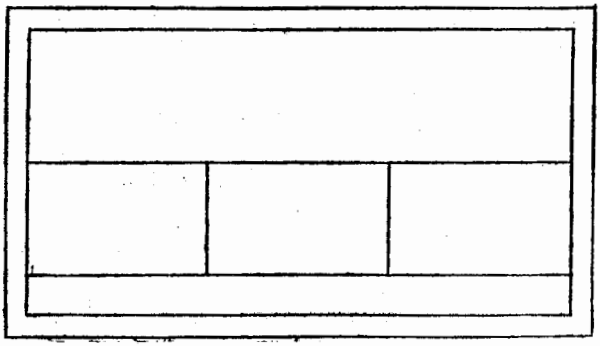


Fig. 43.

any stray ray of light which might otherwise creep in; the shiny side of the cloth was at the back, the woolly side being towards the window. To make absolutely certain that no light penetrated the cloth, ruby paper was pasted on the woolly side of the cloth. At the edges of the frame, where it touched the sashes of the window, a double thickness of woollen list was tacked; so that, when the frame was inserted in place and secured at the top by a turn button and at the bottom by the catch of the window,

there was sufficient pressure on the frame to make it fit up close to the sash and exclude all light. The lower frame was treated in the same way, with this exception, that an aperture was cut in the cloth, and the edges then nailed to the little crosspieces, where the negative is afterwards placed; when these two frames are fitted into the window and the aperture blocked up, there should be no stray streaks of light anywhere. Brown paper, of course, may be used instead of American cloth, but the latter is much more durable, and less likely to suffer accidental damage by the fingers being put through it. Now, let us see as to using a special camera, so that we may not need to darken the room. To make a camera which shall answer this purpose is evidently not very difficult, and we will give an idea on the subject and leave our readers to work out the details themselves. The operator's own camera and lens may be used, and a makeshift arrangement consisting of black silesia running on iron rods, and fitting on to the lens at one end, and bearing a focussing screen and a dark slide to hold the sensitive surface at the other. We have seen earlier that we may use the actual light of the sky itself, and this is shown also in fig. 44, where the camera is presented to the sky. If we are using a darkened room, then the camera must be tilted in the same manner; this may have some advantages, which in our opinion are outweighed by the extremely awkward manner in which the camera has to be sloped, the sensitive surface, of course, having to be parallel with the negative. We come back,

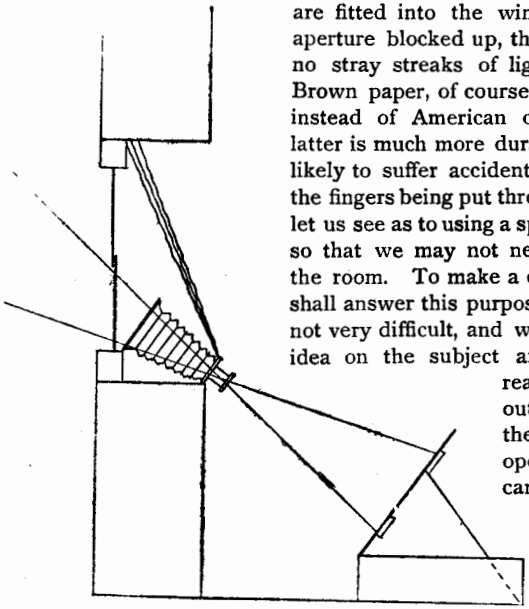


Fig. 44.

Fig. 45.—*r*, reflector; *ww*, window; *n*, negative. Showing also the method of vignetting an enlargement.

therefore, to the method of using the reflected skylight, and fig. 45 will show us how to arrange the whole apparatus. We have described the method of blocking-out the window. The method of placing the negative in position, if more than one size is to be enlarged from, is by the use of carriers as used in dark slides, which should be provided with little buttons for fastening in place, and springs for holding the negative, these said carriers fitting into the aperture in the window. Or the negative may be placed in the dark slide of the camera, and the slide inserted in the groove in the ordinary way, and the shutters of the slide pulled out so as to allow of the free passage of the light through the negative. The camera must be pushed close up to the negative, or a cloth so arranged that no light enters the room but that transmitted through the negative. It is not, of course, absolutely necessary that the camera should be used actually. All that is necessary is a board to support the lens, the focussing cloth or a black sleeve to prevent all light but that transmitted through the negative from having access to the sensitive surface. It will be found convenient if the camera or the lens and easel or board for the support of the sensitive surface be on the same level, so that a board or table may be used, as seen in fig. 46, to obtain this end. The table or board should have two parallel pieces of wood nailed to it, so as to enable the camera and sensitive surface to be kept exactly parallel. The next question is the reflector (see fig. 45) outside the window. Many operators use a mirror for this purpose, but the objection to this is that a dark and a white cloud passing simultaneously over it, or actually the image of the clouds, will cause unequal illumination of the negative, and consequently unequal illumination of the enlargement. Certainly a mirror gives the greatest illumination. In place of the mirror, a sheet of white cardboard, enamelled iron, or opal glass may be used. The operator will make his own choice in this matter. The reflector must be fitted at an angle of 45° outside the window; and a cord fastened to the top of it, and passing through the sash at the middle of the window, will keep it in position, and enable it to be raised or lowered at will. We use a sheet of opal glass mounted in an old picture frame, which is, hinged at the lower end to the bottom of the window sash, and fastened by a cord at the top to the middle of the sash; a gimlet

was used to make a hole in the sash, and the cord run through and rendered taut by a turn or two round a stout nail. The reflector, no matter what material it is made of, must be sufficiently large that, when the eye is placed at the position of the lens, and the negative removed, nothing but the reflector can be seen through the aperture in the shutter. The only point now needing a little elucidation is that of the easel or other support for the sensitive surface. This may actually be an easel, as offered by some commercial firms. We use an arrangement of a large printing frame measuring 24 by 20, which carries a sheet of plate-glass puttied into the rebate. Behind this is placed the ground-glass focussing screen, the centre of which is ruled in small squares of half an inch with lead pencil, and then varnished with crystal varnish for a space of about the size of a quarter-plate; this is used with a compound focusser for obtaining microscopically sharp enlargements. The ground side of the glass is next to the plate-glass, and consequently facing the lens, just as in an ordinary camera; the ground-glass is held, at the sides by two small studs, as used for the interior of dark slides. The printing frame fits into a specially made stand, which runs on a couple of parallel pieces of wood on the table, and is instantly clamped at about the right distance from the lens by lever cams, fine focussing being adjusted by means of a short rack and pinion. The above arrangement is, of course, a little more elaborate than actually required, as a printing frame supported in any way so as to be absolutely steady when placed upright, and also parallel with the negative, is sufficient. What is the best lens for enlarging? is a question we often see asked. Well, the answer is very easy—viz., that lens which took the negative. But this answer requires a little modification. If the negative to be enlarged is a portrait, then a portrait lens may be used; but the back lens of the combination must be placed next to the negative. The most useful lens is undoubtedly the doublet of the rapid rectilinear type, as it gives, as a rule, excellent marginal definition. As ingle or landscape lens may also be used, but from the necessity of using a smaller diaphragm it is obviously slow.

Apparatus for Enlarging by Artificial Light.

To most amateurs, especially those engaged in business during the hours of daylight, artificial light is the only one they can

employ for enlarging; hence considerable attention will be paid to this. We, first of all, as already suggested, divide our lights into petroleum, or mineral oil, gas, enriched gas, limelight, magnesium, and the electric light; and we shall endeavour to describe the arrangements for all, but must premise that the first essentials for successful work are that the light, no matter what kind it is, must be, first, small in dimensions, and, secondly, actinic in quality; the first gives greater sharpness, the latter short exposures.

Mineral Oil Lamps. Opinions differ as to the best form of lamp for enlarging, most, if not all, commercial apparatus being provided with lamps having flat wicks turned endwise to the condensers. Here again we find a divergence of opinion, some preferring two-wick, some three-wick, others four-wick lamps; generally, however, three-wick lamps are used. We have used, with good results, however, a round-wick lamp, or so-called Argand burner, this being actually a Defries lamp of forty-candle power. The burner of this lamp is circular, with an air passage up the centre, and has a chimney of glass contracted just above the burner, and above the contraction the flame appears intensely luminous and solid; it is at this point that the flame should be used. For this purpose it is necessary to provide the lamp with an outer case of brass or tin, which may be fitted in position and slid up and down, without in any way touching the glass chimney. The tinned sheet-iron is carried up above the glass chimney for some distance so as to lengthen the chimney, thus creating more draught, therefore more perfect combustion of the oil and a more actinic light. The outer sheet-iron case is provided with an aperture, circular, of half an inch diameter; and, on looking into this, nothing but an intensely luminous circle of white flame is seen. No matter what lamp is used, the circle of illumination thrown by the objective should show no lines of variable illumination. The most important thing in all illumination is to have the radiant a point, otherwise we are troubled with parallax, varying illumination, and want of sharpness; but, provided the degree of amplification be not too great, this trouble will not arise.

Gas and Enriched Gases. Ordinary gas, unless of good quality, is not so suitable as gas enriched by the vapour of some hydrocarbon. The commercial form of albo-carbon will be found very suitable. Mr. Traill Taylor has suggested a very convenient arrange-

ment, " which consists of two fish-tail burners separated from each other by the extent of an inch, both flames having their flat sides towards the condensers, there being an opaque disc, with a circular aperture in it of a little over half an inch in diameter, placed as close as possible up against the foremost flame so as to reduce its effective area. The position of this aperture must be such as to be opposite to the most luminous part of the flame. The second flame behind the anterior one serves to confer intensity, and is of great utility; but nothing seems to be gained by a third burner. The gas flame, when thus enriched by the so-called albo-carbon (naphthalene), is very intense. An Argand flame from gas thus enriched ought to yield a light of great excellence, provided it has a smaller flame ascending through its centre, and that provision is made to condense it by diminishing its diameter, either by a brass solar cap to cause a strong current of air to impinge upon the flame a little above the burner, or by a contraction in the glass chimney. Whiteness and intensity in such a case are increased by a judicious lengthening of the chimney to increase the draught. The area of the flame must, however, be reduced by the expedient already pointed out." The Welsbach or Incandescent gas burner is one particularly adapted for enlarging, as the light emitted is exceptionally rich in actinic rays, and the exposure thereby considerably shortened. In some experiments in connection with this light we found that with the ordinary household gas supply the exposure was cut down to one-quarter of that with an ordinary three-wick lamp.

nelight. This is, of course, one of the most convenient of all sources of light, and is so well known as to need but little description.

Magnesium. So far as we know there is no commercial apparatus for utilising magnesium as an illuminant with condensers, though of course it would be quite possible to utilise any ordinary enlarging lantern with a clockwork arrangement for feeding the magnesium to a small spirit flame, so as to keep the radiant point at one particular distance from the condensers.

The Electric Light. Few amateurs, or even professionals, can afford the necessary outlay for this light, the cost of even a primary battery or accumulators being considerable. In many parts of London, however, the wires for electric lighting are now

laid along the principal thoroughfares, and it would be easy to connect. The apparatus for enlarging by artificial light bears some resemblance to the ordinary or so-called magic-lantern. It is immaterial of what nature or substance the body of the lantern is, provided it be light-tight and strong. Russian or sheet-iron, copper, or wood with metal lining—all are used by commercial firms. The enlarging apparatus practically consists of a camera attached to an optical lantern, focussing being effected by rack and pinion. We need make no further mention of these, except that we shall later give a sketch showing how an ordinary magic-lantern may be adapted for enlarging.

The Condensers. The function of the condenser is to collect the rays of light and refract them through the negative. The usual form of condenser employed is two plano-convex lenses placed side by side, with the convex surfaces nearly touching. The first question to decide in purchasing an enlarging lantern is, What size condensers are required? as the size of the condensers governs the price. It is a question which has often been asked by beginners as to what size condenser will cover a certain-sized plate. This is by no means difficult to decide. All that it is requisite to do is to measure the diagonal of the negative in question, and this diagonal will be the diameter of the required condenser. In practice it is always advisable to allow an extra quarter or half an inch where this does not add too much to the cost. Mr. Hughes has introduced a rectangular condenser. In selecting condensers, the most important points to note are, first, to see that they are as free as possible from colour; secondly, that the one next the negative is free from air-bubbles and striæ; thirdly, that they are not set too tightly in their mountings, or when heated from the light they will crack.

Enlarging by Artificial Light without Condensers. This is a procedure which will commend itself to many an operator, because the necessary apparatus may, in many cases, be constructed up from odds and ends in odds and ends of spare time. Thus we utilised an old square sugar case which cost 4*d.*, and the sheet-tin to line it 9*d.*, the lamp 15*s.*, odds and ends, such as screws, ground-flashed opal glass, another 2*s.*; so that for 18*s.* an enlarging apparatus was obtained, which worked well for over two years. As condensers are usually rather costly, the following ingenious arrangement, which dispenses with them altogether

may be utilised; it is suggested by Major Barrington Baker, in the *British Journal of Photography* for 1888. Fig. 47 on next page is a rough reproduction of Major Baker's diagram, and the following *précis* is given of his directions. The case is made of ½-in. deal, with a hole, N, 6¼ by 4½ for negative, or made the size desired. L, a Belge lamp of 42-candle power, is placed in the case through the door D, half a dozen holes (A A) being bored in the bottom of the box for ventilation. An opal globe is used to diffuse the light; the negative is placed film side outwards in a rebate at N, and held in its place by two small turn-buckles; the camera may be used, or a specially made pair of bellows. The exposure is, of course, prolonged with rapid papers, being from 10 to 15 mins. The author would suggest as an improvement upon this that the case be lined throughout with tin, and a sheet

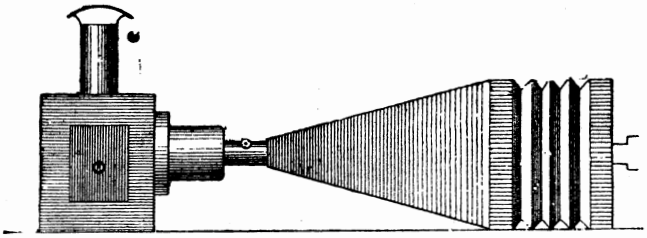


Fig. 46.

of ground glass or opal be placed before the negative, and that a parabolic reflector be used. Some of the modern cameras will be found utterly useless for enlarging, the pull of the bellows, or the greatest distance they will stretch, being very short; then the following arrangement, now used by the author, will take their place:—Obtain some black twill, 1 yard in width and length, and cut it into four pieces in the following manner (it is better to cut paper pattern first, in case of error):—Fold the cloth in half, and again in half, so as to give four pieces 9 ins. wide and 36 ins. long; now cut two slanting strips from each, commencing at 2 ins. wide, and narrowing down to the other end; this will give four pieces of cloth 36 ins. long—9 ins. wide at one end, and narrowing to 5 ins. at the other. Have these sewn together by the edges, so as to form a conical sleeve, which will take the place of bellows 36 ins. long. At the wide end nail a

frame of wood large enough to take the negative, and at the narrow end a piece of wood to take the lens, or the camera front may be utilised for this purpose. It will not be necessary to pleat it like bellows, but it can be finely pleated at intervals, and safety pins used to hold the pleats together when required to shorten the distance, so the pleats can easily be let out when required, or pieces of elastic can be run along the edges to serve the same purpose. The possessor of a magic-lantern can easily utilise that, no matter what size the condenser, if a sleeve of black cloth is made to fasten at one end round the lantern

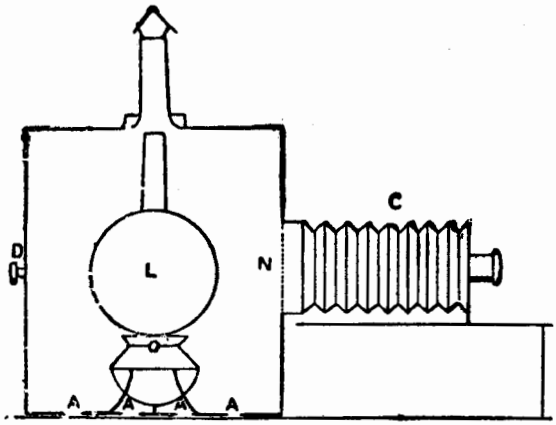


Fig. 47.

objective and at the other to the camera, the negative being placed in the position of the focussing glass of the camera. Where the operator can utilise gas or several oil-lamps it is only necessary to place between them and the negative a sheet of flashed opal glass ground on the flashed side, or a piece of ground glass coated on the ground side with an emulsion of sulphate of baryta in gelatine or of finely sifted carbonate of lead. When using an ordinary lantern it is absolutely necessary that no stray light should find its way out of the same; therefore it is nearly always necessary to enclose it in an outer box. This is a point which requires careful attention, or foggy, degraded whites will ensue in the resulting enlargement.

Focussing.

It may be taken as an accepted axiom that the nearer the light is to the condensers and the nearer the condensers to the negative the greater will be the illumination, and the greater the distance between the lens and sensitive surface the less the illumination; or, in other words, the larger one enlarges, the longer one must expose, everything else being constant. There is one precaution necessary when using condensers, or even artificial light of any kind with condensers, and that is, to see that everything is gradually warmed. Don't turn your light on full power at once, and place it close up to the condenser, and then be surprised if your condenser cracks. Warm everything gradually by having your light low and some distance from the condenser, and gradually reduce the distance and increase the light. It will be obvious to the merest tyro in enlarging that the farther the lens is from the sensitive paper the larger the image, and *vice versâ*; and also that there are certain distances which bear a certain relation one to the other, so that when enlarging, the distance between the negative and lens and lens and sensitive surface bear a strict relation to one another. The approximate distance between the negative and lens and lens and paper may be found from the following formula :—

$$(1)\ d = f + \frac{f}{n}.$$

$$(2)\ \mathrm{D} = (n + 1)f.$$

Wherein d = the distance between the negative and lens.
D = the distance between the lens and sensitive surface.
f = the equivalent focus of the lens.
n = the number of times of enlargement.

Or to the non-mathematic mind we will put it in another way. To find the distance between the lens and sensitive surface, add one to the number of times (linear measurement) the negative is to be enlarged, and multiply by the focus of the lens. To find the distance between the lens and negative, divide the product of the above calculation, or the distance between the lens and sensitive surface, by the number of times of enlargement, and the quotient will be the distance between negative and lens. For example, it is required to enlarge a quarter-plate negative to 16 × 12 with a 6-inch lens. 4¼ × 3¼

enlarged to $16 \times 12 = 4$ times (linear). The distance will be then approximately $(4 + 1) \times 6 = 30$ inches, between lens and sensitive surface. To find the distance between lens and negative $30 \div 4 = 7\frac{1}{2}$. To save trouble, however, there are well-known tables which have been calculated for enlargements with lenses of varying foci, and the Table of Enlargement or Reduction, given on the next page, is based on the principles already explained, and is convenient for ready reference. The distances given in the tables will be found to be approximately correct; but in all cases accurate focussing should be obtained by adjustment of the screen or lens by rack and pinion. Whilst many operators are content to use merely a white piece of paper, and to focus from the front, it will be found far preferable to use the ground-glass screen and compound focusser above described. In all cases where marginal definition is defective, stops or diaphragms must be used, exactly as in field work. Having obtained a sharp focus, the next operation is placing the sensitive paper in position. The methods adopted for this are slightly different, some operators preferring to use a cap in which a piece of yellow or ruby fabric or glass is placed, so as to illuminate the surface focussed on. Others, again, cap the lens as usual, and use a ruby lantern to place the paper in position; we prefer the former plan, because, when orange glass is used in the cap, it enables one to ascertain whether any alteration in focal sharpness of the image takes place, as this may sometimes occur from the sensitive paper buckling. Another point is the method of fastening the sensitive surface to the easel board if this be used. Of course, if the large printing frame be used, as we have suggested, there will be no difficulty about this point; but when the paper has to be affixed to a board there is a slight difficulty. One plan we have tried with success has been to have a quarter-inch groove cut in the face of the easel board along one side or the top, and in the groove a piece of stout steel or copper wire, preferably the former, is placed, and the ends of the wire are turned over the sides of the board, and passed through stout brass eyelets, and then provided with a screw thread, on which fits a milled nut. The action of this wire is merely to clip the paper in the groove, and if such a groove is placed at top and bottom of easel board, it is possible to clip the paper firmly under one groove, and then

Focus of Lens in Inches.	Reduction.	1.	2.	3.	4.	5.	6.	7.	8.	Enlargement.
		Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	
2	A	4	6	8	10	12	14	16	18	B
	B	4	3	2¾	2½	2⅖	2⅓	2⅐	2¼	A
2½	A	5	7½	10	12½	15	17½	20	22½	B
	B	5	3¾	3⅓	3⅛	3	2 1/12	2⅞	2 3/16	A
3	A	6	9	12	15	18	21	24	27	B
	B	6	4½	4	3¾	3⅗	3½	3⅜	3⅜	A
3½	A	7	10	14	17½	21	24½	28	31½	B
	B	7	5	4⅔	4¾	4⅕	4 1/12	4	3 5/16	A
4	A	8	12	16	20	24	28	32	36	B
	B	8	6	5¼	5	4⅘	4⅔	4⅞	4½	A
4½	A	9	13½	18	22½	27	31½	36	40½	B
	B	9	6¾	6	5⅝	5⅖	5¼	5⅐	5 1/16	A
5	A	10	15	20	25	30	35	40	45	B
	B	10	7½	6⅔	6¼	6	5 5/6	5⅞	5⅝	A
5½	A	11	16½	22	27½	33	38½	44	49½	B
	B	11	8¼	7⅛	6⅞	6⅗	6 5/12	6⅔	6 3/16	A
6	A	12	18	24	30	36	42	48	54	B
	B	12	9	8	7½	7⅙	7	6⅞	6¾	A
6½	A	13	19½	26	32½	39	45½	52	58½	B
	B	13	9¾	8⅔	8⅛	7⅕	7 7/12	7⅜	7 5/16	A
7	A	14	21	28	35	42	49	56	63	B
	B	14	10½	9⅓	8¾	8⅖	8⅛	8	7⅞	A
7½	A	15	22½	30	37½	45	52½	60	67½	B
	B	15	11¼	10	9⅜	9	8¾	8⅞	8 7/16	A
8	A	16	24	32	40	48	56	64	72	B
	B	16	12	10⅔	10	9⅗	9⅛	9⅐	9	A
8½	A	17	25½	34	42½	51	59½	68	76½	B
	B	17	12¾	11⅓	10⅝	10⅛	9 7/12	9⅝	9 5/16	A
9	A	18	27	36	45	54	63	72	81	B
	B	18	13½	12	11¼	10⅞	10½	10⅛	10⅛	A
9½	A	19	28½	38	47½	57	66½	76	85½	B
	B	19	14¼	12⅔	11⅞	11⅖	11 1/12	10⅞	10 1/16	A
10	A	20	30	40	50	60	70	80	90	B
	B	20	15	13⅓	12½	12	11⅔	11⅜	11¼	A
10½	A	21	31½	42	52	63	73½	84	94½	B
	B	21	15⅜	14	13⅛	12⅗	12⅔	12	11 3/16	A
11	A	22	33	44	55	66	77	88	99	B
	B	22	16½	14⅔	13¾	13⅕	12⅚	12⅝	12⅜	A
11½	A	23	34½	46	57½	69	80½	92	103½	B
	B	23	17¼	15⅓	14⅜	13⅘	13 5/12	13⅐	12 1/16	A
12	A	24	36	48	60	72	84	96	108	B
	B	24	18	16	15	14⅖	14	13⅝	13½	A

to pass it under the other, and stretch it taut, and then screw up the milled nuts. Another method is to use large-headed drawing pins at the four corners, or to use broad indiarubber bands. The advantage of using some broad surface like the head of a drawing pin is that it enables one to accurately determine whether the whites of the enlargement are pure or fogged. Surgeon-General J. L. Ranking suggested in the *Amateur Photographer* of November 28th, 1890, curving the paper, and gives the following directions:—"I have applied this principle to my easel in the following manner: The *centre* of a sheet of paper, 16 × 12 in., my usual size for enlarging from a quarter-plate negative, being pinned to the easel top and bottom, a wedge-shaped piece of wood was passed beneath one *end* of the paper till the margin of the picture was equally sharp with the centre. The distance to which the margin was advanced towards the lens was found to be 1 in. Two pieces of wood were then prepared, 12 ins. long and 6 ins. wide. They were then planed down so as to form two wedge-shaped pieces 1 in. deep at outer and $\frac{1}{8}$ in. at inner edge. These were then screwed down upon the easel, and to them a thin piece of cardboard fixed, thus forming the required curved surface. Upon the picture being sharply focussed the sheet of sensitised paper is pinned. With Ilford rapid paper and the artificial light I use, which I shall presently describe, and using an R.R. lens, 8-in. focus, at full aperture, an exposure of from 8 to 10 seconds suffices to enlarge from a quarter-plate up to 16 × 12. If a longer exposure be necessary, as it is in enlarging from landscape negatives, into which skies have to be introduced, the lens can be stopped down to any extent, the exposure being calculated upon the well-known ratios of the squares of the diameters of the stops, or a slow paper can be used. The artificial light I use is the Welsbach incandescent gaslight, said to be 16-candle power, and I find it most convenient. It is attached to the nearest gas-bracket by a flexible tube, and it can be lighted and extinguished in a moment."

Exposure.

Having obtained a critically sharp image, the next point to decide is what exposure is required; and the determination is perhaps quite as difficult and equally important as in negative

making. Various methods have been suggested, but before entering upon these it would be advisable to consider the factors which govern the duration of exposure :—(1) The actinic power of the light; (2) The density of the negative; (3) The intensity ratio of the stop; (4) The number of times of enlargement, or the distance between the lens and sensitive surface; (5) The sensitiveness of the material on which the enlargement is made.

(1) *The Actinic Power of the Light.* The only satisfactory method of determining this is by the aid of an actinometer; and the most satisfactory, and, in fact, the only ones to use are those based upon the action of light upon bromide of silver paper impregnated with solution of nitrite of potassium. There are such actinometers in the market, as Stanley's and Watkins', in which the actinic power of the light is gauged by the time a bromide of silver paper prepared as above takes to match a standard tint. In connection with this we would point out that it is said to be extremely difficult to match the standard tint; but the following quotation from the instructions issued by the maker of the latter actinometer is worth consideration :— "In testing the light no notice should be taken of the exact colour of the sensitive paper, which may vary slightly with the humidity of the air; the depth of tint is the important point. The paper darkens rapidly in light; up to a certain point it is *lighter* than the standard tint, after this point it is *darker*. The point when it is neither lighter nor darker is that to be timed." To prepare a somewhat similar actinometer it is only necessary to soak ordinary bromide paper in a 10 per cent. solution of *nitrite* of potassium, and then to dry it in the dark. A small piece is allowed to darken in daylight, and the time that it takes to deepen to a tint which may be arbitrarily chosen accurately counted, or timed by a watch. This tint should then be matched in water-colours, and painted on a strip of paper. It must be noted, however, that the tint of the paint when dry must agree with the tint of the darkened paper. Now, to use this actinometer, paste the strip of painted paper on the top of a cardboard match-box, place inside the box the sensitive paper soaked in the nitrite solution, and draw a small piece out and allow it to darken at a distance of about 18 ins. from a No. 5 Bray's gas burner turned full on without flaring behind the half-tones of a negative, noting accurately the number of seconds it takes

to darken to the standard tint. Now take a sample of some bromide paper, Eastman's, for instance, and expose half-a-dozen sheets of the same paper behind the negative at the same distance, 18 ins., giving various exposures, then on developing these six sheets it will be possible to pick out one print correctly exposed; and from this we can establish one factor, which will enable us to calculate other exposures under other conditions. Thus if the actinometer paper takes 10 seconds to darken to the standard tint, and we find 8 seconds the correct exposure for the said negative at 18 ins. from the gas burner, it will not be difficult to calculate the exposure for any distance or any more or less actinic light. For example, the exposure required for the same negative at a distance of 36 ins. from the same gas burner is easily calculated by the rule that the exposure alters as the square of the distance between the light and sensitive paper. The exposure required at 18 ins. 8 secs. ∴ is the exposure required at 36 ins. will be in the ratio of $18^2 : 36^2$, or as 324 : 1296. Now 324 : 1296 are as 1 : 4, ∴ if the exposure in the first case = 8 secs., the exposure in the second case = $8 \times 4 = 32$ secs. This will explain the use of the actinometer, and determine the first factor. (For other actinometers see EXPOSURE.)

(2) *The Density of the Negative.* It is difficult to accurately determine this, as the actual deposit of silver does not alone represent the density of the negative. The colour of the deposit, and the presence or absence of stain in the film, will also influence this factor; but by using the actinometer as suggested under the first factor we practically determine the second factor also.

(3) *The Intensity Ratio of the Stop.* Most workers know the usual definition of this term, which is the ratio the aperture of the stop or diaphragm bears to the equivalent focus of the lens; when using a lens for enlarging, however, we never use it at its equivalent focus, the focus altering with the degree of enlargement. Therefore we have to calculate anew the intensity ratio of our stops for the new focus. Thus, supposing we are using an 8½-in. focus lens for an enlargement of a quarter-plate to 12 by 12, or, in other words, if we are enlarging four times, the focus of our 8½-in. lens becomes 10⅝ in.; therefore all the diaphragms will be proportionately reduced in ratio diameter. It will always be found

more convenient if diaphragms of definite diameters are used. Thus special diaphragms of 1-in. diameter aperture or ½-in. diameter aperture can be obtained; and it is thus easy to calculate at once the new intensity ratio, without troubling to measure the diameter every time. (See DIAPHRAGMS.)

(4) *The Number of Times of Enlargement, or the Distance between the Lens and Sensitive Surface.* It is requisite to take into account this factor, because, according to the well-known rule, *the intensity of illumination coming from a point and impinging on a given surface is inversely as the square of its distance from the source of light*, or, in other words, the greater the distance of the sensitive surface from the lens the longer the

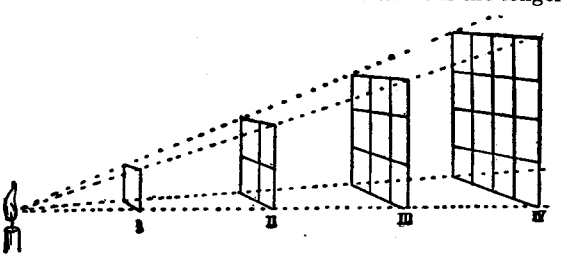


Fig. 48.

exposure. This is very clearly seen from the above diagram. Let L be the source of light, and if we place the bromide paper at I., 12 ins. from the light, and we find the exposure to be 45 seconds, when we place the paper at II., III., IV., respectively —*i.e.*, at 24, 36, and 48 ins., the exposure will not be 45, 90, 135, and 180 seconds, but in the proportion of 1, 2^2, 3^2, 4^2, or 45, 180, 395, and 720 seconds respectively.

(5) *The Sensitiveness of the Material on which the Enlarge ment is made.* This has been, to a great extent, a matter of conjecture hitherto; but I give a table of relative speeds compiled by Mr. Alf. Watkins for use with his exposure meter, merely noting that the exposures will be in inverse ratio to the P. numbers.

	P. Numbers.	Exposure.
Eastman slow	6	6⅔
„ rapid	40	1
Morgan and Kidd	15	2⅔
Anthony rapid	50	

	P. Numbers.	Exposure.
Ilford slow	3	13⅓
„ rapid	30	1⅓
Dr. Just	4	10
Mawson	6	6⅔

The first column shows the P. number obtained, and the second one the relative exposures required. Before closing this note it would be but fair to give to Mr. Ferrero the honour of having first drawn out a table of exposures for enlarging, which is given below.

Table of Exposures for Enlarging.

By E. Ferrero.

Stanley's Actinometer.	*f*/16	*f*/22	*f*/26	*f*/32	*f*/40	*f*/48	*f*/72	*f*/100
Seconds.	min.sec.	min.sec.	min.sec.	min.sec.	min.sec.	min.sec.	min.sec.	min.sec.
10	0 9	0 17	0 23	0 36	0 55	1 20	3 0	5 47
15	0 13	0 25	0 34	0 54	1 23	2 0	4 30	8 40
20	0 18	0 32	0 46	1 12	1 51	2 40	6 0	11 34
25	0 22	0 42	0 57	1 30	2 18	3 20	7 30	14 27
30	0 27	0 49	1 9	1 48	2 46	4 0	9 0	17 21
40	0 36	1 5	1 34	2 24	3 42	5 20	12 0	23 8
50	0 45	1 24	1 54	3 0	4 36	6 40	15 0	28 54
60	0 54	1 38	2 18	3 36	5 32	8 0	18 0	34 42
70	1 3	1 54	2 42	4 12	6 28	9 20	21 0	40 29
80	1 12	2 10	3 7	4 48	7 24	10 40	24 0	46 15
90	1 21	2 29	3 28	5 24	8 18	12 0	27 0	52 0
100	1 30	2 48	3 48	6 0	9 12	13 20	30 0	57 48
120	1 48	3 16	4 36	7 12	11 5	16 0	36 0	69 24
140	2 6	3 48	5 23	8 24	12 56	18 40	42 0	81 0
160	2 24	4 20	6 14	9 36	14 48	21 20	48 0	92 0
180	2 42	4 58	6 56	10 48	16 36	24 0	54 0	104 0
200	3 0	5 36	7 36	12 0	18 25	26 40	60 0	116 0
225	3 22	6 18	8 33	13 30	20 45	30 0	67 30	130 0
250	3 45	7 0	9 30	15 0	23 0	33 20	75 0	144 0
275	4 7	7 42	10 27	16 30	25 20	36 40	82 30	159 0
300	4 30	8 24	11 24	18 0	27 40	40 0	90 0	174 0

The table shows the exposures to be given to Eastman's and Britannia slow bromide papers, according to the actual intensity ratio of the lens, and to the actinic power of light as measured by Stanley's actinometer. Britannia rapid bromide paper requires one-fiftieth of the exposure indicated, and gelatino-bromide plates of ordinary rapidity one-fifteenth to one-twentieth.

Enlarging

Full directions for developing, clearing, fixing, etc., will be found included under Bromide Paper (*q.v.*).

Vignetting, Printing-in Clouds, Reducing, and Intensifying Prints.

To vignette enlargements is not a difficult matter, and for portraits the result is sometimes more pleasing than without vignetting. For vignetting it is only requisite to take a piece of card-board the same size as the enlargement is to be, and cut in the cardboard an opening the shape of the desired vignette, *but small*; it should not be much larger than the lens aperture. The size of the vignette is determined by the distance of the vignetting paper from the sensitive surface, as the nearer this the smaller the vignette, and, *vice versâ*, the nearer the lens the larger the vignette. The edges of the vignetting opening in the card need not be serrated, as the vignette is softened by keeping the card constantly moving between the lens and sensitive surface. Many operators, however, prefer to use a vignetting shape with deeply serrated edges; and this is so adjusted as to give a pleasing soft outline on the focussing easel or screen; and this method is preferred because the moving vignette is stated to be the cause of blurring of the outlines from double vibration, a charge we have not found substantiated. Enlargements of landscapes are always improved by the addition of clouds; and if these are non-existent in the negative, a separate suitable negative should be used. There are several methods of inserting clouds, which are given below. One method is to make a small transparency by contact printing from the negative to be enlarged, and make a transparency of the cloud negative, masking out the landscape. The two will then be bound film to film, care being taken that the clouds are not reversed in lighting, and then making an enlarged negative from this. Another method is to make a silver print from the small negative, and carefully cut out the landscape, and allow the two pieces of the silver print to blacken completely in the sun. Then fasten the landscape print on to the cloud negative, and the sky print on to the original negative, or else paint out the sky with some opaque colour. Having focussed and exposed the landscape negative, cap your lens with a piece of orange glass, and carefully adjust your cloud negative till it is in exactly the same position as the

first negative, and the outline agrees with that of the view, which may be marked at the edges of the sensitive paper; then expose. Another method is to expose as usual for the landscape, develop, and clear; then, without fixing, place again on the easel, and with the yellow cap on the lens, focus the clouds from the cloud negative and adjust till in correct position, and then cover up the landscape with a mask cut from ruby paper, and expose for the clouds. The exposure for clouds should be very short, so as not to make them too dark and prominent; practically about one-fourth of the exposure required for the view will be correct for the clouds. Trees, church steeples, and other objects projecting into the sky may be practically disregarded, as these will print over the sky and give a more realistic effect. To prevent too sharp a line of demarcation, the mask, or a sheet of cardboard cut roughly to shape, may be gently moved up and down near the sensitive surface to shade the landscape into the sky. In enlarging, as in every other photographic process where success depends upon a variable quantity as personal skill, care, and judgment, failures are unfortunately too often met with. We shall therefore proceed to consider these in the order of the several operations.

The enlargement is out of focus, especially at the edges. This fault may be due to non-coincidence of the plane of the sensitive surface with that of the focussing paper or ground glass. This may be remedied by focussing as usual, then placing a piece of orange glass over the lens, fixing the sensitive surface in position, and examining the focus; and, if it appear sharp, exposing and examining the developed print. It may also be caused by the sensitive paper buckling or not lying quite flat, and also by using too large an aperture of the lens. The former may be prevented by straining the paper very tightly, and the latter obviously by the insertion of a diaphragm. It may also be caused by using too large a flame surface as illuminant. Other failures are treated of under Bromide Paper (*q.v.*).

Sensitising Canvas for Enlargements.

A writer in the *Photographische Correspondenz* gives the following methods of sensitising canvas for enlarging direct. The canvas must first be well washed with a solution composed of

Liquid ammonia ·880	...	...	...	10 parts.
Alcohol (methylated)	...	...	...	40 ,,

A clean pad of linen should be used till the film shows no sign of greasiness, and is then allowed to dry thoroughly. The following solution is then made :—

Gelatine	7 parts.

This is allowed to soak in

Distilled water	250 parts

till soft, and then dissolved by the aid of a gentle heat. In the meantime take

Fresh egg albumen	50 parts

and mix with

Distilled water	125 parts.

Add

Potassium iodide	9 parts.
Ammonium bromide	4 „
Ammonium chloride	1·25 „

Beat the solution well, allow to stand for about one hour, filter through flannel, and add to it

Distilled water	125 parts

and the solution of gelatine prepared as above. The solution is flowed over the surface of the canvas, or, preferably, applied with a Buckle or Blanchard brush, or small piece of sponge. The coated canvas is then allowed to dry, and several thus prepared may be stored for use, and sensitised as required by the following solution :—

Silver nitrate	20 parts.
Glacial acetic acid	10 „
Distilled water	240 „

A small quantity of this is poured on to the gelatinised canvas, and evenly distributed with a Buckle brush, and exposed while still wet, allowing about seventy-five seconds to elapse between sensitising and exposing. This is fairly sensitive, about sixty seconds being required for a good light from a clear sky with an ordinary negative. When the exposure is complete, develop with

Gallic acid	3·5 parts.
Lead acetate	·6 „
Distilled water	250 „

Apply to the canvas in the same manner and with the same brush as used for the sensitising solution. When sufficiently dense, rinse, and fix face downwards in

Hyposulphite of soda	20 parts.
Water	100 „

Enlargements on Opal and Glass.—Enlarged Negatives.

Enlarging on to opal glass or dry plates presents no difficulties after enlarging upon paper has been mastered, greater care only being necessary to avoid mistakes and failures, as the cost of opals or dry plates is considerably more than with bromide paper. Most manufacturers include with each box of opals trial sheets of bromide paper, which may be used for test exposures, as described previously. For enlarging on dry plates the slowest brand possible should be obtained, the so-called lantern plate being the most suitable. All other operations of developing, clearing, and fixing, are precisely the same, with one slight exception. Enlargements on paper are usually seen by reflected light, whereas enlargements on opal may be examined by reflected or transmitted light, and enlargements on dry plates are always viewed by transmitted light. For this reason enlargements on opal and larger transparencies on dry plates must be developed till they look dense enough by transmitted light, and they will probably appear too dense in the shadows by reflected light; therefore their density must be judged by holding them up to the dark-room window or lamp, just as with negatives. When making large transparencies on dry plates by enlarging, we are enabled to use both pyrogallol and quinol, and obtain a warmer tone than when they have to be examined by reflected light. When many enlarged prints all of the same dimensions from one negative are required, it will often be found advantageous to make an enlarged negative and print by contact from this. For this purpose it is obvious that a small positive must first be made by contact printing from the original negative, and then the enlarged negative from this in the usual way. The best method of making the small negative is a matter of dispute, some preferring the carbon process, others the ordinary lantern or gelatino-bromide or chloride plate. The latter plan will certainly be found the more convenient for amateur workers. The small

positive may be made on any lantern plate and developed with any developer. Care should be taken to make it as perfect as possible, and all small imperfections, etc., should be retouched or spotted out on the positive. By making a cloud positive on a separate slide, and using it as a cover glass like a lantern slide, clouds may be obtained in the enlarged negative. The enlarged negative may, of course, be developed with any developing agents; but in this, as when developing the small positive, care should be taken to keep the whole rather thin, a delicate, full-of-detail negative and positive, giving the best results. The large negative may also obviously be made by using a negative in the first instance, and obtaining a positive by enlargement, and then obtaining a negative from this by contact printing. Celluloid coated with gelatino-bromide emulsion may also be obtained commercially; and this may be utilised either for positives, transparencies, or negatives, the necessary treatment being precisely the same as indicated above, for paper, opals, or plates, according to the method of viewing for which the enlargement is required.

Eosin. A generic name given to various colouring matters obtained from fluorescine, which have been used in orthochromatic work.

Equivalence, Chemical; Calculations and Data. No short instruction or elaborate tabulation of formulæ or equivalent numbers can make one who has not a fundamental chemical training quite safe in determining equivalent quantities, but we shall endeavour to give such general instructions as may assist the novice; also tabular matter. Each chemical element is represented in the symbolic language of the chemist by an abbreviated form of the name; this abbreviated form being sometimes the initial letter, or the initial letter together with another characteristic letter; but in some cases Latinised, Latin, or other names are thus abbreviated. Thus Ag stands for silver (argentum), K for potassium (kalium), and Na for sodium (natrium). In the following table, which gives the elements as tabulated by chemists of the present time, a symbol is given against the name of each element, also a number (commonly called the Atomic Weight); these numbers indicating the proportions by weight in which the elements interact on each other. As regards these numbers, which are the basis of calculations as to chemical

equivalence, two facts must be remembered. First, these numbers are determined experimentally, hence are subject to error, both of observation and theory, and secondly, it is frequently multiples of these numbers that represent equivalence. Thus the amount of silver which is equivalent in a reaction to 65 of zinc is not 108, but twice 108 or 216. Except in the case of chlorine, a whole number is given as the atomic weight, although in some instances a fractional number might perhaps carry with it a somewhat greater probability of approximation to the actual truth. Take silver for instance; 107·66 may perhaps be a little nearer the actual truth than 108, but as many careful determinations have been made, and have given numbers between these limits, one has to choose somewhere, and for all ordinary calculations the whole numbers are usually taken, except in the case of chlorine.

TABLE OF ELEMENTS AND ATOMIC WEIGHTS.

Name.	Symbol.	Atomic weight.
Aluminium	Al	27
Antimony	Sb (Stibium)	120
Argon	Ar	39 (?)
Arsenic	As	75
Barium	Ba	137
Beryllium	Be	9
Bismuth	Bi	208
Boron	B	11
Bromine	Br	80
Cadmium	Cd	112
Cæsium	Cs	132
Calcium	Ca	40
Carbon	C	12
Cerium	Ce	140
Chlorine	Cl	35·5
Chromium	Cr	52
Cobalt	Co	59
Copper	Cu (Cuprum)	63
Erbium	Er	166
Fluorine	F	19
Gadolinium	Gd	156
Gallium	Ga	70

Name.	Symbol.	Atomic weight.
Germanium	Ge	72
Glucinum (see Beryllium)		
Gold	Au (Aurum)	197
Helium	He	4 (?)
Hydrogen	H	1
Indium	In	114
Iodine	I	127
Iridium	Ir	193
Iron	Fe (Ferrum)	56
Lanthanum	La	138
Lead	Pb (Plumbum) ...	207
Lithium	Li	7
Magnesium	Mg	24
Manganese	Mn	55
Mercury	Hg (Hydrargyrum) ...	200
Molybdenum	Mo	96
Neodymium	Nd	141
Nickel	Ni	59
Niobium	Nb	94
Nitrogen	N	14
Osmium	Os	191
Oxygen	O	16
Palladium	Pd	106
Phosphorus	P	31
Platinum	Pt	194
Potassium	K (Kalium)	39
Prasodymium	Prd	143
Rhodium	Rh	103
Rubidium...	Rb	85
Ruthenium	Ru	102
Samarium	Sa	150
Scandium	Sc	44
Selenium	Se	79
Silicon	Si	28
Silver	Ag (Argentum) ...	108
Sodium	Na (Natrium) ...	23
Strontium	Sr	87
Sulphur	S	32
Tantalum	Ta	182

Name.	Symbol.	Atomic weight.
Tellurium	Te	125
Terbium	Tb	162
Thallium	Tl	204
Thorium	Th	232
Tin	Sn (Stannum)	119
Titanium	Ti	48
Tungsten	W (Wolfram)	184
Uranium	U	240
Vanadium	V	51
Ytterbium	Yb	173
Yttrium	Y	89
Zinc	Zn	65
Zirconium	Zr	90

When two symbols are written side by side without any intervening sign, it is implied that the elements represented are in combination. Thus, AgCl indicates that silver and chlorine are combined together to form silver chlor*ide* (-ide being the recognised termination for a compound of two elements); indeed, to the chemical expert very much more is indicated, the most important thing being that 108 parts by weight of silver are united with 35·5 parts by weight of chlorine.

Most chemical reactions connected with photographic practice are sufficiently understood for chemists to be able to represent them by such symbolic representation as show the quantities of materials concerned in the reactions, and it is from this point of view that the table of atomic weights is of special value. Limit of space does not allow us to give all the various rules and usages of the symbolic language by which chemists represent the quantities taking part in reactions, but an example will teach a good deal.

When a solution of potassium bromide (KBr) is mixed with a solution of nitrate of silver ($AgNO_3$), the silver and the potassium change places, forming silver bromide (AgBr)—which, being insoluble, is precipitated—and potassium nitrate (KNO_3), which remains in solution.

$$KBr + AgNO_3 = AgBr + KNO_3.$$

If we wish to bring about this reaction without loss or interfer-

ence by reason of excess of either substance, we can take the quantities indicated by the equation, these being as follows:—

$$\begin{array}{cccccccccc} K & Br & + & Ag & N & O_3 & = & Ag & Br & + & K & N & O_3. \\ 39 & 80 & & 108 & 14 & 16 & & 108 & 80 & & 39 & 14 & 16 \\ & & & & & 3 & & & & & & & 3 \\ & & & & & 48 & & & & & & & 48 \\ \underbrace{\quad} & & & \underbrace{\quad\quad\quad} & & & & \underbrace{\quad} & & & \underbrace{\quad\quad\quad} & & \\ 119 & & & 170 & & & & 188 & & & 101 & & \end{array}$$

Although tabular matter and lists of chemical formulæ may mislead one unversed in chemical matters, and will be quite superfluous to one skilled in chemistry, certain tables are subjoined, the first being a table of Dr. Eder's, which will be of service to emulsion makers, as it shows in plain figures the actual weight of various salts required to react with 170 parts by weight of silver nitrate. It will be noticed that the fractional parts involve a slight departure from the figures which would be obtained from our table of atomic weights, a matter sufficiently explained by our previous remarks. As a guide to practice, even this very clear and explicit table requires special knowledge, for many reasons. In the first place, it is usual in making emulsions to employ a great excess of the compound required to decompose the silver nitrate, and the question of water of crystallisation, shown in the formulæ as H_2O (= 18), $2H_2O$ (= 36), $4H_2O$ (= 72), etc., steps in as a disturbing factor very often, the salts having lost water or gained water from the atmosphere. (See Efflorescence; also Deliquescence.

Dr. Eder's table of equivalents of Haloid Salts which are required to decompose 170 parts of Silver Nitrate.

58·5	Sodium chloride	... (NaCl).
74·6	Potassium chloride ...	... (KCl).
53·5	Ammonium chloride ...	... (NH_4Cl).
55·5	Calcium chloride	... ($CaCl_2$).
109·5	Crystal calcium chloride ...	... ($CaCl_26H_2O$).
133·2	Strontium chloride ...	... ($SrCl_26H_2O$).
79·2	Anhydrous strontium chloride	... ($SrCl_2$).
42·5	Lithium chloride	... (LiCl).
101·5	Magnesium chloride ...	... ($MgCl_26H_2O$).
47·5	Anhydrous magnesium chloride	... ($MgCl_2$).

68·0	Zinc chloride	($ZnCl_2$).
119.0	Cobalt chloride	($CoCl_26H_2O$).
85·25	Crystal cupric chloride	($CuCl_22H_2O$)
119·1	Potassium bromide	(KBr).
139·0	Sodium bromide	($NaBr2H_2O$).
103·0	Anhydrous sodium bromide ...	(NaBr).
177·4	Strontium bromide	($SrBr_26H_2O$).
98·0	Ammonium bromide	(NH_4Br).
112·5	Zinc bromide	($ZnBr_2$).
172·0	Cadmium bromide	($CdBr_24H_2O$).
136·0	Anhydrous cadmium	($CdBr_2$).
126·33	Cadmium and ammonium bromide	($2NH_4Br,2CdBrH_2O$)
166·1	Potassium iodide	(KI).
1860·	Sodium iodide (cryst.)	($NaI2H_2O$).
187·54	Lithium iodide	($LiI3H_2O$).
145·0	Ammonium iodide	(NH_4I).
159·5	Zinc iodide	(ZnI_2).
182·5	Cadmium iodide	(CdI_2).

Calculations.

With a view of simplifying the calculations involved in emul sion making, Mr. William Ackland has worked out and published some useful tables, which will assist even those who are able to perform the calculations in the recognised style.

Mr. Ackland's Table. No. I.

	Equivalent weights.	Weight of $AgNO_3$ required to convert one grain of soluble haloid.	Weight of soluble haloid required to convert one grain $AgNO_3$.	Weight of *silver* haloid produced by one grain of *soluble* haloid.	Weight of *soluble* haloid required to produce one grain of *silver* haloid.	Weight of silver haloid produced from one grain $AgNO_3$.
Ammonium bromide ...	98	1·734	·576	1·918	·521	
Potassium ,, ...	119·1	1·427	·700	1·578	·633	
Sodium ,, ...	103	1·650	·606	1·825	·548	1·106
Cadmium ,, com.	172	·988	1·012	1·093	·915	
,, ,, anh.	136	1·25	·800	1·382	·723	
Zinc ,, ...	112·1	1·509	·663	1·670	·600	
Ammonium chloride ...	53·5	3·177	·315	2·682	·373	·844
Sodium ,, ...	58·5	2·906	·344	2·453	·408	
Ammonium iodide ...	145	1·172	·853	1·620	·617	
Potassium ,, ...	166·1	1·023	·977	1·415	·707	1·382
Sodium ,, ...	150	1·133	·882	1·566	·638	
Cadmium ,, ...	183	·929	1·076	1·284	·778	

Mr. Ackland's Table. No. II.

	Ammonium Bromide.	Potassium Bromide.	Sodium Bromide.	Cadmium Bromide. (Com.)	Cadmium Bromide. (Anhyd.)	Zinc Bromide.	Ammonium Chloride.	Sodium Chloride.	Ammonium Iodide.	Potassium Iodide.	Sodium Iodide.	Cadmium Iodide.
Ammonium bromide ...	**1**	·823	·951	·57	·72	·87	1·832	1·675	·676	·59	·653	·535
Potassium ,, ...	1·215	**1**	1·156	·692	·876	1·058	2·226	2·036	·821	·717	·794	·651
Sodium ,, ...	1·051	·865	**1**	·599	·757	·915	1·925	1·761	·71	·62	·686	·563
Cadmium ,, com.	1·755	1·444	1·67	**1**	1·265	1·527	3·215	2·94	1·186	1·035	1·146	·94
,, ,, anh.	1·387	1·141	1·32	·79	**1**	1·207	2·542	2·324	·938	·819	·906	·743
Zinc ,, ...	1·149	·945	1·093	·655	·828	**1**	2·104	1·925	·776	·678	·75	·615
Ammonium chloride ...	·546	·449	·519	·311	·393	·475	**1**	·914	·369	·322	·356	·292
Sodium ,, ...	·597	·491	·568	·34	·43	·519	1·093	**1**	·403	·352	·39	·319
Ammonium iodide ...	1·479	1·217	1·408	·843	1·066	1·287	2·712	2·478	**1**	·873	·966	·792
Potassium ,, ...	1·695	1·394	1·612	·965	1·221	1·475	3·104	2·839	1·145	**1**	1·107	·907
Sodium ,, ...	1·53	1·259	1·456	·872	2·103	1·332	2·803	2·564	1·034	·903	**1**	·819
Cadmium ,, ...	1·867	1·536	1·776	1·064	1·345	1·625	3·42	3·128	1·262	1·102	1·22	**1**

This Table gives in separate columns the relative converting values of each of the soluble haloid salts in ordinary use, showing how much of any salt must be used to replace one grain of any other. In each column will be found a unit (printed in larger type) which represents one grain of the salt named at the head of the column; the other figures in the same column show the exact quantities of the other salts which must be used in lieu of a single grain of that particular haloid. Thus, taking the first column, which is headed "Ammonium Bromide," we find against ammonium bromide in the margin the figure 1, representing one grain of that salt. If we wish to know the relative converting power of potassium bromide we take the number in the same column which stands against the latter salt in the margin—viz., 1·215; that is to say, 1·215 grain of potassium bromide will be required to do the same work as one.

The principal bromides, chlorides, and iodides, which are likely to be used in emulsions of either gelatine or collodion, have been included in these tables. Table No. 1 presents to the reader, without any mystification which may be involved in equivalents, the actual weights of haloid or silver, as the case may be, required to convert or combine with one grain of the other. In order to test the utility of this table, let us suppose that it is desired to make (say) 10 ozs. of emulsion by a new formula, which, for the sake of showing the working of the table, we will write down as follows:—

Bromide of potassium	150 grains.	Chloride of ammonium	10 grains.
Iodide of potassium	10 „	Gelatine	200 „

Now, we want to know how much silver nitrate should be employed in sensitising this mixture. For this purpose we use the first column, in which we find against each haloid the exact quantity of silver nitrate required to fully decompose one grain. Taking, then, the figures we find in column No. 1 against the three salts in the above formula, and multiplying them by the number of grains of each used, we have the following sum:—

Potassium bromide	150 × 1·427 = 214	Weight
„ iodide	10 × 1·023 = 10·23	silver nitrate
Chloride of ammonium	10 × 3·177 = 31·77	required;

or the total quantity of silver nitrate required for full conversion, 256 grains.

General Table of Formulæ: Chemicals in frequent use. In giving the following table of formulæ and molecular weights, all previously stated about the insufficiency of concise information, or even its misleading nature, must be emphasised. As examples, we may refer to the formula given for boracic or boric acid; the acid in this particular form and molecular value being rather a chemical abstraction—useful to be remembered by the student—than to be definitely weighed out; and the same remark replies to sulphurous acid. Again the inexperienced manipulator would have small or no chance of weighing out carbonate of potassium so as exactly to correspond to what he might gather from the formula K_2CO_3; and alum might quite as reasonably have been represented by half the value assigned to it in our table. Again, in the case of ammonium carbonate, it was impossible to give any formula corresponding with a commercial product. For the understanding of the table, it is necessary to

point out that a large figure before a group multiplies all after until one comes to a stop or sign, and a small figure following anything within brackets multiplies all within the brackets. Thus $3H_2O$ and $(H_2O)_3$ signify the same.

	Formula.	Molecular Weight.
Acid, Acetic	$HC_2H_3O_2$	60
,, Boracic or Boric ...	H_3BO_3	62
,, Carbolic...	HC_6H_5O	94
,, Citric	$H_3C_6H_5O_7$, H_2O	210
,, Formic	$HCHO_2$	46
,, Gallic	$HC_7H_5O_5$	170
,, Hydrobromic	HBr	81
,, Hydrochloric	HCl	36·5
,, Nitric	HNO_3	63
,, Oxalic	$H_2C_2O_4$, $2H_2O$	126
,, Pyrogallic	$H_3C_6H_3O_3$	126
,, Salicylic...	$HC_7H_5O_3$	138
,, Sulphuric	H_2SO_4	98
,, Sulphurous	H_2SO_3	82
,, Tannic	$H_4C_{27}H_{18}O_{17}$	618
,, Tartaric...	$H_4C_4H_2O_6$	150
Alcohol...	C_2H_5HO	46
,, Methyl	CH_3HO	32
Alum	$Al_2(SO_4)_3$, $K_2SO_4 24H_2O$	948
,, Chrome...	$Cr_2(SO_4)_3K_2SO_4$. $24H_2O$	999
Ammonia	NH_3	17
Ammonium Bichromate ...	$(NH_4)_2Cr_2O_7$	253
,, Bromide	NH_4Br	98
,, Carbonate(normal)	$(NH_4)_2CO_3$	96
,, Chloride	NH_4Cl	53·5
,, Iodide	NH_4I	145
,, Nitrate	NH_4NO_3	80
,, Oxalate	$(NH_4)_2C_2O_4$	124
,, Hydrosulphate ...	NH_4HS	51
,, Sulphocyanide ...	NH_4CNS	76
Barium Bromide	$BaBr_2$	297
,, Chloride	$BaCl_2$, $2H_2O$	244
,, Iodide...	BaI_2	391
,, Nitrate	$Ba(NO_3)_2$	261
Cadmium Bromide	$CdBr_2 4H_2O$	344
,, Chloride	$CdCl_2$	183
,, Iodide	CdI_2	366
Calcium Bromide	$CaBr_2 4H_2O$	272
,, Carbonate	$CaCO_3$	100
,, Chloride	$CaCl_2$	111
,, Iodide	CaI_2	294
Copper Acetate	$Cu(C_2H_3O_2)_2H_2O$	199

	Formula.	Molecular Weight.
Copper Bromide	$CuBr_2$	223
,, Chloride	$CuCl_2H_2O$	171
,, Sulphate	$CuSO_45H_2O$	249
Glycerine	$C_3H_5(HO)_3$	92
Gold Perchloride	$AuCl_3$	302·5
Hydroquinone	C_6H_42HO	110
Hydroxylamine Chloride ...	NH_3OHCl	69·5
Iron Chloride (ferrous) ...	$FeCl_2$	127
,, ,, (ferric)	Fe_2Cl_6	325
,, Citrate	$Fe_3(C_6H_5O_7)_2$	598
,, Iodide	FeI_2	310
,, Nitrate	$Fe(NO_3)_26H_2O$	288
,, Oxalate (ferrous) ...	FeC_2O_4	144
,, ,, (ferric)	$Fe_2(C_2O_4)_3$	376
,, Sulphate (ferrous) ...	$FeSO_4, 7H_2O$	278
,, ,, (ferric) ...	$Fe_2(SO_4)_3$	400
,, Ammonia Sulphate ...	$FeSO_4, (NH_4)_2SO_46H_2O$	392
Lead Acetate	$Pb(C_2H_3O_2)_23H_2O$	379
,, Iodide	PbI_2	460
,, Nitrate	$Pb(NO_3)_2$	331
,, Oxide	PbO	223
Lithium Bromide	$LiBr$	87
,, Chloride	$LiCl$	42·5
,, Iodide	LiI	134
Magnesium Bromide	$MgBr$	184
,, Chloride	$MgCl_2$	95
,, Iodide	MgI_2	278
,, Sulphate	$MgSO_47H_2O$	246
Mercury Chloride (mercuric)	$HgCl_2$	271
,, ,, (mercurous)	$HgCl$	235·5
,, Cyanide	$HgCy_2$	252
,, Iodide (mercuric) ...	HgI_2	454
,, ,, (mercurous) ...	HgI	327
Platinum Chloride	$PtCl_4$	339
Potassium Bicarbonate ...	$KHCO_3$	100
,, Bichromate ...	$K_2Cr_2O_7$	294
,, Bromide	KBr	119
,, Carbonate	K_2CO_3	138
Potassium Chlorate	$KClO_3$	122·5
,, Chloride	KCl	74·5
,, Chloro-platinite ...	$PtCl_2(KCl)_2$	414
,, Citrate	$K_3C_6H_5O_7H_2O$	324·3
,, Cyanide	KCN	65
,, Ferricyanide ...	$K_6Fe_2C_{12}N_{12}$	658
,, Ferrocyanide ...	$K_4FeC_6N_63H_2O$	422
,, Hydrate	KHO	56
,, Iodide	KI	166

	Formula.	Molecular Weight.
Potassium Nitrate	KNO_3	101
,, Permanganate ...	$K_2M_2O_8$	316
,, Sulphocyanide ...	KCNS	97
Silver Acetate	$AgC_2H_3O_2$	167
,, Bromide	AgBr	188
,, Carbonate	Ag_2CO_3	276
,, Chloride	AgCl	143·5
,, Citrate	$Ag_3C_6H_5O_7$	513
,, Fluoride	AgFl	127
,, Iodide	AgI	235
,, Nitrate	$AgNO_3$	170
,, Nitrite	$AgNO_2$	154
,, Oxalate	$Ag_2C_2O_4$	304
,, Oxide	Ag_2O	232
,, Sulphide	Ag_2S	248
Sodium Acetate	$NaC_2H_3O_2$, $6H_2O$	190
,, Biborate (Borax) ...	$Na_2B_4O_710H_2O$	382
,, Bromide	NaBr	103
,, Bicarbonate	$NaHCO_3$	84
,, Carbonate	$Na_2CO_310H_2O$	286
,, Chloride	NaCl	58·5
,, Citrate	$Na_3C_6H_5O_7$	258
,, Hydrate	NaHO	40
,, Hyposulphite ...	$Na_2S_2O_35H_2O$	248
,, Iodide	NaI	150
,, Nitrate	$NaNO_3$	85
,, Sulphate	$Na_2SO_410H_2O$	322
,, Sulphite	$Na_2SO_37H_2O$	252
Strontium Bromide	$SrBr_26H_2O$	355·5
,, Chloride	$SrCl_26H_2O$	266·5
,, Nitrate	$Sr(NO_3)_2$	211·5
Tin Chloride (Stannic) ...	SnCl4	260
,, ,, (Stannous) ...	$SnCl_22H_2O$	225
Uranium Bromide	UBr_48H_2O	704
,, Nitrate	$UO_2(NO_3)_26H_2O$	504
,, Sulphate	$UO_2(SO_4)3H_2O$	422
Zinc Bromide	$ZnBr_2$	225
,, Chloride	$ZnCl_2$	136
,, Iodide	ZnI_2	319
,, Nitrate	$Zn(NO_3)_26H_2O$	189
,, Sulphate	$ZnSO_4$, $7H_2O$	287

As bearing on calculations relating to chemical equivalence reference may be made to the following articles :—CALCULATIONS AND CONSTANTS, HYDROMETER, THERMOMETER, also WEIGHING AND MEASURING.

Equivalent Focus. See FOCUS.

Equivalent Terms. See SYNONYMES.

Erythrosine. $C_{20}H_6I_4O_5K_2$. Synonym: Potassium Salt of Tetraiodofluorescine. This is a derivation of fluorescine, and closely allied to Eosine (*q.v.*). It is used in orthochromatic photography.

Ether. $C_4H_{10}O = 74$. Sometimes called Sulphuric Ether, as a survival of an old and mistaken view of its nature. A volatile, inflammable, colourless liquid, prepared from alcohol by distillation with sulphuric acid, and subsequent purification. It has a peculiar, strong, sweet odour, and a hot, burning taste, evaporates quickly on exposure to the air, and when applied to the skin leaving a feeling of considerable coldness. It boils at 95° F., and gives off at ordinary temperatures a heavy, inflammable vapour. Water takes up about one-tenth of its volume of ether, and *vice versâ;* a much greater miscibility with water proves the presence of alcohol, often present in commercial samples, as ether mixes in all proportions with alcohol. Specific gravity of good commercial ether should be about ·735. It is a solvent of all fixed and essential oils, iodine, bromine, and sparingly of sulphur and phosphorus. It dissolves most resins and balsams, also india-rubber and caoutchouc. It contains about 8 per cent. of alcohol.

Pure or Absolute Ether is prepared from commercial by shaking it with half its weight of distilled water, which dissolves any alcohol, and decanting the supernatant ether and distilling it with chloride of calcium, which extracts the small amount of water absorbed by the ether.

Methylated Ether is prepared precisely as above, but from methylated spirit. It is, if carefully purified, almost as satisfactory for the preparation of collodion as that from rectified spirit. One test as to whether a sample be suitable for preparing collodion is to put one drop of tincture of iodine into an ounce of methylated ether, and expose to daylight. If the colour is discharged after a few hours, the sample should be rejected. Ether, whether prepared from rectified or methylated spirit, is liable to become ozonised, and acid, by exposure to light, in which

condition it is unfit for the preparation of collodion. This state can be tested for by agitating it with an alcoholic solution of iodide of potassium. When ozonised, as it is called, the iodine is liberated, and the solution is coloured the characteristic yellow colour of free iodine. The active agent in this case appears not to be ozone, but peroxide of hydrogen.

Euryscope. One of the many names applied to the rectilinear or symmetrical doublet. (See LENS.)

Exposure. Placing any sensitive surface under the action of light, either in the camera or in a printing frame. Of the latter but little need be said, as the result is, in the case of sensitised paper, visible; and in the case of bromide papers for development, instructions will be found under the heading BROMIDE PAPER. Of the former but little can be said here, yet whole volumes might be written without affording much material aid. We may well divide the factors which influence the duration of exposure into five distinct sections: (1) Light, (2) Plate, (3) Subject, (4) Diaphragm, (5) Distance.

(1) *Light.* In estimating the quality of the light which falls upon the subject, we have several points to take into consideration. It has been and still is the accredited custom of many operators to judge of the quality of the light by the image as seen on the focussing screen; that is to say, many operators still employ the method of calculating exposure by means of the optical brightness of the light, and not by the chemical brightness—two totally distinct properties of light, between which there is not, unfortunately, any fixed ratio or connection. Other important factors in determining the quality of the light are, climatic or meteorological circumstances, the latitude of the place, and the height of the object above the level of the sea, this last only being taken into account when on mountains, etc. It will be almost impossible for me to give full and complete information, but as far as possible within reasonable limits I shall do so. Dr. Holetschek, of Vienna, has reckoned for Vienna and all places of that latitude the chemical light intensity of sunlight and that of a blue sky, these results being embodied in the following tables :—

HOLETSCHEK'S TABLES CALCULATED FOR VIENNA LATITUDE.

Chemical Intensity of the Light from a Blue Sky.

	Noon.	11 a.m.	10 a.m.	9 a.m.	8 a.m.	7 a.m.	6 a.m.	5 a.m.	4 a.m.
Jan. 21st ...	26·53	25·53	22·30	16·42	7·41	...	...	...	...
Feb. 20th ...	32·22	31·43	28·93	24·14	16·31	5·13	...	...	...
March 20th .	36·23	35·77	34·10	30·65	24·64	15·32	2·78	...	...
April 21st ...	38·07	37·90	37·13	35·12	30·99	24·14	14·18	1·64	...
May 22nd ...	38·30	38·29	38·02	36·85	33·98	28·66	20·62	10·23	...
June 21st ...	38·27	38·30	38·18	37·27	34·77	30·06	22·75	13·14	2·07
July 21st ...	38·30	38·29	38·02	36·85	33·98	28·66	20·62	10·23	...
Aug. 21st ...	38·07	37·90	37·13	35·12	30·99	24·14	14·18	1·64	...
Sept. 23rd ...	36·23	35·77	34·10	30·65	24·64	15·32	2·78	...	...
Oct. 21st ...	32·22	31·43	28·93	24·14	16·31	5·13	...	...	...
Nov. 21st ...	26·53	25·53	22·30	16·42	7·41	...	...	...	...
Dec. 21st ...	22·63	22·57	19·14	12·90	3·48	...	...	...	...
	Noon.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.

Chemical Intensity of Direct Sunlight.

	Noon.	11 a.m.	10 a.m.	9 a.m.	8 a.m.	7 a.m.	6 a.m.	5 a.m.
Jan. 21st	13·27	10·97	5·44	0·80	...	...	...	...
Feb. 20th	33·54	29·81	20·09	8·27	0·76	...	...	...
March 20th	62·25	57·64	44·45	26·44	9·18	0·47	...	...
April 21st...	93·29	88·17	73·51	51·96	27·87	8·27	0·25	...
May 22nd	111·77	106·65	91·85	69·52	43·65	19·24	3·50	0·01
June 22nd	117·44	112·30	97·77	75·62	49·26	24·11	6·06	0·12
July 21st	111·77	106·65	91·85	69·52	43·65	19·24	3·50	0·01
Aug. 21st	93·29	88·17	73·51	51·96	27·87	8·27	0·25	...
Sept. 23rd	62·25	57·64	44·45	26·44	9·18	0·47	...	...
Oct. 21st	33·54	29·81	20·09	8·27	0·76	...	...	...
Nov. 21st	13·27	10·97	5·44	0·80	...	...	...	...
Dec. 21st	7·40	5·81	2·24	0·10	...	...	...	...
	Noon.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.

Combined Power of Blue Sky and Sunlight.

	Noon.	11 a.m.	10 a.m.	9 a.m.	8 a.m.	7 a.m.	6 a.m.	5 a.m.	4 a.m.
Jan. 21st ...	39·80	36·50	27·74	17·22	7·41	...	...	...	...
Feb. 20th ...	65·76	61·24	49·02	32·41	17·07	5·13	...	...	...
March 20th .	98·48	93·41	78·55	57·09	33·82	15·79	2·78	...	...
April 21st ...	131·36	126·07	110·64	87·08	56·86	32·41	14·43	1·64	...
May 22nd ...	150·00	144·94	129·87	106·37	77·63	47·90	24·02	19·23	...
June 21st ...	155·70	150·66	135·94	112·89	84·03	54·17	28·21	13·26	2·07
July 21st ...	150·07	144·94	129·87	106·37	77·63	47·90	24·12	10·23	...
Aug. 21st ...	131·36	126·07	110·64	87·08	56·86	32·41	14·43	1·64	...
Sept. 23rd ...	98·48	93·41	78·55	57·09	33·82	15·79	2·78	...	...
Oct. 21st ...	65·76	61·24	49·02	32·41	17·07	5·13	...	...	...
Nov. 21st ...	39·80	36·50	27·74	17·22	7·41	...	...	...	...
Dec. 21st ...	31·03	28·38	21·38	13·00	3·48	...	...	...	...
	Noon.	1 p.m.	2 p.m.	3 p.m.	4 p.m.	5 p.m.	6 p.m.	7 p.m.	8 p.m.

The following table by Dr. Spitaler may be regarded as supplementary to the foregoing, as it will enable Dr. Holetschek's results to be applied with sufficient accuracy to other degrees of latitude:—

Spitaler's Table of the Chemical Intensity of the Light for every ten degrees of latitude, for the northern hemisphere, and the middle of each month. This may be used for the southern hemisphere by altering the time of year; thus, January in the place of July, etc.

Latitude.	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°
January	408	332	250	161	80	22	1	...	...	...
February	437	385	315	232	146	68	15	...	...	...
March	451	433	391	329	251	166	84	23	...	...
April	433	451	445	414	361	288	203	113	31	...
May	396	442	465	464	438	388	315	212	195	203
June	373	430	467	481	469	432	367	280	313	324
July	384	432	465	471	452	408	340	222	250	259
August	418	446	451	431	388	323	242	150	69	72
September	444	438	408	356	286	20	119	45	5	...
October	441	399	338	261	176	94	30	2	...	...
November	415	348	266	178	96	32	2	...	...	...
December...	397	319	231	142	64	14	...	...	...	...
Mean of the Year ...	416	405	374	327	267	203	146	87	72	74

The variation of light during the day is a very important matter, and practice seems to have proved that the most intense light is on a cloudless sunny day about 11 to 12 in the morning; after noon the intensity sinks, because the heat of the sun has filled the air with aqueous vapour and the sun itself has begun to sink, and therefore its light, passing through a greater and ever-increasing thickness of atmosphere, loses in a marked manner its chemical activity, which resides, as we have already seen, in the blue and violet rays, which are more quickly, and in greater proportion, absorbed than the less refrangible rays. Professor Langley (Washington, 1884) has given the following results of the experiments carried out by him, as to the absorption of the different rays of the spectrum.

Ultra violet rays	absorbed,	61%;	allowed to pass,	39%.
Violet	,,	58%	,,	42%.
Blue	,,	52%	,,	48%.
Greenish blue	,,	46%	,,	54%.
Yellow	,,	37%	,,	63%.
Red	,,	30%	,,	70%.
Infra red	,,	24%	,,	76%.

From this it is obvious that the greater the thickness of atmosphere through which the sun's rays have to pass, the greater the absorption of the chemical or more refrangible rays. The chemical power of the sun's light is, moreover, dependent on the absence or presence of dust, the height of the barometer, etc. Again, the wind has some influence, because when a dry north-east or east wind prevails, and prevents the condensation, or rather the increase, of the aqueous vapour, the chemical intensity of the light will increase; on the other hand, when a wet south-west or west wind prevails, the increase of the aqueous vapour will lower the intensity. Clouds, we all know, play an important part in determining the duration of exposures, but there are clouds and clouds. Thin haze or mist, such known as "heat mist," lowers the chemical power enormously; yet optically there is little difference. The fine white masses of clouds floating in a blue sky rather increase than decrease the power of the light, in that they act as enormous reflectors of the sun's light. Generally, however, when the sky is cloudy and the sun not actually shining, the exposure is about three times that with the sun out; with a dull leaden pall of cloud the chemical intensity of the light may be reduced to one-fourth or one-eighth, or even more. The following table by Dr. J. A. Scott may be useful:—

Hour of Day. a.m.	p.m.	June.	May. July.	April. Aug.	March. Sept.	Feb. Oct.	Jan. Nov.	Dec.
12		1	1	1¼	1½	2	3½	4
11	1	1	1	1¼	1½	2½	4	5
10	2	1	1	1¼	1¾	3	5	6
9	3	1	1¼	1½	2	4	12	16
8	4	1½	1½	2	3	10		
7	5	2	2½	3	6			
6	6	2½	3	6				
5	7	5	6					
4	8	12						

Yellow Sunset affects these times of relative exposure.

In connection with the above, Platt's table of Subject and Light will be useful:—

Compiled and slightly altered from Eder's and Burton's Tables.	Sunshine.	Diffused Light.	Dull.	Very Dull.	Gloom.
Sea and Sky	¼				
Panoramic View	1	2	3	4	5
Do. with Thick Foliage, or Strong Foreground, or Light Buildings	2	4	6	8	10
Dark Buildings	3	6	9	12	15
Heavy Foliage Foreground ...	4	8	12	16	20
Woods and badly lit River Banks	10	20	30	40	50
Living Objects Outdoors ...	4	8	12	20	30
Portrait near Window	8	16	24	40	60
Interiors ... ... upwards of	100	12	20		
Copying same Size	6				

Hurter and Driffield's actinograph (for the description of which see below) gives, quite apart from its other functions, a ready means of finding equivalent exposures at all times and seasons. A separate instrument, however, or a separate cylinder, is required for each considerable variation in latitude.

As bearing chiefly on the light factor, we may give the following useful tables for calculating the time of exposure due to A. de la Baume Pluvinel. For the time of exposure, t, of a photographic plate applies approximately the well-known and easily-proved formula—

$$t = \text{constant} \times \left\{ \frac{\text{Focus}}{\text{Diameter of diaphragm}} \right\}^2$$

in which the constant receives certain values, first empirically determined by Dorval. In this formula are now, however, as one perceives at first sight, several important factors totally disregarded, and it may be therefore desirable, on the ground of the laws of mathematical optics, and with the aid of certain necessary assumptions, to submit the problem to a deeper investigation, and to strive to bring its solution into better harmony with the physical facts.

In a meritorious brochure ("Le Temps de Pose," Paris, 1890, Gauthier-Villars), issued recently, the French investigator, De la Baume Pluvinel, made the attempt to determine a formula applicable to any possible case, according to which "the time of

exposure"—indeed, any time can be reckoned which will be required to expose a photographic plate, actually an orthochromatic—so that a correct printing negative will be finally obtained. If actually La Baume Pluvinel's theory and tables of resultant times of exposure have only an approximate precision—which is to be expected from the impossibility of accurate measurement of the different constants which arise—still it will be useful to the reader to be made acquainted with the results of this theory, even without following the long mathematical calculations of the author, and therefore we recapitulate the principal results and empirical data of La Baume Pluvinel.

However, before the general final formula for the time-exposure is given, the units of the factors appearing in it should be explained, or their mathematical expressions be given.

An important factor is the amount—

$$\frac{\log A_1 \cos^4 a_1 - \log A_2 \cos^4 a_2}{A_1 \cos^4 a_1 - A_2 \cos^4 a_2} \times \frac{40m}{p\,v\,(1 - e^{-m2})}.$$

This is briefly designated $\frac{1}{E}$. In which e represents the thickness of the gelatino-bromide of silver film; m, its absorptive coefficient; v, the absorptive coefficient of the film saturated with reduced silver; a_1 and a_2 the angle which the secondary axes of the different illuminated elements of the object form with the principal axis of the objective; A_1 and A_2, the corresponding actinic active quality of light (reckoned for units of time, surface, and distance). One can now actually, for any single case, approximately reckon the value of $\frac{1}{E}$, with the help of certain assumptions, and on the basis of actinometrical and other measurements. Still, this would be impracticable for practical work; it is thus better to estimate $\frac{1}{E}$ in a purely experimental way for special requirements, and the different cases which occur in practice, from this to reduce (see the table of the value of $\frac{1}{E}$ below). This also applies to the amount J, which represents the actinic intensity of the illuminating beam of light, and for which one finds a table below. For the desired time of exposure, t, results now, according to La Baume Pluvinel's theory—

$$t = \frac{1}{E} \times \frac{1}{J} \times \frac{1}{10} \times \frac{F^2}{d^2} \left\{ \frac{4}{3} \right\} 25 - N \times \frac{1}{\left\{ 1 - \frac{F}{D} \right\}^2}$$

in which F represents the equivalent focus of the objective; D, the distance of the object from the lens, measured along the principal axis; d, the working aperture of the lens—with doublets $d = \frac{P \times d'}{P - l'}$, where P is the equivalent focus of the front lens, d' the diameter of the diaphragm, l the distance of the centre of the diaphragm from the optical centre of the front lens; N, the number of degrees of Warnerke's sensitometer which the plate used shows. N, with the most sensitive plates, = 25, and varies usually between 16 and 23.

The co-efficient $\frac{1}{\left\{1 - \frac{F}{D}\right\}^2}$ with landscape is about 1, because then D is great; on the other hand, it comes considerably into account in enlargements, since then D is only small. In the above, it must be noticed that the absorption, as well as the reflection of the lenses of the objective, is not calculated. The same has a mean result of loss of light of about 20 per cent.

VALUE OF $\frac{1}{E}$.

Clouds	0·0005
Sea	0·001
Snow	0·001
Ships on sea	0·003
Glaciers with rocks	0·003
Open landscape (panorama)	0·003
Foliage, with water or white houses...	0·005
Foliage only, and near	0·01
Living subjects, portraits, still life, etc.	0·01
Reproduction of black lines on white ground ...	0·02

VALUE OF $\frac{1}{J}$ ACCORDING TO EDER, ABNEY, AND VOGEL.

Direct upright sunlight; for Paris, June 21st, noon; also if the sun stands 66° above the horizon ...	1
Diffused light, bright weather	4
„ „ sky covered	4 to 10
Under trees	270
In the studio	12
In a room, 1 metre from window	70
Well-lighted church	200

VALUE OF $\frac{I}{J}$ FOR DIRECT SUNLIGHT.

	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.		Afternoon.
	1-15	15-31	1-15	15-29	1-15	15-31	1-15	15-30	1-15	15-31	1-15	15-30	
Hour.													Hour.
4	...	...	...	...	...	...	...	...	...	...	...	30	8
4.30	...	...	...	...	...	...	...	...	...	...	30	15	7.30
5	...	...	...	...	...	...	...	...	30	15	14	10	7
5.30	...	...	...	...	...	...	30	24	15	12	8	6	6.30
6	...	...	...	...	...	30	15	12	8	6	5	4	6
6.30	...	...	...	30	15	12	8	6	4	3·5	3	3	5.30
7	...	...	30	15	12	4	6	4	3	2·5	2·3	2	5
7.30	...	30	15	12	6	4	3·5	3	2·5	2	1·8	1·7	4.30
8	30	15	10	6	4	3	2·5	2	1·8	1·7	1·6	1·6	4
8.30	15	12	7	4	3	2	1·8	1·8	1·7	1·6	1·5	1·4	3.30
9	10	6	4	3·5	2·1	1·8	1·7	1·6	1·5	1·4	1·3	1·3	3
9.30	7	5	3	2·5	1·8	1·7	1·6	1·5	1·4	1·3	1·2	1·2	2.30
10	5	4	3	2	1·8	1·6	1·5	1·4	1·3	1·2	1·1	1·1	2
10.30	4	3·5	2·5	1·8	1·7	1·5	1·4	1·2	1·1	1·1	1·1	1·1	1.30
11	4	3·5	2·5	1·8	1·7	1·5	1·3	1·2	1·1	1·1	1	1	1
11.30	3·5	3	2·5	1·8	1·6	1·4	1·3	1·2	1·1	1	1	1	12.30
Noon.	3·5	3	2·5	1·8	1·6	1·4	1·2	1·1	1	1	1	1	Noon.
Morning.	15-31	1-15	15-30	1-15	15-31	1-15	15-30	1-15	15-31	1-15	15-31	1-15	
	DECEMBER.		NOVEMBER.		OCTOBER.		SEPTEMBER.		AUGUST.		JULY.		

FACTORS WITH WHICH ONE HAS TO MULTIPLY THE VALUE OF $\frac{I}{J}$ FOR DIFFUSED SKY LIGHT.

	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.		Evening.
	1-15	15-31	1-15	15-29	1-15	15-31	1-15	15-30	1-15	15-31	1-15	15-30	
Hour.													Hour.
4	...	...	...	...	...	...	...	...	...	...	...	7·5	8
4.30	...	...	...	...	...	...	...	...	...	...	7·5	5	7.30
5	...	...	...	...	...	...	...	...	7·5	5	3·7	3·5	7
5.30	...	...	...	...	...	...	...	6·2	3·7	3·2	2·7	2·5	6.30
6	...	...	...	...	...	7·5	4	3·5	3	2·5	2	1·7	6
6.30	...	...	...	...	7·5	3·8	3·3	2·5	2	1·8	1·7	1·6	5.30
7	...	...	...	7·5	3·8	3	2	1·9	1·7	1·7	1·6	1·5	5
7.30	...	7·5	6·2	3·8	3	2	1·8	1·4	1·6	1·5	1·4	1·4	4.30
8	7·5	4	3·5	3	2	1·7	1·6	1·5	1·4	1·4	1·3	1·2	4
8.30	4	3·5	3	2	1·7	1·6	1·5	1·4	1·2	1·2	1·2	1.2	3.30
9	3·5	3	2	1·7	1·6	1·5	1·4	1·3	1·2	1·2	1·1	1·1	3
9.30	2·5	2	1·8	1·6	1·5	1·4	1·2	1·2	1·1	1·1	1	1	2.30
10	2	1·9	1·7	1·5	1·4	1·2	1·2	1·1	1·1	1	1	1	2
10.30	1·9	1·8	1·6	1·5	1·2	1·2	1·1	1	1	1	1	1	1.30
11	1·8	1·7	1·6	1·4	1·2	1·1	1·1	1	1	1	1	1	1
11.30	1·8	1·7	1·5	1·4	1·2	1·1	1·1	1	1	1	1	1	12.30
Noon.	1·8	1·7	1·5	1·4	1·2	1·1	1·1	1	1	1	1	1	Noon.
Morning.	15-31	1-15	15-30	1-15	15-31	1-15	15-30	1-15	15-31	1-15	15-31	1-15	
	DECEMBER.		NOVEMBER.		OCTOBER.		SEPTEMBER.		AUGUST.		JULY.		

The formula determined for t can approximately be written as follows:—

$$t = L \times \frac{1}{10} \times \frac{F^2}{d^2}.$$

For this the values of L, according to Dorval, are:—

	Sunlight.		Diffused Light.		Cloudy.
	Day.	Morning.	Day.	Morning and Evening.	
Panorama and sea views ...	$\frac{5}{1000}$	$\frac{1}{100}$	$\frac{1}{100}$	$\frac{3}{100}$	$\frac{3}{100}$
Panorama with large masses of foliage	$\frac{1}{100}$	$\frac{2}{100}$	$\frac{2}{100}$	$\frac{4}{100}$	$\frac{6}{100}$
View with bright foreground or white buildings ...	$\frac{1}{100}$	$\frac{2}{100}$	$\frac{2}{100}$	$\frac{4}{100}$	$\frac{6}{100}$
View with dark foreground or dark buildings... ...	$\frac{15}{1000}$	$\frac{3}{100}$	$\frac{3}{100}$	$\frac{6}{100}$	$\frac{9}{100}$
Under trees, shady river banks, ravines, etc. ...	$\frac{5}{100}$	$\frac{1}{10}$	$\frac{12}{100}$	$\frac{2}{10}$	$\frac{3}{10}$
Living objects, groups, portraits, etc., in the open air	$\frac{2}{100}$	$\frac{4}{100}$	$\frac{6}{100}$	$\frac{12}{100}$	$\frac{2}{10}$
The same, very near a window or under a roof ...	$\frac{4}{100}$	$\frac{8}{100}$	$\frac{12}{100}$	$\frac{24}{100}$	$\frac{4}{10}$
Reproductions, enlargements of photographs, engravings, etc.	$\frac{3}{100}$	$\frac{6}{100}$	$\frac{6}{100}$	$\frac{12}{100}$	$\frac{25}{100}$

"Day," in Summer, from 9 to 4; in Winter, from 11 to 2.

(2) *The Plate.* The sensitiveness of the plate used is another important factor, and is that factor concerning the accurate expression of which there is most difficulty; and most workers —even at the present time—prefer to secure uniformity of results by keeping as far as possible to one make of plates, and if using another make to ascertain what allowance to make, once for all, as double, one and a third, or half. Various systems of plate-speed numbers have been devised, and the Hurter and Driffield system, which is based not on the minimum exposure required to obtain an impression on the plate, but rather on that required to produce a full gradation of tones throughout the scale, is at least as reliable as any other system. As several makes of commercial plates are now marked in accordance with the Hurter and Driffield system, and the actinograph is graduated to correspond, it is a very convenient one to adopt. And by

working backwards with the actinograph—taking a thoroughly satisfactory exposure as the basis—some approximation towards the determination of a number for any given batch of plates may be made, even by the casual worker. More or less arbitrary speed numbers are used with the various actinometers, and owing to the very different conditions under which the estimates are made, and the fact that the speed of a plate is rather a complex matter than a simple quantity, these numbers are by no means comparable among themselves. Another difficulty in comparing various scales arises from the fact that the degrees progress unequally on some scales, although in the case of the Hurter and Driffield, and perhaps some others, the sensitiveness is in direct ratio with the numbers, so that a plate corresponding to, say, 10° will not be precisely twice as sensitive as one corresponding to 5°. This is very well illustrated by the following table of the experimental value of the degrees on Warnerke's sensitometer, one of the first instruments which came into general use for determining the relative rapidities of plates :—

CADETT'S TABLE, SHOWING THE RELATIVE RAPIDITIES OF PLATES OF VARYING SENSITOMETER NUMBERS.

Number of times more sensitive than—

	25	24	23	22	21	20	19	18	17	16	15	*B*
25	1	1⅓	1¾	2⅓	3	4	5	7	9	12	16	
24	—	1	1⅓	1¾	2⅓	3	4	5	7	9	12	
23	—	—	1	1⅓	1¾	2⅓	3	4	5	7	9	
22	—	—	—	1	1⅓	1¾	2⅓	3	4	5	7	
21	—	—	—	—	1	1⅓	1¾	2⅓	3	4	5	
20	—	—	—	—	—	1	1⅓	1¾	2⅓	3	4	
19	—	—	—	—	—	—	1	1⅓	1¾	2⅓	3	
18	—	—	—	—	—	—	—	1	1⅓	1¾	2⅓	
17	—	—	—	—	—	—	—	—	1	1⅓	1¾	
16	—	—	—	—	—	—	—	—	—	1	1⅓	
15	—	—	—	—	—	—	—	—	—	—	1	

A

To use this table to compare the rapidity of two plates, the sensitometer numbers of which are known, run the eye up the column *A* till the sensitometer number is reached, and then along the line of figures till it reaches the column of figures under the sensitometer number of the second plate, when the figure there shown will tell at once the difference in rapidity. *Example*—A plate has been used of ordinary rapidity showing 18 on sensitometer, and it is desired to use a plate of sensitometer No. 22: what will be the reduction in exposure? Find 22 in column *A*, and carry the eye along the line of figures opposite to it till it meets the column under 18 in *B* line—the number 3 will be found; therefore the 22 plate is three times as sensitive as the No. 18, and will therefore require one-third of the exposure.

Relative Sensitiveness of Commercial Plates. This can only be given with much reserve and a distinct understanding that the numbers must be regarded as mere estimates, which may, however, serve as a rough guide for a beginner. These numbers are based on the Hurter and Driffield scale, and if assumed of the plates in question and the Hurter and Driffield actinograph is used according to the instructions issued with it, the beginner may feel assured of making an exposure sufficiently near the correct one to serve as a guide for further attempts. It may be mentioned that with thickly coated plates an exposure of double or half the best may be given without complete ruin to the result, provided that the development be suitably modified according to the behaviour of the plate. (See DEVELOPMENT and DEVELOPERS.)

Barnet ordinary and studio	140
„ rapid	190
Beernaert	200
Blair (film)	200
Cadett's (*all packages marked*).	
Eastman (film)	200
Edwards' snap shot	250
„ instantaneous isochromatic... ...	150
„ special portrait	160
Fitch's films. Extra rapid	180
„ „ Rapid	120
„ „ Ordinary	80
Ilford ordinary	60

Ilford rapid	120
„ special rapid	220
„ process	25
Imperial sovereign and extremely rapid ...	300
„ flashlight	400
„ rapid	200
„ ordinary	120
Lumière orthochromatic A or B	150
„ rapid	200
Marion's (*all packages marked*).	
Mawson's special	240
„ castle	180
„ photo-mechanical	25
Paget's XXXXX...	250
„ XXX	150
Thomas's cyclist	240
„ landscape	120
Wratten drop shutter	240
„ instantaneous...	200

(3) *The Subject.* This is one of the factors much misunderstood. Experience soon teaches the novice that a short exposure is required for a white object, more for a dark-coloured; some fail to recognise that darkness in colour or tone is not the same thing as darkness in lighting, and that a white object badly lit may require more exposure than a dark object well lit. We may also consider the subject with regard to colour sensitiveness. If we have to copy, for instance, a yellowish object, and use an ordinary plate which is not sensitive to yellow, we must give a much longer exposure than when using a plate which has been "colour sensitised" for yellow, if we wish to show correctly the difference in the lightness or darkness of objects.

As a guide to exposure on various subjects, the following table by Mr. Burton may be of special value. The figures giving exposure must be regarded as relative to the season and also to the speed of the plates rather than absolute, and must be corrected by the table of plate speeds, also by the season and hour table already given. The exposure times as they stand in the table apply fairly well to exposures made about noon on a bright day in March, and with plates ranging from 100 to 120.

Mr. W. K. Burton's Table of Comparative Exposures.

Apertures calculated on the Standard System of the Photographic Society.	Sea and Sky.	Open Landscape.	Landscape with heavy foliage in foreground.	Under Trees, up to	Fairly Lighted Interiors	Badly Lightly Interiors, up to	Portraits in bright diffused Light, out of doors.	Portraits in good Studio Light.	Portraits in Ordinary Room.
				min. sec.	min. sec.	hr. min.		min. sec.	min. sec.
No. 1, or $\frac{f}{4}$	$\frac{1}{100}$ sec.	$\frac{1}{50}$ sec.	$\frac{1}{8}$ sec.	0 10	0 10	0 2	$\frac{1}{6}$ sec.	0 1	0 4
No. 2, or $\frac{f}{5{\cdot}657}$ ...	$\frac{1}{80}$ sec.	$\frac{1}{25}$ sec.	$\frac{1}{4}$ sec.	0 20	0 20	0 4	$\frac{1}{3}$ sec.	0 2	0 8
No. 4, or $\frac{f}{8}$	$\frac{1}{40}$ sec.	$\frac{1}{12}$ sec.	$\frac{1}{2}$ sec.	0 40	0 40	0 8	$\frac{2}{3}$ sec.	0 4	0 16
No. 8, or $\frac{f}{11{\cdot}314}$ ...	$\frac{1}{20}$ sec.	$\frac{1}{6}$ sec.	1 sec.	1 20	1 20	0 16	$1\frac{1}{3}$ sec.	0 8	0 32
No. 16, or $\frac{f}{16}$	$\frac{1}{10}$ sec.	$\frac{1}{3}$ sec.	2 sec.	2 40	2 40	0 32	$2\frac{2}{3}$ sec.	0 16	1 4
No. 32, or $\frac{f}{22{\cdot}627}$ ...	$\frac{1}{5}$ sec.	$\frac{2}{3}$ sec.	4 sec.	5 20	5 20	1 4	$5\frac{1}{3}$ sec.	0 32	2 8
No. 64, or $\frac{f}{32}$	$\frac{2}{5}$ sec.	$1\frac{1}{3}$ sec.	8 sec.	10 40	10 40	2 8	$10\frac{2}{3}$ sec.	1 4	4 16
No. 128, or $\frac{f}{45{\cdot}255}$ ...	$\frac{4}{5}$ sec.	$2\frac{2}{3}$ sec.	16 sec.	21 20	21 20	4 16	21 sec.	2 8	8 32
No. 256, or $\frac{f}{64}$ ...	$1\frac{3}{5}$ sec.	$5\frac{1}{2}$ sec.	32 sec.	42 40	42 40	8 32	42 sec.	4 16	17 4

(4) *The Diaphragm.* The influence of the diaphragm or stop on exposure has been rather fully dealt with under the headings DIAPHRAGM (*q.v.*), also incidentally in some of the above tabular matter; but in addition we may here give the following:—

TABLE SHOWING AT A GLANCE THE U. S. NO. FOR ALL DIAPHRAGMS.

F. divided by	U. S. No.	F. divided by	U. S. No.
1	$\frac{1}{64}$	9·5	5·64
1¼	·097	9·75	5·94
1·414	$\frac{1}{8}$	10	6·25
1·5	·140	11	7·56
1·75	·191	11·31	8·0
2	$\frac{1}{4}$	12	9·0
2·25	·316	13	10·56
2·5	·390	14	12·25
2·828	$\frac{1}{2}$	15	14·06
2·75	·472	16	16·0
3	·562	17	18·06
3·25	·660	18	20·25
3·5	·765	19	22·56
3·75	·878	20	25·0
4	1·0	21	27·56
4·25	1·12	22	30·25
4·5	1·26	22·62	32·0
4·75	1·41	23	33·06
5	1·56	24	36·0
5·25	1·72	25	39·06
5·5	1·89	26	42·25
5·656	2·0	27	45·56
5·75	2·06	28	49·0
6	2·25	29	52·56
6·25	2·44	30	56·25
6·5	2·64	31	60·06
6·75	2·84	32	64·0
7	3·06	33	68·06
7·25	3·28	34	72·25
7·5	3·51	35	76·56
7·75	3·75	36	80·0
8	4·0	37	85·56
8·25	4·25	38	90·25
8·5	4·51	39	95·06
8·75	4·78	40	100·0
9	5·06	41	105·06
9·25	5·34	42	110·25

F. divided by	U. S. No.	F. divided by	U. S. No.
43	115·56	72	324·0
44	121·0	73	333·06
45	126·56	74	342·25
45·25	128·0	75	351·56
46	132·25	76	361.0
47	138·06	77	370·56
48	144·0	78	380·25
49	150·06	79	390·06
50	156·25	80	400·0
51	162·56	81	410·06
52	169·0	82	420·25
53	175·56	83	430·56
54	182·25	84	440·0
55	189·06	85	451·56
56	196·0	86	462·25
57	203·06	87	473·06
58	210·25	88	484·00
59	217·56	89	495·06
60	225·0	90	506·25
61	232·56	90·50	512·0
62	240·25	91	517·56
63	248·06	92	529·0
64	256·0	93	540·56
65	264·06	94	552·25
66	272·25	95	564·09
67	280·06	96	576·0
68	289·0	97	588·06
69	297·56	98	600·25
70	306·25	99	612·56
71	315·06	100	625·0

(5) *Distance.* Mr. Watkins, in his little pamphlet "Notes on Exposure," says on this subject: "It may be taken as a general rule that, except when photographing near objects (less than twenty-four times the focus of the lens distant), or, on the other hand, extreme distances in landscape, no variation need be made for differences in distance. When a very near object is photographed, the camera has to be racked out, and the exposure increases in proportion to the square of the increased focus of the lens. When the subject is more than twenty-four times the focus of the lens distant (18 feet for a 9-in. lens), this variation is too minute to be taken into account, and if the air were perfectly clear—as it is sometimes among the Swiss peaks —all objects beyond that distance would require the same ex-

Proportion of image to original (linear).	Distance of image from lens in terms of principal focus.	Proportionate exposures.	Exposures proportioned to that required for copying same size.
$\frac{1}{30}$	$1\frac{1}{30}$	1·07	·27
$\frac{1}{20}$	$1\frac{1}{20}$	1·10	·28
$\frac{1}{10}$	$1\frac{1}{10}$	1·21	·3
$\frac{1}{8}$	$1\frac{1}{8}$	1·27	·31
$\frac{1}{6}$	$1\frac{1}{6}$	1·36	·34
$\frac{1}{4}$	$1\frac{1}{4}$	1·56	·39
$\frac{1}{2}$	$1\frac{1}{2}$	2·25	·56
$\frac{3}{4}$	$1\frac{3}{4}$	3·06	·76
1 (same size)	2	4	1
2	3	9	2·25
3	4	16	4
4	5	25	6·25
5	6	36	9
6	7	49	12·25
7	8	64	16
8	9	81	20·25
9	10	100	25
10	11	121	30·25
11	12	144	36
12	13	169	42·25
13	14	196	49
14	15	225	56·25
15	16	256	64
16	17	289	72·25
17	18	324	81
18	19	361	90·25
19	20	400	100
20	21	441	110·25
21	22	484	121
22	23	529	132·25
23	24	576	144
24	25	625	156·25
25	26	676	169
26	27	729	182·25
27	28	784	196
28	29	841	210·25
29	30	900	225
30	31	961	240·25

posure. In England, however, the slight fog or mist almost always present in the air adds reflected light to objects more than one or two hundred yards distant, and thus decreases the

exposure (it is impossible to express this by rule, as it depends entirely upon the *amount* of mist in the air)." Distance, then, is scarcely a factor in ordinary landscape or ordinary work, but in enlargement or reduction it becomes a large factor, and may be allowed for by Mr. Debenham's table of relative exposures (p. 277) for varying proportions of image to the original.

Hurter and Driffield's Actinograph is a slide and roller calculating machine which Messrs. Marion supply fitted in a light mahogany box, 4½ in. by 2¾ in. by 1¼ in., and it weighs about 4 ozs. Inside and at the back is a cylinder, upon which is a chart showing geographically the intensity of daylight for every hour of each day of the year. The slide next to this cylinder is furnished with two scales—one marked for lens apertures, and the other set out for exposures. Next to this is a small pointer-slide which is adjusted to a fixed plate-speed scale, and the pointer-slide now indicates the exposure for each of six selected and typical meteorological conditions. The instrument sold for this country is plotted out for a latitude of 52° 30′; but instruments are supplied for any desired latitude.

Green and Fuidge's Actinometer. This presents the appearance of a small box about the size of a watch, on the cover of which are painted seven tints, each successive tint increasing in depth of colour, the same being intended to represent the colour from its lightest to its deepest shade as produced by printing on sensitive albumenised paper. The instrument assumes that the colour obtained by printing on albumenised paper is always the same; that is to say, that all albumenised papers will print to the same tint, an assumption by no means borne out by experience.

Reid's Actinometer somewhat resembles in appearance a pocket comb, and depends upon the same principle as Green and Fuidge's actinometer, and is open to the same objections.

Watt's Bijou Actinometer. Based on exactly the same principle as the two previous ones.

Stanley's Actinometer. This consists of a reel of paper, coated with a gelatino-bromide emulsion which has been treated with a 10 per cent. solution of nitrite of potassium, which causes a very definite and distinctive coloration by the action of light.

Watkins' Exposure Meters. One form consists of a brass cylinder with movable pointers and scales. At one end is an actinometer of bromide of silver paper, which is exposed to the

light which falls upon the subject, whilst the other end of the cylinder is unfastened and set swinging, each swing being half a second. One of the pointers is set to the number of seconds, and the other pointers are set to the various factors of plate number, subject number, and diaphragm, when the last pointer will indicate the exposure required. An improvement has lately been introduced into this instrument in the shape of a small circle of pale blue glass, covering the bromide paper, which renders the matching of the standard tint, previously a difficulty sometimes met with, very easy. Similar instruments are now made in watch form. The degree on Watkins' exposure meter is often assumed to be equal to one and a half times the Hurter and Driffield figure.

Wynne's Exposure Meter. This is now made in watch form, and, like that previously described, depends for its datum of light intensity upon a standard tint obtained by exposing sensitive paper.

Decoudun's Photometer. This instrument consists practically of a small brass circular box containing sheets of tissue paper in increasing thickness, and it was introduced commercially in 1888. The method of using this instrument is as follows :—The instrument is held with the right hand on the ground-glass of the camera, whilst the focussing cloth must be carefully wrapped round the operator's head, so as to exclude any light but that passing through the ground-glass. The operator now observes from the distance of normal vision the small aperture to the left of the photometer, where three small holes and one large one are seen. The milled head in the centre of the instrument is now turned till the three small holes are no longer visible, and the instrument is then removed, turned over, and a letter will be observed, which gives an index of the exposure required, as against the letter in the table of the instrument will be found the exposure. Weber (" Phot. Mittheil.," vol. xxv., p. 37) has pointed out that this instrument possesses a scale of brightness of 9·48 to 0·35, to which the exposure is theoretically inversely proportional—that is to say, the time of exposure should be from 1 to 27—whilst Decoudun gives his scale of exposures from 1 to 750, which is quite sufficient to condemn it. Goerz, of Berlin, has introduced an improved and simplified form, which, however, is also open to the same theoretical objections.

Tylar and Pickard's Exposure Meter. This consists of a metal tube, the interior of which is provided with holes and increasing thicknesses of a translucent material which are brought before the holes by means of an external pointer, which indicates the exposure on a tablet affixed to the outside. This is open to the same objection as the last instrument, but differs from it in that it is directed to the subject, and not to the screen.

Warnerke's Phosphorescent Photometer. The principle of this is the excitation of a patch of luminous paint by the light falling upon the subject for one second, and then the estimation of the brightness of the luminescent paint by means of translucent screens of increasing thickness.

Ballard's Actinometer. This depends for its action on the power of luminous paint to retain and throw out again the light impressions it has received, and it consists of a square tube of wood, having at one end a hinged cover, with, on the inside, a prepared surface and a spot in the centre. The method of using is to open the cover, and look through the tube directly at the object to be photographed for half a minute; then, closing the tube, a central blue spot will be seen, which will gradually disappear. The number of seconds which it takes to do this forms the basis of the calculation of a series of tables which accompany the actinometer. The fault of these instruments, which depend upon phosphorescent paint, is that the personal equation of the individual eye comes into play, and that, according to Wiedeman (Eder's "Jahrbuch," 1891, p. 588), if Balmain's luminous paint be exposed for one second, the brightness of the light emitted from that paint is not constant, as shown by the following table:—

After the lapse of		4	secs.,	brightness	= 27·8
,,	,,	20	,,	,,	= 7·6
,,	,,	40	,,	,,	= 4·2
,,	,,	60	,,	,,	= 3·1
,,	,,	90	,,	,,	= 1·9
,,	,,	180	,,	,,	= 1·0
,,	,,	240	,,	,,	= 1·0

and the shorter the exposure the greater the sudden drop—indeed, there is no constant ratio.

The Ilford Exposure Meter. This is practically a circular slide rule, with discs which can be revolved and set to the

different factors of plate, stop, time, and subject; the exposure being read off and modified, according to the time of year, from a table on the back compiled by Dr. Scott, by whom the instrument was devised.

Counting the Time of Exposure. Possessors of a watch with a second hand will have no difficulty in counting the duration of a lengthy exposure, but for shorter periods than this some other aid is required. Most modern watches tick five times in a second—occasionally one may be picked up which ticks four to the second; there are also cheap stop-watches on the market, which have an extra hand marking fifths of a second, and which can be stopped or started in one-fifth of a second. It has also been suggested to use a bunch of keys or a bullet tied to a string 9½ ins. in length, which, when set swinging, beats half-seconds. But in many cases it is desirable to look at the subject whilst making an exposure, especially when such is of short duration; it then becomes impossible to look at a watch or swinging body at the same time. Therefore, it is convenient to practise the counting of seconds. Accuracy can only be obtained by practice, but it soon becomes easy. A convenient method of counting is as follows: Say, for instance, 3 secs. are required. As soon as the cap is removed, count 1, 2, 3, 4; 2, 2, 3, 4; 3, 2, 3, 4. Again, we will suppose 1½ sec. is required, 1, 2, 3, 4; 2, 2. It will be seen from this that four are counted to the second, and each second begins with the number which the four when counted will complete. See SENSITIVENESS.

Fabric, Golden. A translucent cloth, coloured yellow, used for the dark-room window. It should always be tested to see whether actinic light filters through, as described under DARK-ROOM (*q.v.*).

Fading. The worst of all ills to which good or interesting negatives and prints are subject; but in some cases a benefit to humanity.

Negative fading. This is due to insufficient washing or fixing, and the consequent action of hypo on the delicate image of silver.

Fading of Prints. The cause of this may in most cases be traced in some way or other to sulphur, or its compounds. Albumen itself contains a minute trace of sulphur, and conse-

quent decomposition may give rise to the formation of some compound of sulphur and silver. Again, insufficient fixing may form the insoluble variety of hyposulphite of silver, and insufficient elimination of the fixing salt itself may supply the unlooked-for result. Hypo is used as an anti-chlor in the manufacture of some mounts, and this should be tested for as described under the head of SODIUM HYPOSULPHITE (*q.v.*). An acid or decomposing mountant, or absorption by an hygroscopic mount of the aqueous vapour from the atmosphere holding in solution certain acids, may also cause it. To prevent any such action, great care should be taken to completely eliminate the fixing salts, and to keep the prints where damp is not likely to reach them; the use of encaustic paste is in itself a partial protection from the aqueous vapour.

Fahrenheit. See THERMOMETER.

Falling Front. See RISING FRONT.

Feer-type. This process is founded on the property possessed by diazo compounds, of forming diazo-sulphonic salts with sodium sulphite; and these diazo-sulphonic compounds, when mixed with phenols or amines and exposed to light, are decomposed, and the diazo compound is set free and forms a colouring matter—a positive is thus obtained from a negative. This process was patented by Dr. Adolf Feer in 1889, and the following is the substance of his specification:—The present process rests on the fact that, as the inventor has discovered, diazo-sulphonic salts react with phenol alkalies and hydrochloric or free aromatic amines, under the influence of solar or electric light, with the formation of the azo colouring matter. To carry out this process the inventor impregnates paper or cloth with a diluted mixture of a diazo-sulphonic salt (*e.g.*, of aniline, amido azo-benzol, benzidine, and their homologues) and alkaline compounds of phenols (as phenol, resorcin, α- and β-naphthol) on one hand, or hydrochloric and amines (aniline, naphthylamine, phenylendiamine, and their homologues) on the other hand; the paper or material is then dried in the dark, and exposed under a negative for about five minutes, or to the electric light. By this means there is formed on the exposed places the insoluble azo colouring matter, whilst on the unexposed parts, under the opaque portions of the negative, the preparations remain in their

original conditions of solubility and colourlessness. The picture is thus developed. After exposure the print is washed with water or very dilute hydrochloric acid, by which means the unchanged preparation, which has not been exposed under the negative, is removed. The print is then fixed and finished when dry. The following may be taken as samples of solutions :—

I.

Sodium toluene-diazosulphonate	25 parts.
β-naphthol	25 ,,
Sodium hydrate	8 ,,
Water	1000 ,,

II.

Sodium ditolyl-tetrazosulphonate	25 parts.
Metaphenylene-diamine	20 ,,
Water	1000 ,,

III.

Sodium ditolyl-tetrazosulphonate	25 parts.
Resorcinol	12 ,,
Sodium hydrate	16 ,,
Water	1000 ,,

The following may also be used :—

IV.

Sodium ditolyl-tetrazosulphonate	30 parts.
Resorcinol	20 ,,
Sodium hydrate	15 ,,
Distilled water	1000 ,,

Finely powder all the salts and dissolve in the water by the aid of a gentle heat.

V.

Sodium ditolyl-tetrazosulphonate	30 parts.
α-naphthol	25 ,,
Sodium hydrate	7 ,,
Distilled water	1000 ,,

VI.

Sodium ditolyl-tetrazosulphonate	30 parts.
Phenylendiamin	20 ,,
Distilled water	1000 ,,

For sensitising the paper or materials solutions IV. and V. or V. and VI. may be mixed in equal parts. The paper is impregnated with the desired mixture, dried, and then exposed under a negative for ten or fifteen minutes, and after exposure washed in dilute hydrochloric acid, and finally with water, and dried. Feer has lately suggested diazo-pseumocumidine sulphonate, and this, with β-naphthol and sodium hydrate, gives scarlet-red images; by replacing the β-naphthol with α-naphthylamine violet images are obtained, and by using resorcinol orange colours are obtained.

Ferrotypes. Positives taken by the wet process on thin iron plate, which is coated with brown or black varnish. As the production of these is exactly the same as the production of collodion positives on glass, instructions are given for this under Wet Collodion (*q.v.*). Ferrotype plates coated with a thin film of a highly argentiferous gelatine emulsion have been introduced commercially for use with a semi-automatic camera, like that of Mr. Nievsky, and which is described under the heading AUTOMATIC PHOTOGRAPHY. A much better ferrotype dry plate, esteemed by those itinerant professional photographers who use the automatic camera out of doors, is one coated with a collodion emulsion film, and put on the market by Mr. Nievsky.

Ferrous Oxalate Developer. See DEVELOPER; also BROMIDE PAPER.

Ferrous Salts. See IRON and its salts.

Field of a Lens is the illuminated circle given by the lens, the diameter of which is usually expressed in degrees, but, as we have already noted, is conveniently expressed in terms of the focal length. The extent of surface which a lens will cover is independent of the diameter of the diaphragm aperture, but the area of sharp focus is affected by the diameter of the stop. (See also ANGLE OF VIEW.)

Filigrane. This term is applied by the French to that which we call the water-mark of paper, and Mr. W. B. Woodbury imitated water-marking by passing a sheet of plain paper between rollers together with one of his gelatine reliefs (see WOODBURYTYPE). Those parts of the sheet which were subjected to most pressure became of greater transparency than the rest. Woodbury called this process Photo-filigrane.

Film. The thin pellicle or skin of sensitive material on plates or paper is generally spoken of as the film.

To Remove Old Films. Nothing is better for quick removal than glacial acetic acid made into a cream with pumice-stone powder and applied with a tuft of rag, the acid instantly dissolving the film, and the pumice powder acting as a mechanical means of removing it. When time is not an object, soaking in a weak solution (1 to 40) of caustic soda is a useful method.

To Clean the Film from the Back of Plates. Few plate manufacturers coat their plates so carefully but what some small smears of emulsion get on the back of plate. To remove this, when the plate is thoroughly dry, place it face downwards upon a pad of blotting paper, and use a little salt with a moistened rag. The salt must not be allowed to reach the front of the plate.

Film Photography. The disadvantages of glass when used as a support for the sensitive material—which are its weight, its bulk, and liability to fracture—have induced many experimenters to search for a light, flexible support which might be used as a substitute. Thirty years ago waxed paper was used, and on the introduction of gelatine emulsions the search for a substitute received great impetus. Woodbury, in 1871, suggested rollable films; Warnerke, in 1876, used gelatine emulsion spread on paper, from which it was afterwards stripped; Pumphrey, Vergara, and others followed; but it was not till the introduction of Celluloid (*q.v.*) that a satisfactory stage may be said to have been reached. The treatment of films is so similar to that for glass plates, that no special instructions need be given.

Films, Hardening. See FORMALIN.

Filtration. In most cases such filtration as is incident to photographic operations is through white blotting-paper, or the somewhat similar paper which is sold as filtering paper, this latter being often sold ready cut to circular shape. A piece of the paper having been twice folded and opened out so as to form a conical cup, is placed in a glass funnel and the liquid to be filtered is carefully poured in.

Finder. See VIEW FINDER AND VIEW METER.

Fish Glue Process. One of the most common methods of making typographic blocks for representing photographic half-

tone as a kind of quarried or lined stipple. The short account here given may not quite serve as a complete guide to the beginner in all complications and difficulties which may arise, but will be sufficient indication as to the way. In the case of a photograph to be reproduced by the fish-glue process, a new negative must be made, and not only must this negative be reversed laterally, but its texture must be broken up in the way indicated. The new negative is usually made from a print—this print being photographed by a camera provided with a reversing prism or mirror before the lens. Inside the camera, and near the plate, is a "screen" formed of a plate of glass upon which cross lines have been ruled, etched, and filled in with a black pigment, the distance of this in front of the negative plate being ordinarily between $\frac{1}{16}$ of an inch and $\frac{1}{8}$ of an inch: the criterion of the distance being the formation of a pinhole image of the lens aperture by each window of the screen; but a certain amount of penumbra is required. The grained and reversed negative having been made, such a mixture as the following is prepared for use in coating the plate to be etched (generally copper):—

Commercial Liquid Fish Glue	2 ozs.
White of Egg	2 „
Water	4 „
Ammonium Bichromate	60 grs.

These materials are agitated together by shaking in a bottle containing some pieces of glass, and the mixture is filtered through cotton wool. A carefully cleaned and highly polished copper plate is now coated by flooding it with the mixture and pouring off the excess, and it is then dried in a horizontal position. Two or three minutes in sunlight is generally a sufficient exposure. After exposure the plate is soaked in water to remove the unaltered bichromate and such portions of the film as remain soluble; after which it is dried. When dry the plate is heated so strongly as almost to char—or at any rate to darken—the film, which then forms an admirable resist to an etching fluid. Perchloride of iron is generally employed, and for details see under the heading PHOTOGRAVURE.

Fixed Focus.—This term has become so general of late that one writer actually says, "With regard to fixed-focus lenses I am

quite ignorant of the principle on which they are constructed, but it seems to me a most extraordinary thing, if they can be constructed at all, why any other kind should be made. With the lens on my . . . everything from three feet to the extreme distance is in the sharpest possible focus; and this being so, it is most amazing that makers should go on manufacturing lenses that require re-focussing for every picture, which is in all cases an unmitigated nuisance and, in the case of instantaneous pictures, the cause of the loss of more than half the chances offered, and of half the pictures actually taken being out of focus." It is quite possible that there are many in the same state of amazement as the above writer, who may, for all we know, still be in the same state; therefore to him and to others like him it may be of interest to learn that every lens has a fixed focus, and that there is no lens which is manufactured which is not quite as much a fixed-focus lens as the particular lens which called forth the above remarks, and that, moreover, there never has been a fixed-focus lens yet made and never will be. But what we mean to state is this—a fixed focus is a theoretical impossibility, but with every lens there is a point beyond which objects are in sufficient sharpness to satisfy our requirements as to definition, because when the image of a point is less than the $\frac{1}{100}$ part of an inch in diameter, then the eye perceives the image as a point sharply defined; and this has given rise to the term in question. Several rules are in existence for finding out the nearest point in focus, but one of the best is that by Mr. W. Cheyney, in the "Journal of the Franklin Institute," which is as follows:—Multiply the diameter of the aperture of a lens by the equivalent focus thereof, divide the product by the greatest allowable error, and to the quotient add the equivalent focus. The sum will be the distance of an object upon which the lens should be accurately focussed in order that all objects beyond a point one-half of the above distances shall be apparently in focus. Thus—

Let f = the equivalent focus.
a = the diameter of aperture.
e = the greatest allowable error.
Then d = the distance of an object, upon which if the lens be accurately focussed, all objects beyond $d/2$ will apparently be in focus.

Or,

$$\frac{a \times f}{e} + f = d, \text{ then } d \div 2 = \text{point in focus.}$$

Examples:—Thus with a lens of 8-in. focus and *f*/8 diaphragm we have

$$\frac{1 \times 8}{\frac{1}{250}} + 8 = d = 2{,}008 \text{ in.} = 167 \text{ ft. } 4 \text{ in.}$$

Then $d \div 2$, or 167 ft. 4-in. $\div 2 = 83$ ft. 8 in.

Again, if we use a lens of 4-in. focus and *f*/16 aperture we have

$$\frac{\frac{1}{4} \times 4}{\frac{1}{250}} + 4 = d = 254 \text{ in.} = 21 \text{ ft. } 2 \text{ in.}$$

Then $d \div 2$ or 21 ft. 2 in. $\div 2 = 10$ ft. 7 in.

Mr. Cheyney gives the following table, tested by various rectilinear, wide-angle, and single landscape lenses:—

Equiv. Focus.	Aperture.	Distance of Object Focussed Upon.	All Objects in Focus Beyond.
2	*f*/8	10 ft. 7 in.	5 ft. 3 in.
2	*f*/11·31	7 „ 11 „	3 „ 11 „
2	*f*/16	5 „ 4 „	2 „ 8 „
3	*f*/8	23 „ 8 „	11 „ 10 „
3	*f*/11·31	17 „ 10 „	8 „ 11 „
3	*f*/16	11 „ 11 „	5 „ 11 „
4	*f*/8	42 „ 0 „	21 „ 0 „
4	*f*/11·31	31 „ 3 „	15 „ 7 „
4	*f*/16	21 „ 2 „	10 „ 7 „
5	*f*/8	65 „ 6 „	32 „ 9 „
5	*f*/11·31	49 „ 3 „	24 „ 7 „
5	*f*/16	32 „ 11 „	16 „ 5 „
6	*f*/8	94 „ 3 „	47 „ 1 „
6	*f*/11·31	70 „ 9 „	35 „ 4 „
6	*f*/16	47 „ 4 „	23 „ 8 „
7	*f*/8	126 „ 1 „	63 „ 0 „
7	*f*/11·31	94 „ 8 „	47 „ 4 „
7	*f*/16	63 „ 4 „	31 „ 8 „
8	*f*/8	167 „ 4 „	83 „ 8 „
8	*f*/11·31	125 „ 8 „	62 „ 10 „
8	*f*/16	84 „ 0 „	42 „ 0 „

Fractions of an inch are unnecessary. On reading through the above table many readers may at once exclaim, "If this is right,

Messrs. Blank & Blank, lens makers or lens sellers, are wrong when they state that all objects beyond so many feet will be in focus with their lens; their distances are not nearly so much as the above table. Take, for instance, one special hand-camera: this has a 5-in. focus lens, and works at *f*/8, and yet the vendor states that everything beyond 15 ft. is in focus: by the above table everything beyond 32 ft. is in focus." To reconcile these seeming paradoxes is not difficult, as it will be noted that Mr. Cheyney takes $\frac{1}{250}$ of an inch as the greatest permissible error; if, however, we take $\frac{1}{100}$ of an inch as the permissible error we get totally different results, as seen by working out his examples:—

$$\frac{1 \times 8}{\frac{1}{100}} + 8 = 808 \text{ in.} = 67{\cdot}4 \text{ ft.}$$

Then $67{\cdot}4 \div 2 = 33$ ft. 8 in.

And $\frac{\frac{1}{4} \times 4}{\frac{1}{100}} + 4 = 104 = 8$ ft. 8 in.

Then 8 ft. 8 in. $\div$ 2 = 4 ft. 4 in.

Taking $\frac{1}{100}$ of an inch as the permissible error, we have worked out from Mr. Cheyney's rule the following table, which may be useful:—

POINT BEYOND WHICH ALL OBJECTS WILL BE IN FOCUS.

EQUIVALENT FOCUS.	APERTURES.			
	f/8.	*f*/11·31.	*f*/16.	*f*/22.
3 inches ...	4 ft. 9 in.	3 ft. 6 in.	2 ft. 6 in.	1 ft. 9 in.
3½ " ...	6 " 6 "	4 " 9 "	3 " 3 "	2 " 6 "
4 " ...	8 " 6 "	6 " 3 "	4 " 3 "	3 " 3 "
4½ " ...	10 " 9 "	8 " 10 "	5 " 6 "	4 " 6 "
5 " ...	13 " 3 "	9 " 9 "	6 " 6 "	5 " 0 "
5½ " ...	16 " 0 "	11 " 9 "	8 " 0 "	6 " 0 "
6 " ...	19 " 0 "	15 " 0 "	9 " 6 "	7 " 6 "
6½ " ...	22 " 6 "	16 " 6 "	11 " 3 "	8 " 3 "
7 " ...	26 " 0 "	20 " 0 "	13 " 0 "	10 " 0 "

We may also give Miethe's table of fixed foci:—

Aperture.	Distance of nearest object in focus expressed in units of the focal length.
F/4	87
F/5	70
F/6	58
F/7	50
F/10	35
F/12	29
F/15	23
F/20	17·5
F/30	11·6

Example: To find the nearest point in focus with a 5-in. lens working at F/10. $5 \times 35 = 175$ ins. $= 14$ ft. 7 ins.

Another rule for finding the same is:—Multiply 2·7 by the square of the focal length of the lens and by the fraction expressing the diameter of the diaphragm aperture.

Example:—Required the nearest point in focus with a lens $4\frac{1}{4}$-in. focus, *f*/10 diaphragm.

$$2{\cdot}7 \times 4\tfrac{1}{2} \times 4\tfrac{1}{2} \times \tfrac{1}{10} = 2{\cdot}7 \times 20{\cdot}25 \times {\cdot}1 = 5{\cdot}46 \text{ yards.}$$

Fixing. The removal of any sensitive salt unacted upon by light or by the developer, thus rendering the negative or print unalterable by the further action of light. The usual method of effecting this in the case of the silver salts is by the solvent action of Hyposulphite or Thiosulphate of Sodium (*q.v.*); cyanide of potassium, sulphocyanide of potassium or ammonium, and sulphite of sodium, have also been recommended. Cyanide of potassium is more powerful than hypo, but its action on the image is so great as to deteriorate the half-tones occasionally. Hypo, then, is our chief resource; but the difficulty of completely eliminating, however, is its great drawback. For fixing negatives it is desirable to use two fixing baths, the strength being about 4 ozs. to the pint of water in each, the negative being allowed to remain for ten minutes in the first, and for about five minutes in the second; by this a more thorough fixing of the negative is effected. For fixing prints the strength generally recommended is about half that for negatives—that is, about 2 ozs. to the pint —and sufficient liquor ammonia or carbonate of ammonia should

be added to make the solution smell faintly of ammonia. This neutralises any free acid which may be present in the solution, and prevents any loss of tone in fixing. One may safely use the same strength as for negatives with the addition of ammonia, as above described; and lengthened experience shows the advantage of doing this, as the fixing is completed in half the time, and there is less chance of loss of tone. R. E. Liesegang has suggested the use of Thiosinamine (*q.v.*) as a fixing agent, and it is specially adapted for prints. For plates its action is much slower than hypo, but it is said to possess the advantage of being more quickly removed. The strength suggested is 1 per cent. Captain Abney has recommended sulphite of soda as a fixing bath for prints, but as chloride of silver is much less soluble in sulphite of soda than in hyposulphite, failures have occurred. The following editorial remarks, taken from the *Amateur Photographer*, touch on the essential points of success and the sources of failure:—"Owing to the fact that much of the commercial sulph*ite* contains sulph*ate*, or has become converted by oxidation, the use of sulphite as a fixing agent is often disappointing. We do not recommend a much stronger solution than 20 per cent., but it is desirable to use a much larger quantity than is ordinarily recommended—say 3 or 4 ozs. of the sulphite for half a sheet of paper; and a *sufficient time should be allowed for it to act.* That is to say, double the time should be allowed that is necessary for the *apparent* dissolution of the chloride of silver, when the print is viewed by transmitted light. If a print, such as on albumenised or any not very thick paper, be looked at against the light during fixation, it will reveal the gradual disappearance of the chloride of silver in cloudy masses, in much the same manner as with a glass negative; and when, after an interval of time, such indications of the presence of unacted open chloride are removed, the print should be returned to the fixing bath (or to a fresh bath) for the same length of time again. This is a good old rule given in connection with hyposulphite fixing, and may with still greater advantage be applied in the case of sulphite of soda. (See ACID FIXING BATH; and for the combined fixing and toning bath, see TONING.)

Flare. A fogged patch, generally central, circular, or arch-shaped, on a developed plate, and of course recognisable by the

eye on the focussing screen. Flare may be due to many causes. For example, an image of one glass reflected from the concave surface of another, or an image of the diaphragm or its edges. In these cases only the more strongly illuminated portion of the "object" will cast an appreciable image, and the flare spot will not form a complete circle. Monckhoven, in his "Photographic Optics," states that it is often due to too close an adherence to the globular form by the optician who constructed the lens. Others, again, state that it is due to the edges of the diaphragm aperture being worn bright, and this no doubt is a general cause for its sudden appearance in a lens. The Iris diaphragm, but lately introduced for photographic objectives, seems to be particularly liable to this, from the friction of the tongues of metal of which it is formed ; others state that when the lenses are mounted in cells which are not blackened, a flare is almost certain to make its appearance. All lenses should be examined for this most annoying effect, which can rarely be wholly eradicated. It is very often a defect in portrait lenses when such are used for outdoor work where any portion of bright sky is included in the background, and in this instance it is clearly an image of the lens by reflection from the surfaces. The remedies are not by any means satisfactory, as, whatever is done, at its best the flare spot is so distributed over the whole plate instead of being localised. When the diaphragm edges are worn bright they should be blackened, and the cells in which the lenses are mounted should also be attended to. It can be eliminated partially as stated above, by altering the position of the diaphragm slightly ; but as this is used to reduce distortion to a minimum, the remedy may be worse than the disease by introducing this defect. Slightly altering the relative positions of the two lenses will often efface it, but, as said before, only by distributing it.

Flash Light. One of the most useful lighting methods for portraiture at night is to so suddenly burn magnesium or aluminium dust that an instantaneous flash is produced, the combustion being so rapid that the exposure is finished before the sitter has time to move. One disadvantage of flash-light portraiture is the fact that the eyes of the sitter are generally shown as having the iris unnaturally open, and an unusual expression results.

Magnesium dust, or the very finest aluminium bronze powder, may be blown through a spirit lamp or gas flame by means of a piece of a halfpenny pea-shooter, or one of the very diverse but essentially similar flash lamps sold in the shops. Three grains of magnesium will suffice for a portrait if a rapid portrait lens is used and also quick plates; but it is important to work in an apartment with a low and very white ceiling and a white sheet on the floor, to act as reflectors. Success depends largely on using the minimum quantity of magnesium, as it is only then that complete and rapid combustion can be depended upon. Explosive mixtures of magnesium with oxidising salts, as chlorate of potassium, are sometimes used, especially when a powerful flash of the briefest possible duration is required; but such mixtures should be made and used with extreme caution, as several fatalities are on record. As regards these precautions, we cannot do better than quote from an article in *The Amateur Photographer*, by a contributor writing as "Index":—"When an explosive mixture is used, the following may be taken as one which has worked satisfactorily:—

Magnesium powder...	60 grs.
Chlorate of potash	90 „

The mixture should not be made up in bulk, but only as required. The powders should both be dry; they may be, if necessary, *separately* dried in an oven only moderately warm, and *when cold* mixed with a piece of card, or a feather, on a sheet of paper. Any lumps in the chlorate should be thoroughly crushed before mixing. There should be no friction with a hard substance during mixture or after the powders have been mixed, or a disastrous explosion may ensue. A cautious manipulator will so arrange matters that if at any instant the mixture should fire, neither he nor any one else will be seriously hurt. The mixture may be fired by a taper affixed to the end of a stick. If the exposure is to take place out of doors, a small quantity of sulphide of antimony may be added, as in the following formula:—

Chlorate of potash	60 grs.
Magnesium powder...	30 „
Sulphide of antimony	10 „

Combustion is more rapid with this mixture, estimated, indeed, by Messrs. Gaedicke and Miethe to take place in from the fiftieth

to the thirtieth of a second; but the fumes given off are so offensive and poisonous that it should not be used in the house unless in a large lantern or combustion chamber, furnished with a chimney leading into the open air." As a comment on the latter remark, we may mention that outdoor scenes, groups, and even buildings, have been successfully photographed by flash light.

Flatness. A want of vigour and contrast in the negative and resulting prints, due to over-exposure, or to the use of too strong or too weak a developer.

Fluorescence. See RADIOGRAPHY.

Fluorhydric, or Hydrofluoric Acid. $HF = 20$. Is obtained by heating fluor-spar with sulphuric acid in a leaden or platinum retort, connected with a receiver of the same metal. It is a colourless gas, very soluble in water, and condensing at 20° C. into a mobile fuming liquid, which boils at 59° F. It has the peculiar property of dissolving glass and other silicates, and for this reason leaden or platinum vessels are used to prepare it, and the aqueous solution is stored in india-rubber bottles. Extreme care is necessary in handling it, as even when dilute it causes very painful ulcers when applied to the skin, and dissolves the nails. It has several photographic uses, all of which depend on its solvent action on glass. Hydrofluoric acid has been recommended for detaching the negative film from glass plates, for preparing a film negative. See NEGATIVES, STRIPPING OF; also HYALOGRAPHY.

Fluorine. $F = 19$. A non-metallic element never met with in a free state. Fluorine has only recently been isolated.

Focal Length, Focus, or Equivalent Focus. The latter term is applied specially to a compound or doublet lens. It is the focus of parallel rays entering the lens, and is thus called from the fact of the image formed equalling in size that formed by a single lens. It is extremely important that every photographer should know how to find the focal length of his lens, because upon this depends the determination of several factors. Before deciding, however, on the best method of measuring the focal length, it is necessary to know where we are to start measuring from. If we take a single or landscape lens we shall

find that there are three or four points which we can measure from. Thus we may measure from the plane of the diaphragm, from the front surface of the lens, or from the centre of the lens, or from the posterior surface of the lens; and each point will give us a different length. Thus in the case of a rectilinear lens we can measure from several points: from the front lens, from the plane of the diaphragm, from the back surface of the posterior lens. It is very usual to see in some opticians' catalogues the term "back focus," and this is the distance between the posterior lens and ground-glass; and is given to enable the user to judge whether the lens can be used on any particular camera. The correct point to measure the focal length from is one of the "nodal points" of a lens, but, practically, the following methods may be used with the satisfaction of knowing that the focal length of any lens thus measured is sufficiently accurate for all practical purposes. For practical purposes it is quite sufficient to set the camera up and focus the sun or the clouds, and in the cases of single lenses measure the distance between the front surface of the lens and ground-glass, and with portrait or doublet lenses the distance between the diaphragm slot and ground-glass. This method is not precise, and more accurate measurements may be made by one of the following plans:—

(1) *Grubb's Method.* On the ground-glass of the camera draw two pencil lines about an inch from the margin at each side.

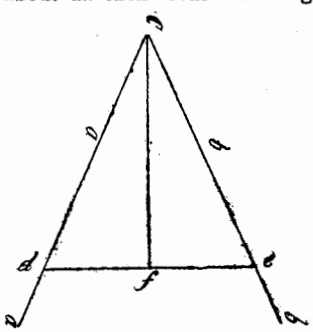


Fig. 49.

Now set up the camera before a window, preferably upon some flat surface, such as a table, upon which is spread a sheet of

white paper, and focus for some distant scene, more than 150 or 200 yards off, in which there is some distinct feature, such as a church spire or tall chimney. Make the image of this fall upon one of the pencil marks on the focussing screen, and with a pencil draw a line upon the paper along the side of the camera; now bring the image of the chimney or spire upon the other line, when draw another line upon the paper also along the side of the camera; remove the camera, and with a flat rule continue these lines till they cut one another, so as to form an angle, across which draw a line, so as to form a triangle, which line must be exactly the same length as the distance between the two pencil marks on the focussing screen. Find the centre of this base accurately, and connect the junction or apex of the angular lines with the centre of the base. This line will then be the true equivalent focus of the lens. The lines *aa'*, *bb'*, are those traced on the paper along the sides of the camera, extended until they meet at *c*. *d e* is the base, being the exact distance apart of the two pencil marks; *f* its centre, and *cf* the true equivalent focus of the lens.

(2) *Method by Focussing a Given Object the Same Size.* With long-extension cameras a very common method is to focus on any object till the image is exactly the same size as the object, then measure the distance between the object and ground-glass, and divide by four, when the result will be the equivalent focus. A convenient object to use is a foot rule. Example:—On focussing a foot rule, till the image or part of it measures exactly the same, we find the distance between object and ground-glass to be $73\frac{1}{2}$ in. Then $73\frac{1}{2} \div 4 = 18\frac{3}{8}$ in., the focal length of lens used. For single lenses this method is sufficiently accurate, but subject to error in other cases.

(3) *Schroeder's Method.* This can only be used by possessors of a telescope. First of all take a piece of cardboard—a mount will do—and punch two holes in it some little distance apart; place this card flat on the ground side of the focussing screen, and with a lead pencil blacken the ground-glass through the holes. Now go into a darkened room and set up the card, and place behind it a lamp or candle; erect the camera, and rack the lens in or out till the bright spots of light coming through the holes in the card fall exactly on the black spots on the ground-glass, and mark accurately the position of the ground-glass on

the base-board of the camera, as shown in fig. 50, in which A is the card with the two holes, P the lens—here represented by a single double-convex lens—and B the focussing screen, marked by the pencil with the two black dots, on which are focussed the bright spots of light as shown by the dotted lines. A small

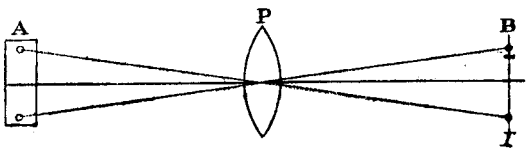


Fig. 50.

telescope is now focussed on the moon, and, the focus temporarily fixed, the ground-glass is removed from the frame, and a negative of a strong contrasted subject is placed in the frame, from which the ground-glass has just been removed. A very good negative,

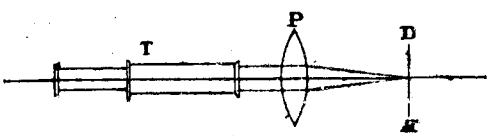


Fig. 51.

if handy, is that of a line-drawing. The eye-piece of the telescope is now placed in the same position as the card previously used—*i.e.*, opposite the lens of the camera; a candle or lamp is placed behind the negative, and the camera racked-in till the

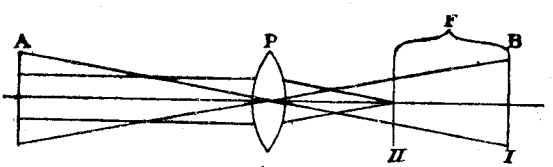


Fig. 52.

lines of the negative are seen sharp and clear. Now, as the telescope focus has been fixed for infinity, the negative will only appear sharp when it is at the true focus of the lens; this position is then accurately marked, as shown in fig. 51, in which T is the telescope focussed for infinity, P the lens, and D H the position of

the plane of the negative. Fig. 52 is, as will be at once seen, a combination of the two previous diagrams—figs. 50 and 51—and the distance between the plane I and plane II is the true equivalent focus of the lens designated in the diagram by F.

(4) *Stolze's Method.* This, or the following method, No. 5, will be found the most convenient in practice. Dr. Stolze described his method in "Photographische Nachrichten, vol. ii., p. 164, 1890, as follows:—"One first focusses on a very distant object, or, so to speak, on infinity, and marks this position of the focussing screen on the base-board of the camera. Then the camera is directed at a very near upright object of known, or easily measurable, size—best on a foot rule—so that the image falls on the focussing screen; this is sharply focussed, and this position of the screen again marked on the base-board; a negative is taken of the object in this position, and after development the size of the image of the photographed object is carefully measured, and one thus determines how much smaller the former is than the latter. If one multiplies the difference between the two foci with this number, the result will be the focal length." Possibly an example will make this a little clearer: We have focussed on a very distant object, and marked the base-board, and have also focussed on a foot rule and taken a negative, and find that the image of the foot rule measures 10 in., the distance between the two marks on the base-board is 19 in., then

$$F = 19 \times \tfrac{12}{10} = 22{\cdot}8 \text{ in.}$$

The size of the image should be as large as possible—that is to say, the amount of reduction should be as little as possible, because the greater the reduction the less accurate the result.

(5) *Proportional Method.* This method is extremely convenient when working with somewhat short-focus cameras and long-focus lenses. The camera is placed upon a table, when convenient, or if such is not handy, on the ordinary tripod. We support on a wall, shelf, or convenient place a foot rule which is plainly marked in inches. On the ground-glass of the camera a space of two inches is accurately marked as near the centre as possible: it is merely necessary to mark off the two inches, not to divide it out into parts. The camera is now moved backwards or forwards till the image of the foot rule of twelve inches just falls on the two-inch space we have marked out. The coincidence

of the image on the lines should be examined with an eye-piece or compound focusser, to see that they do coincide, then the distance between the foot rule and the focussing should be carefully measured, and this distance jotted down, as from this we obtain the focal length of the lens. This number is multiplied by the figure which represents the proportion of the image to the original object, and the result is then divided by the square of the proportional number plus one. Taking an example, we find that the distance between the foot rule and its image equals 63 ins.

$$\therefore 63 \times 6 = 378;$$
$$378 \div 49 = 7\tfrac{5}{7} \text{ in., the required focal length.}$$

It must not be thought that the above proportion between the object and its image is essential; any convenient proportion may be taken, such as 4, 5, 8, etc., but the rule holds good with all.

Parallel rays proceeding from any object and transmitted by a convergent lens are refracted in such a manner that they meet at a point and form an image of that object, this point being called the principal focus. Rays which are not parallel but which diverge from an object are transmitted by a convex lens and united to a point, and the two points thus connected are said to be conjugate foci; or in other words the distance between any point in any object and the lens, and the distance between the lens and the image of that point, are said to be the conjugate foci of the lens. These foci are of great importance when enlargement or reduction of any print, engraving, or negative is required. The rules for finding the conjugate focal distances are given under Enlarging (*q.v.*), and a table is given to save calculation.

Actinic Focus. As has been stated under chromatic aberration the actinic focus is not actually coincident with the visual focus, unless the lens be rendered achromatic.

Depth of Focus is the power of defining upon a plane surface with sufficient definition to satisfy the requirements of the case, the images of objects situated at varying distances. Theoretically depth of focus is an impossibility, but practically when any point is focussed sharply there is a certain distance before and behind that point which is also sharp. To find this distance the following rule may be used. The use of diaphragms increases it;

the smaller the aperture the greater the depth of focus. Having focussed any point, to find the distance in front of that point which will be in focus (all measurements to be in inches, and the distance of object to be measured from the optical centre of lens)—(1) Multiply the focal length by the diameter of the stop, and the result by the difference between the focal length and the distance of the object. (2) Multiply the focal length by the diameter of the stop, and add $\frac{1}{100}$ part of the distance of the object. (3) Divide the first product by the last, add the focal length, and subtract the result from the distance of the object, when the result will be the distance sought for in front in inches. To find the depth of focus behind a given point—(1) Multiply the focal length by the diameter of the stop, and the result by the difference between the focal length and the distance of the object. (2) Multiply the focal length by the diameter of the stop, and subtract $\frac{1}{100}$ part of the distance of the object. (3) Divide the first product by the last, add the focal length, and deduct the distance of the object ; the result is the distance behind in inches.

Example :—Find the depth of focus when focussing an object 15 ft. distant with a lens of 7-in. focus, working at *f*/5.

$f/5 = 1\frac{2}{5}$ in. 15 ft. = 180 in.

$7 \times 1\frac{2}{5} = \frac{49}{5}$.

$180 - 7 = 173$.

$\frac{49}{5} \times 173 = \frac{8477}{5}$ (1).

$7 \times 1\frac{2}{5} = \frac{49}{5}$.

$\frac{49}{5} + \frac{180}{100} = \frac{49}{5} + \frac{9}{5} = \frac{58}{5}$ (2).

$\frac{8477}{5} \div \frac{58}{5} = \frac{8477}{58} = 146$.

$146 + 7 = 153$ $180 - 153 = 27$ in. (3).

The depth of focus in front = 27 in

Example :—To find the depth behind.

$7 \times 1\frac{2}{5} = \frac{49}{5}$ $180 - 7 = 173$.

$\frac{49}{5} \times 173 = \frac{8477}{5}$ (1).

$7 \times 1 = \frac{49}{5}$.

$\frac{49}{5} - \frac{180}{100} = \frac{49}{5} - \frac{9}{5} = \frac{40}{5}$ (2)

$\frac{8477}{5} \div \frac{40}{5} = \frac{8477}{40} = 210.$

$210 + 7 = 217 \qquad 217 - 180 = 37.$

The depth of focus behind = 37 in. (See FIXED FOCUS.)

The following simple optical formulæ and calculations, worked out by Mr. J. A. C. Branfill, and published in the *British Journal Almanac*, will prove useful in many branches of photography, especially where several lenses of varying foci are in constant use for a variety of purposes :—

Let p = Principal focus.
F = Greater conjugate do.
f = Lesser do. do.
$D = F + f$ = distance of image from object.
r = Ratio of any dimension in original to the same dimension in copy (in case of reduction), or *vice versâ* (in case of enlargement).
a = Effective diameter of diaphragm.
U. S. No. = " Uniform System " No. of do.
x = Comparative exposure required.

Then
$$p = D \times \frac{r}{(r+1)^2} = \frac{Ff}{D} = \frac{F}{r+1} = \frac{rf}{r+1}$$

$$F = p(r+1) = \frac{pf}{f-p} = rf = \frac{rD}{r+1}$$

$$f = p \times \frac{(r+1)}{r} = \frac{pF}{F-p} = \frac{D}{r+1} = \frac{F}{r}$$

$$D = p \times \frac{(r+1)^2}{r} = f(r+1) = p\left(2 + r + \frac{1}{r}\right)$$

$$r = \frac{F-p}{p} = \frac{p}{f-p} = \frac{F}{f}$$

U. S. No. $= \frac{p^2}{16a^2}$

$$x = \frac{f^2}{16a^2} = \frac{p^2}{16a^2} \times \frac{(r+1)^2}{r^2}$$

N.B.—For ordinary landscape work, where r is greater than 20, x may be taken as $\frac{p^2}{16a^2}$

NOTE.—In case the above may not be clear to some photographers, the following rules may be better understood :—

To find the principal focus of a lens (p), focus a near object in the camera, and measure the distance between it and the ground-glass (D); next find the proportion which any dimension in the object bears to the same dimension on the ground-glass (r). Thus, if the original dimension be four times as large as its reproduction, we say that r equals (=) 4. Multiply D by r, and divide the product by the square of a number greater by one than r $(r + 1)^2$. This rule is due to Mr. Debenham.

To find the lesser conjugate focus (f) (if p and r are known) multiply p by the sum of $r + 1$ and divide the product by r. Or divide D by $r + 1$.

To find the greater conjugate focus (F) multiply p by $r + 1$. Or multiply f by r.

To find D (the distance which the ground-glass should be from the object to be copied in order to get a given value for r) multiply p by the sum of $r + \frac{1}{r} + 2$.

To find r divide $F - p$ (the difference between F and p) by p. Or divide p by $f - p$. Or divide F by f.

To find x divide the square of f by 16 times the square of a (the diameter of aperture to lens).

For example : focus an object which is five inches high, so that it is one inch high on the ground-glass; thus we know that $r = 5$. Next measure the distance between the object and the ground-glass (D), which is found to be 45 inches.

Then $p = 45 \times$ (multiplied by) $5 \div$ (divided by) $6 \times 6 = 6\frac{1}{4}$ inches.

$f = 6\frac{1}{4} \times 6 \div 5 = 7\frac{1}{2}$ inches. Or $f = 45 \div 6 = 7\frac{1}{2}$ inches.

$F = 6\frac{1}{4} \times 6 = 37\frac{1}{2}$ inches. Or $F = 7\frac{1}{2} \times 5 = 37\frac{1}{2}$ inches.

$D = 6\frac{1}{4} \times (5 + \frac{1}{5} + 2) = 6\frac{1}{4} \times 7\frac{1}{5} = 45$ inches.

$r = (37\frac{1}{2} - 6\frac{1}{4}) \div 6\frac{1}{4} = 5$. Or $r = 6\frac{1}{4} \div (7\frac{1}{2} - 6\frac{1}{4}) = 5$.

Under the heading SPECTACLE LENS will be found a table showing the correction to be made on account of chromatic aberration.

Focimeter. An instrument of M. Claudet's for determining the difference between the visual focus of a lens and the chemical focus. A convenient form is a series of small cards, each bearing a number, and placed step-fashion one behind the other, so that each one is at a different distance from the camera. The middle card is accurately focussed and a photograph taken with the full aperture of the lens. If the number on this card is best defined

on the negative the coincidence of the foci is satisfactory, but if another number is sharpest in the negative the lens requires a correction after focussing. When only one lens is to be used on a camera it is usual to so alter the position of the ground-glass in the setting that the figure which is best defined in the photograph shall show as sharpest on the screen.

Focussing Glass, or Compound Focusser. A small magnifying eye-piece, used to obtain microscopic sharpness of focus upon the ground-glass; and it should be invariably used when fine focussing is desirable, especially by those who desire to enlarge the resulting negatives.

Focussing Screen. The ground-glass upon which the image formed by the lens is seen. The best glass to use for this purpose is obscured patent plate, obtained by grinding patent plate with very fine emery. To make a screen of ground-glass rather coarse emery powder (that sold as No. 100) should be made into a paste with water, and lightly rubbed over a piece of glass, using a small painter's muller, or any other convenient flat surface for grinding, till the surface begins to show signs of abrasion, when the coarse emery should be completely washed off, and the finest "flour" emery obtainable used till the glass is obscured enough. Two pieces of glass can be ground at the same time by fixing a small cork, or anything that will serve as a handle, on to one piece of glass, with a piece of cobbler's wax or pitch, and using the one to grind the other. Should the focussing screen be accidentally broken, a piece of plain glass daubed over with putty, or coated with a paste of flour and water, or at a pinch a fine cambric handkerchief, may be used. The following solution spread on glass has been suggested as a substitute for the ground-glass :—

White wax	120 grs.
Ether	1 oz.

Or the following matt varnish :—

Sandarac	18 grs.
Mastic	4 „
Ether	200 mins.
Benzole	80 to 100 „

The more benzole the finer the matt surface obtained. Or an ordinary negative varnish, containing one per. cent. of tartaric acid, and as much water as it will bear without becoming turbid, may be used. Another preparation is the following:—

Gelatine or glue	60 grs.
In water	4 drms.

and adding

Boiled milk	2 drms.

melting by the aid of a gentle heat, and flowing over the glass.

Aids to Focussing. Oiling the screen renders the grain of the glass but very little perceptible. Or a better expedient still for use with the compound focusser is a microscopic covering glass cemented to the ground surface of the screen with a drop of Canada balsam; a small cross should be marked in lead pencil on the ground surface before doing this or else, through the ready accommodation of the focus of the eye, this plan will prove a hindrance rather than a help. Both the cross and image should be in focus together.

Fog is one of the commonest of all faults with gelatine negatives, and is seen as a veil over the whole negative, or is a deposit of silver upon the shadows more or less dense according to the greatness or slightness of the fog. There are two great divisions of fog—chemical and light fog. The former is caused by errors in the manipulation of the plate manufacture, or in development; the second by the impact of light, as through some crevice in the camera or dark slide, or over-exposure.

Chemical Fog, from errors in manufacture, may be traced to several causes, the chief being an abnormal excess of silver nitrate in the emulsion, and also decomposed gelatine, caused by too long stewing, when the emulsion is made by the boiling process. If the fog is very bad, there is no cure for it, but when slight the emulsion may be squeezed through coarse canvas or muslin, as described under Emulsions (*q.v.*), into a solution of bichromate of potash, ten grains to the ounce, allowing it to stand for one hour, then washing for two hours in running water, or the addition of a few grains of cupric chloride or auric chloride will sometimes effect a cure. Chemical fog is often seen as

iridescent green stains near the edges of plates, and is likely to make its appearance with an ammonia developer; it is less likely to ensue with the fixed alkalies, potash and soda, and rarely with ferrous oxalate. The obvious remedy for this evil, with a brand of plate known to be liable to green fog, is the use of potash and soda or ferrous oxalate; but where it does exist it can sometimes be eliminated by treating the plate after fixing and washing with

Ferric chloride	50 grs.
Potassium bromide	30 „
Distilled water	4 ozs.

Soak the plate in this for a minute or two, when it will be found that, as the fog disappears, the plate will be reduced in density; rinse well, and then apply a ferrous-oxalate developer, when the required density can be obtained; the plate should be then refixed and washed.

Light Fog makes its appearance generally all over the plate, and, as has been stated above, may be due to three causes, When the fault is supposed to lie in the camera (and the reason to suspect this is to find the edges of plate covered by rabbet of slide free from fog), cap the lens, remove the focussing screen, cover the head with the focussing cloth, and carefully examine the interior of camera to see if any stray ray of light is admitted. The plate may be fogged in the dark slide, and the effect will be seen on development by certain streaks and bands of fog making their appearance, a very usual place being at the leather hinge which allows the shutter of this slide to be folded back; and this fog seems to be not only due to light, but in many cases is actually induced by the material or something used in making the hinge. It may also make its appearance at the side where the manufacturer places the small slips of cardboard to separate the plates, and in this case it is due to some impurity in the paper used. Stray actinic light or an unsafe light in the dark-room may also cause general veil or fog, and if this be suspected the light should be tested as described under DARK-ROOM.

Foreign Terms, Photographic. A glossary of these will be found under the heading SYNONYMES.

Formalin. The liquid sold under this name is a solution in water of the gaseous aldehyde of methylic alcohol; this aldehyde having the composition CH_2O, and the commercial solution usually contains 40 per cent. The solution of formic aldehyde has such tendency to harden gelatine and make it insoluble, that a film, whether on glass or on paper, can be made to resist the action of even boiling water by a soaking for five minutes in a mixture of 1 part of the commercial formalin with from 8 to 12 parts of water. It is seldom, however, that so strong a solution need be used, 1 part to 20 or 25 of water being sufficient for the prevention of frilling if ten or fifteen minutes is allowed; moreover, the strong solution evolves irritating vapours, sometimes causes opalescence of the film, and occasionally brings about a condition of extreme brittleness or even a falling into dust. If negatives are soaked for ten minutes in the weaker formalin solution as given above, after the final washing, the film may be surface dried with blotting paper, and then completely dried in a few minutes before a fire. A lantern slide similarly treated may be exhibited at once in the lantern without fear of the film melting. One disadvantage of using formalin is that subsequent intensification or reduction becomes very difficult. Some workers rinse the negative, transparency, or print on gelatine emulsion paper, in a few changes of water after fixing, then soak for about five minutes in a 10 per cent. formalin bath, and after this wash in boiling water. Formalin is a powerful antiseptic—one drop to a quart serving to preserve even milk from change.

Formic Acid. (Ger., *Ameisensäure;* Fr., *Acide Formique*). $HCHO_2$=46. An acid liquid prepared by oxidation from various organic materials, but was originally obtained from ants, whence its name. This has been recommended as preservative of pyro, and we have found that half an ounce of dilute formic acid will preserve 1 oz. of pyrogallol even when exposed to light and air for over two months, but when mixed with the accelerator the developer turns thick and muddy more rapidly than plain pyro.

Formic Aldehyde. See FORMALIN.

Formulæ, Chemical. See EQUIVALENCE, CHEMICAL.

Freezing Mixtures. See COOLING AND FREEZING.

Frilling. By this is meant the gelatine leaving the plates in folds or wrinkles. It usually begins at the edges, and occurs chiefly when fixing, but often during development or washing. The causes are numerous, but as most of these are but slightly under the control of the operator they will only be enumerated, and the possible cures given at length. The chief cause is the use of a gelatine of too horny a nature, and possessing but little tenacity. Again, long-continued boiling of an emulsion especially tends to this evil; an improperly washed plate, unequal drying, and excessive slowness of the emulsion in setting, due to the use of a soft gelatine or the heat of the weather, or by allowing too forcible a stream of water to impinge upon the edge of a plate, or the use of an exceeding strong developer, or the differing temperatures and densities between the developing, fixing, and washing fluids. The use of formalin is one of the most complete preventives of frilling. (See FORMALIN.) When a batch of plates purchased is found to be subject to frilling, they may be kept for two or three months, when the fault will often be eradicated; but where this remedy is impracticable, or, by reason of the number of the plates being but small, is hardly desirable, the following immediate steps may be taken, or Formalin (*q v.*) may be used. The plate, before development, may be coated with collodion made as follows:—

Pyroxyline	6 grs.
Alcohol (·820)	½ oz.
Ether (·735)	½ „
Castor oil	4 drops.

When this is used, the plate, after being collodionised, must be well washed with clean water till it no longer repels water from the surface of the film. When the plate is collodionised, it is advisable to add about 10 per cent. of methylated alcohol to developer. Soaking the plates in the following for five minutes is sometimes a preventive, but it prolongs development:—

Chrome alum	2 grs.
Dissolved in	
Water	1 oz.
Add	
Methylated spirit	1 oz.

Another plan is the following:—Have by the side of the developing or fixing bath a dish of methylated spirit, and if the slightest sign of frilling or blisters, which are but localised frilling, makes its appearance, immerse the plate immediately in the spirit till the frill disappears; then proceed with development or fixing. Some plates frill at the edges only; for these an edging of grease or india-rubber solution is the remedy. When plates are found to frill in the fixing, but not in developing, the use of a 5 per cent. formalin bath will generally prevent any further spread of the mischief. (See FORMALIN.)

Fuming. The process of subjecting sensitive albumenised paper to the vapour of ammonia. It is claimed for this that it renders the prints more brilliant, that the paper prints more rapidly, and that it facilitates the toning. Many elaborate boxes have been designed for this purpose, but the simplest and a really efficient plan is to use an old cardboard plate box, and, having cut the paper to the required size, pin it by the four corners face downwards to the lid, and on the bottom inside sprinkle a few drops—about ten or fifteen—of liquor ammoniæ ·880; put on the lid, and leave it for ten minutes in hot or fifteen in cold weather. Paper when once fumed should be used within two or three days, or the good effect will be lost. Fumed paper is more liable to discolour than ordinary. The after-operations of washing, toning, and fixing are precisely the same as usual.

Fusible Metal. An alloy sometimes used in making casts from gelatine surfaces for the production of printing blocks or plates. Wood's formula for fusible metal is the best, and melts far below the boiling point of water, or at about 70° C.

Bismuth	7 parts.
Lead	4 „
Tin	2 „
Cadmium	1 part.

Gall. See OX-GALL.

Gallate of Iron Process. See INK PROCESS.

Gallic Acid (Ger., *Gallussäure;* Fr., *Acide gallique;* Ital., *Acido gallico*). $HC_7H_5O_5 = 170$. Obtained by fermentation from powdered galls. Solubility 1 per cent. in cold, 33 per cent. in boiling water, very soluble in alcohol, less so in ether. It was

used for developing in the collodion and waxed paper processes, and has been also suggested for developing gelatino-chloride paper.

Gallon. See WEIGHTS AND MEASURES.

Galvanography, Photo-. A general term for processes in which a printing plate or block is produced by electrotyping on a photographic original; the earliest forms of the method being the electrotyping of the daguerreotype image, the resulting plate, however, being too shallow for satisfactory printing. According to Waterhouse's method a carbon print is developed on a metal plate (see CARBON PRINTING), and dusted over while wet with waxed sand. When dry the sand is brushed off, and we then have a basis upon which the electrotype cast is made. According to the Pretsch method, a gelatine film very similar in its nature to the collotype film is the basis upon which the electrotype copper is deposited. Details of photo-galvanographic methods belong rather to special treatises than a general handbook, and the reader is referred to Herr Volkmer's *Photogalvanographie* (German), published by Wilhelm Knapp, of Halle-a-S. English readers will find details of the Pretsch method in the *Process Photogram* for January 1897.

Gamboge, or Camboge (Ger. *Gummigutti*; Fr. *Gomme Gutte;* Ital. *Gomma Gutta*). An orange-coloured gum resin, from the *Garcinia Morella*, a native of Siam and Cochin China. The finest is that called "Pipe Gamboge," which is collected in bamboo canes. The inferior is called cake gamboge. It is almost entirely soluble in alcohol, and when rubbed down with water forms a thick emulsion of a brilliant yellow colour. It has but little taste, and no smell. It is used in photography as a colouring matter for varnishes and lacquers; also as a chemically opaque material in spotting negatives. Inks used by those who draw in line for process reproduction often contain gamboge. The action upon human beings when taken internally is that of a drastic and hydragogue cathartic.

Gelatine. An animal substance obtained by boiling bones, hoofs, horns, and other animal substances. It contains about 15 to 20 per cent. of water at ordinary temperatures, and in cold water swells up and absorbs from five to ten times its weight. Good samples will absorb sufficient water to dissolve them when

the temperature is raised above 90° F., the solution setting again to a jelly on cooling. The continued application of heat for some time destroys this setting powder, a modification called metagelatine being formed. Gelatine will keep indefinitely in the dry state, but in the presence of water it soon putrefies, turning first acid, and then alkaline; and at this stage ammoniacal vapours are given off. Alum, alcohol, carbolic, salicylic, and boracic acids, thymol, formalin, and the salts of zinc, act as antiseptics. Acetic, hydrochloric, sulphuric, and oxalic acids dissolve gelatine even in the cold—acetic acid very readily, and forming a useful liquid glue. Carbolic acid and alcohol precipitate it from aqueous solutions when they are in excess. Silver nitrate exposed to sunlight in contact with gelatine produces a red colour, due to a compound of gelatine and suboxide of silver. The alkaline bichromates in solution of gelatine render the latter after exposure to light insoluble and incapable of absorbing water, this action being the basis of the carbon and nearly every photo-mechanical printing process. Chrome alum and tannin render it insoluble, but capable of absorbing water. Ordinary alum raises the melting point, but does not render it completely insoluble. The composition of gelatine varies with the source from which it is obtained, but the following may be taken as the percentage composition :—

Carbon	50·1
Hydrogen	6·6
Nitrogen	18·3
Oxygen	25·0
Sulphur	0·12

The selection of a gelatine suitable for emulsion making is a most important point, but the following leading characteristics of a suitable kind may be of service to the amateur plate manufacturer :—The weight of the ash left after incineration should never exceed 2 per cent., proving the absence of earthy or mineral matter. The amount of water it will absorb should in no case exceed ten times nor be less than five times its weight. For emulsion making by the boiling process it should give an acid reaction, and its solubility should not be affected at a lower temperature than 70° F., nor higher than 110° F. Another most important test is its expansive power, for upon this depends

to a great extent its frilling or non-frilling properties. The following table of the chief characteristics of the best commercial brands will be of practical use; but it may be stated that the best film can, as a rule, be obtained by a mixture of one part of hard and two parts of soft gelatine :—

Name.	Character.	Ash. Per Cent.	Water Absorbed. Times in Weight.
1. Coignet's gold label	hard	1	$7\frac{1}{2}$
2. ,, special...	,,	1	$7\frac{1}{2}$
3. Nelson's No. 1 photographic	soft	2	6
4. Nelson's opaque ...	hard	2	$8\frac{3}{4}$
5. ,, amber ...	soft	1	$4\frac{3}{8}$
6. Swinborne No. 2 isinglass	,,	1	$6\frac{1}{4}$
7. Russian isinglass	,,	1	$2\frac{3}{4}$
8. Simeon's Swiss ...	hard	1	$8\frac{3}{4}$
9. Heinrich's	,,	1	$8\frac{3}{4}$

Nos. 1, 3, 8, and 9 are the best to use.

Gelatine Emulsions. See EMULSION.

Gelatino-Chloride Emulsion Paper. This is an outcome of collodio-chloride emulsion paper, which was known in England as Simpson-type; just as gelatine took the place of collodion for plates, so gelatine replaced the collodion for this purpose, J. B. Obernetter, of Munich, being among the first to make the gelatino-chloride emulsion paper. The following formulæ will be found all that can be desired.

No. I.

Gelatine	230 grs.
Distilled water	6 drms.

Soak for an hour and dissolve by the aid of a gentle heat, and add

Nitrate of silver	6 grs.

To this mixture add gradually

Lithium chloride	1 gr.
Tartaric acid...	1 ,,
Distilled water	1 drm.

No. II.

Nelson's soft gelatine	...	...	...	139 grs.
Heinrich's hard gelatine	...	...	...	293 ,,
Ammonium chloride	...	...	...	540 ,,
Distilled water	...	...	...	100 drms.

Allow to soak for half an hour, and dissolve by the aid of a water bath, and add gradually, almost drop by drop, with constant stirring, the following at about 90° F. :—

Nitrate of silver	...	...	...	154 grs.
Distilled water	...	...	...	336 mins.

Allow the emulsion to set hard, press through canvas, wash in four changes of water five minutes each, and drain well. Now prepare the following :—

Heinrich's gelatine	...	...	...	100 grs.
Distilled water	...	...	...	150 mins.

Soak for half an hour and dissolve, and add the following at a temperature of 90° F., with constant stirring :—

Sodium citrate (neutral)	...	...	...	30 grs.
Distilled water	...	...	...	170 mins.

Dissolve

Nitrate of silver	...	...	...	46 grs.
Citric acid	...	...	...	77 ,,
Distilled water	...	...	...	170 mins.

Add to the citrate and gelatine very gradually, constantly stirring, set quickly and wash in five changes of water five minutes each, drain well, and add to the chloride emulsion as above, and add

Citric acid	...	...	...	15 grs.
Distilled water	...	...	...	119 mins.

Allow the emulsion to stand in a fluid state for one hour, occasionally stirring. Keep for three days, and then coat the paper.

No. III.

Mr. W. K. Burton gives the following. Two separate emulsions are made, as in the last case :—

A.

Ammonium chloride	...	...	...	53 grs.
Gelatine	...	...	...	420 ,,
Distilled water	...	...	...	30 ozs.

Allow to soak for an hour, and dissolve by the aid of a water bath; then add

Nitrate of silver	150 grs.
Distilled water	½ oz.

B.

Sodium citrate	30 grs.
Gelatine	100 „
Distilled water	3½ ozs.

Soak for an hour, dissolve by heat, and add

Nitrate of silver	45 grs.
Citric acid	80 „
Distilled water	½ oz. „

Mix both emulsions. Allow to set, and wash as directed for No. II. emulsion. The same authority also suggests the following formulæ and method of mixing the same:—

Formula No. 1.

A.	Nitrate of silver	400 grs.
	Water	4 ozs.
B.	Gelatine, soft	80 grs.
	Chloride of ammonium	80 „
	Citric acid	120 „
	Water	8 ozs.

Formula No. 2.

A.	Nitrate of silver	400 grs.
	Water	4 ozs.
B.	Gelatine (soft)	80 grs.
	Chloride of ammonium	80 „
	Citric acid	120 „
	Carbonate of soda (dry)	45 „
	Water	8 ozs.

Formula No. 3.

A.	Nitrate of silver	400 grs.
	Water	4 ozs.
B.	Gelatine (soft)	80 grs.
	Chloride of ammonium	80 „
	Citric acid	60 „
	Carbonate of soda (dry)	80 „
	Water	8 ozs.

The first formula gives an emulsion suitable for preparing paper to be used for printing from dense negatives, the second from medium negatives, and the third from thin negatives. Of the third Mr. Burton says: "There is just about enough of ammonium chloride and of sodium citrate formed by the double decomposition of the citric acid, and of part of the soda, to decompose the whole of the nitrate of silver. The formula works all right, and the paper that results from the use of it keeps very fairly. The paper resulting from either of the other formulæ will probably keep as long as any sensitised paper. The following is the method of emulsifying. The two solutions are heated to a temperature of 110° to 120° F. The temperature should not be greater than 120°, or there is a great chance that some of the insoluble silver salts produced will be thrown down in the granular form. A is then added slowly to B with much stirring. The emulsion is filtered through a double thickness of cambric, and is then immediately ready for use. If it is wished to keep the emulsion for any length of time, 10 per cent. of alcohol, in each ounce of which a few grains of thymol have been dissolved, should be added to the emulsion. It is to be observed, however, that, even with this addition, emulsion by formula No. 3 will not keep for very long." Mr. Burton recommends floating the paper for three or four minutes to coat it, or by brushing the emulsion over the paper, allowing it to get surface dry and repeating the operation. The temperature of coating room should be 70° F. The above quantity of emulsion will coat eight sheets 22 by 17, or ten or twelve by floating. Either gold or platinum may be used for toning, but the prints should be well washed first. The best method of coating the paper is a question of quantity: in small quantity the paper should be wetted thoroughly in warm water, and squeegeed to a sheet of glass, and the emulsion poured on it; with larger quantities the sheets should be drawn over the surface of the fluid emulsion. The majority of operators will no doubt prefer to buy their paper ready made, and the following may be considered as the necessary manipulations for producing perfect prints, although this paper undoubtedly gives its best results when used for rather thin negatives or those wanting in contrasts. The paper, cut to the required size, is placed in contact with the film side of the negative in the ordinary printing frame, and placed in a good printing light. Where the negative is exception-

ally thin the frame should be placed in a weak light with opal or green glass over it, where the contrasts are greater use a stronger light; examine the print during the operation of printing in a very subdued light, and great care must be exercised that the paper does not shift whilst thus examining it, as it is very likely to do from its highly polished surface. As a preventive a pad of felt, or two or three thicknesses of stout blotting paper should be used. On the depth of printing depends to a great extent the tone of the resulting print; it is our practice when using this paper to carry the printing sufficiently far, so as to give the very highest lights a decided tinge, and, if black tones are required, till the highest lights are deeply coloured. After printing, the pictures should be carefully preserved from damp and light, and thus may be, if necessary, kept till some considerable number are collected, as they deteriorate but little by being kept a week or even longer. For toning, numerous baths have been suggested to give various tones ; most operators get into a particular groove of working special photographic papers, and from some considerable experience I can recommend the following method of procedure as conducive to good results. The first consideration is the negative; every negative is not suitable for this paper, though every negative will give a print on it. Those negatives which have very weak shadows and dense high lights give unsatisfactory results because there is a tendency in the paper to give an increased contrast; and for this very reason it is exceptionally valuable for weak or somewhat thin negatives. For veritable ghosts, then, we can use green or yellow glass in front of the negative, or tissue paper or opal, so as to reduce the light, and print in weak diffused light. For stronger negatives we can, of course, print in stronger light. The question how far to carry printing is an important one, and a good deal depends upon the toning bath that is used. Practically it may be said that the paper should be exposed till there is a decided tinge on the high lights. Chloride paper may be kept some weeks before toning if actually required, but it is not advisable to keep it too long, or the whites suffer and it is more difficult to tone. We must now enter slightly into the chemical composition of gelatino-chloride emulsions. All commercial papers, we believe, contain chloride of silver, with some organic salt, usually citrate of silver, with free nitrate of silver, and frequently citric acid. The nitrate and

citrate are soluble in water, and cause the milkiness which is apparent when chloride prints are placed in water. These should be got rid of before toning or else they contaminate the toning bath, and in the case of the alkaline baths, such as the acetate or borax, the prints must be free from any acid, or else the bath becomes acid, and tones but slowly or not at all. If the sulphocyanide bath be used, free silver salts mean the formation of silver sulphocyanide, the bath will not keep, and toning is rendered more difficult. In the case of the combined bath we have hypo; and to place a print containing acid in this means decomposition of the hypo and sulphurisation and degradation of the whites. As soon as sufficient prints are obtained, for it is not worth while toning one or two, make a solution of salt, ordinary household salt, 2 oz. to the pint of warm water. When dissolved and cool, place the prints in the solution and keep them on the move for ten minutes, pour away the salt, and wash for ten minutes in plain water. The use of salt renders toning somewhat slower, more even, and obviates any free soluble silver salt. If the prints are washed in water first, the salt being omitted, it is necessary to change the waters very quickly, or yellowed whites will be the result, from the silver combining with the paper and gelatine. It is preferable to use salt or carbonate of soda, the latter in the proportion of 1 oz. to the pint—I prefer the salt. Now with regard to the toning bath. When matt-surface papers were introduced, I started a series of experiments using one print of matt and one of glossy paper, and tried the usual baths, acetate, borax, phosphate, carbonate, and sulphocyanide, and found that with all but the last there was a tendency to pinky tones; and this was puzzling for some time, till the conclusion was come to that it was due to the action of the gold upon very faint—too faint to be visible—impression of light upon the silver salt. This was confirmed by the curious pinkish tinge on vignettes. An instructive experiment was then made: a letter was cut out of deep ruby paper and placed in close contact with a sheet of paper, and the whole put out in the light and strips covered up every thirty seconds—the strip last covered just showed a very faint sign of light action. The print was washed and toned in strips, and in baths of different strengths, and after fixing three decided strips were visible with increasing pinkiness. This proves that the paper must be exposed as little as possible

to white light, or there is an action set up which only becomes visible in gold toning. When the ordinary baths, acetate, borax, etc., were strengthened so as to have the strength of 1½ grs. of gold to the 8 oz., instead of 1 gr., there was less chance of pinkiness. With the matt papers as well as the glossy, no bath works so well as the plain sulphocyanide, but it is absolutely necessary to get rid of all free nitrate and acid by salt and washing, or else the action was uncertain. Plain paper with uranium and gold toning was a great favourite for black tones, but with the matt-gelatine papers black tones could not be obtained; from this bath we were led on to the others. Now, as to the making of the bath, I always keep my gold in a slightly acid solution; and before using it requires neutralising. I strongly recommend also that all commercial gold chlorides should be neutralised, because one well-known brand is very acid. The simplest way to do it is to place a little precipitated chalk or magnesium carbonate into the gold solution; it requires very little for one grain of gold—about as much as will lie on a threepenny piece; shake well, then add the solution to the sulphocyanide. All the sulphocyanides are deliquescent, and when bought should be immediately dissolved in distilled water and kept of a definite strength; a convenient one is one in four. The quantity of sulphocyanide compared to the gold varies in many formulæ, and may vary, provided it is more than four times the weight of the gold and less than sixty times; sulphocyanides will dissolve gelatine when too strong. A convenient strength is gold chloride 1 grain, sulphocyanide 30 grains, water 8 ounces. See that your dish is clean. Mix your bath by adding the gold to the sulphocyanide gradually with shaking, not the reverse. Never mind the slight turbidity caused by the chalk or magnesia. Place your well-washed prints in the bath, not too many at a time; this is important. Keep them moving, touching them with clean fingers at one corner only. Do not attempt to be economical of gold; do not tone more than twelve quarter-, six half-, or three whole-plate prints with one grain of gold; of course, the number depends a good deal on the style of the print. Finally, keep your toning bath at about 65° F. Carry toning on till on looking through the print you see that all the red has disappeared from the heavy shadows for purple tones, and till the red has gone from the half-tones for browns. When the bath is used throw it away or put it in the

residue tank; don't use it again, and don't try and revive it by adding more gold. After toning place the prints in salt and water, and fix in an alkaline bath, and wash well in running water for from twenty to thirty minutes. Combined toning and fixing baths are a great convenience, so it is said, as by their use the number of solutions and operations requisite for making a tint are reduced. It is probable, however, that there is far less chance of the prints being permanent when treated with such a bath by the average worker. If a combined bath is properly made and properly used there is no reason why it should not yield as permanent results as any other; but, as ordinarily used, these baths may be fatal to permanency. Hyposulphite of soda is decomposed by acid and alum, and sulphurous acid and free sulphur are set free and sulphur toning caused. For those who wish to use alum and lead salts the following may be adopted:—

Water	500 parts.
Hyposulphite of soda	200 ,,
Ammonium sulphocyanide	25 ,,
Nitrate of lead	10 ,,
Alum	20 ,,

Dissolve the hypo in the water first, add the sulphocyanide, then dissolve the alum in a little water, and add to the hypo, with constant shaking. Then add the lead nitrate in the same way, that is, dissolved in water, heat the whole to 50° C. for ten minutes, allow to cool and filter, and to every 100 parts of this concentrated bath add 100 parts of water, and 7 to 8 parts of a 1 per cent. solution of gold.

I.

Liesegang's Baths.

Solution A.

Chloride of gold	2 grs.
Distilled water	2 ozs.

Solution B.

Ammonium sulphocyanide	30 grs.
Hyposulphite of soda	1 gr.
Distilled water	3 ozs.

Mix for use by pouring 1 part of A into an equal quantity of B (never reverse this order). This gives a purplish tone.

II.

The Phosphate Bath.

Solution A.

Ammonium sulphocyanide	1 oz.
Sodium phosphate	1 ,,
Distilled water	25 ozs.

Solution B.

Chloride of gold	15 grs.
Distilled water	3 ozs.

Mix for use by pouring 1 part of B into 10 parts of A. This bath gives bluish-black tones.

III.

Solution A.

Chloride of gold	15 grs.
Distilled water	60 ozs.

Solution B.

Ammonium sulphocyanide	1 oz.
Alum	1 ,,
Ammonium carbonate	4 grs.
Distilled water	23 ozs.

For use, pour 3 parts of A into 4 parts of B, with deep printing. This bath gives deep black tones. For rich chestnut brown with no trace of blue, dilute the mixed bath with three times the quantity of water.

IV.

A New Combined Toning and Fixing Bath.

Dr. Liesegang recommends the following in the *International Annual*, 1889:—

Solution A.

Chloride of gold	15 grs.
Distilled water	3 ozs.

Solution B.

Ammonium sulphocyanide	60 grs.
Common salt	240 ,,
Alum	120 ,,
Hyposulphite of soda	2 ozs.
Distilled water	12 ,,

Allow Solution B to stand for at least eight days and then filter. To make

The Toning Bath,

Pour Solution	A	...	...	...	...	7 parts
Into	„ B	...	...	...	...	60 „

and add 40 parts of old used combined toning and fixing bath. This bath gives the prints in ten minutes a red colour, in fifteen minutes it tones to a splendid brown, and in twenty minutes to a brownish violet. The bath acts quicker if the prints are taken out after five minutes and laid on a clean glass slab. As soon as the desired tone is reached, place them in a salt and water bath.

V.

Obernetter's Baths.

Solution A.

Chloride of gold	...	...	...	15 grs.
Distilled water	...	...	...	3 ozs.

Solution B.

Phosphate of Soda	...	...	...	12 drms.
Distilled water	...	...	...	30 ozs.

Solution C.

Ammonium sulphocyanide	...	...	...	10 drms.
Distilled water	...	...	...	30 ozs.

For use mix 10 parts of B with 10 parts of C, and add 1 part of A. This gives warm purplish tones.

VI.

Solution A.

Chloride of gold	...	...	...	15 grs.
Distilled water	...	...	...	4 ozs.

Solution B.

Ammonium sulphocyanide	...	...	...	5 drms.
Distilled water	...	...	...	32 ozs.

For use, pour A into B, and allow to stand for twelve hours. This gives warm brown tones. The addition of 10 to 15 grs. of hyposulphite of soda will give cold tones.

VII.

Solution A.

Chloride of gold	15 grs.
Distilled water	3 ozs.

Solution B.

Acetate of soda	1 oz.
Distilled water	25 ozs.
Solution A	2 „

Solution C.

Ammonium sulphocyanide...	2 drms.
Distilled water	10 ozs.
Solution A	1 oz.

For use add 3 parts of Solution C to 10 parts Solution B. This gives fine brown or black tones. Reddish brown tones may be obtained by adding to Solution C 10 to 15 grs. hypo-sulphite of soda.

VIII.

The following is a toning bath which Mr. Bruce, of Duns, a famous collodio-chloride printer, recommended:—

Solution A.

Ammonium sulphocyanide...	10 drms.
Hyposulphite of soda	9 grs.
Distilled water	60 ozs.

Solution B.

Chloride of gold	22 grs.
Distilled water	60 ozs.

Add one part of B to an equal quantity of A, and add a good-sized pinch of common chalk, and allow to stand for twenty-four hours.

IX.

The following is suggested by Mr. Tylar:—

Chloride of gold	6 grs.
Tungstate of soda	60 „
Ammonium sulphocyanide...	100 „
Hyposulphite of soda	960 „
Distilled water, to make	8 ozs.

Dissolve the salts in half the water made hot, and make the solution measure 8 ozs. by adding more water. Then add the gold.

X.

The following is a simple bath suggested by Mr. W. K. Burton, although the addition of nitrate of lead is due to Mr. J. Chester Jervis:—

Chloride of gold	6 grs.
Nitrate of lead	3 ,,
Hyposulphite of soda	3 ozs.
Distilled water	20 ,,

Put the prints direct into the toning bath without washing.

Chloride prints may be easily developed, and by this a great saving of time is effected. The first method of doing this was by means of gallic acid developers, such a developer being

Gallic acid	4 parts.
Citric acid	6 ,,
Sodium acetate	20 ,,
Solution of lead nitrate (10 per cent.) ...	15-20 ,,
Distilled water	1000 ,,

Warnerke suggested the use of about two feet of magnesium ribbon burnt quite close to the printing frame, by which a very faint image was rendered visible, and it was then developed to full intensity with

Water	1000 parts.
Acetic acid	10 ,,
Sodium acetate	10 ,,
Gallic acid	5 ,,

When dissolved add

Solution of lead acetate (10 per cent.) ...	10 parts.

The above solution should be diluted with from 5 to 10 parts of water, and the print, without washing, being placed in this soon gains in intensity, and the development is stopped by placing the print in salt and water, when it should be thoroughly well washed, and toned in the following bath:—

Water	1000 parts.
Hyposulphite of soda	100 ,,
Acetate of lead	10 ,,
Solution of chloride of gold (1 per cent.)...	20 ,,

Valenta suggested the use of acid hydroquinone and pyrogallol developers.

Hydroquinone Developer.

A.	Hydroquinone	10 parts.
	Alcohol	100 ,,
B.	Sodium sulphite	100 parts.
	Distilled water	500 ,,
	Citric acid	5 ,,

For use, 50 parts of Solution A should be mixed with 50 parts of Solution B, and 1000 parts of water added.

Pyrogallol Developer.

Distilled water	1000 parts.
Sodium sulphite	100 ,,
Pyrogallol	10 ,,
Citric acid	11 ,,

The ingredients should be dissolved in the water in the above, and the clear and almost colourless solution used immediately. The hydroquinone developer works clear and slowly; the violet tone of the printed-out image turns in developing into a yellowish-brown. The prints were toned and fixed in the combined toning and fixing bath composed as follows:—

Distilled water	500 parts.
Hyposulphite of soda	200 ,,
Sulphocyanide of ammonia	25 ,,
Alum	30 ,,
Acetate of lead solution (1 : 10)	40 ,,

This solution is to be heated on a water bath to about 60° C., by which a quick deposition of the precipitate formed is obtained. It should then be filtered, and 100 parts of it mixed with 50 parts of water and 10 parts of 1 per cent. solution of choride of gold. In this combined bath the yellowish-brown developed prints assume a yellow tone, which very soon turns into brownish-red, and into a beautiful deep, purple brown. The toning process should be stopped when the prints have assumed the desired tone, and it should be noted that after washing the tone is rather deeper. Liesegang specially recommends the following for his own paper, but for others it is not suitable:—

A. Pyrogallol Developer.

Solution of pyro (7 per cent.)	2 parts.
,, ,, sodium acetate (20 per cent.)	6 ,,
Distilled water	60 ,,

B. Paramidophenol Developer.

Solution of paramidophenol (7 per cent.)	2 parts.
,, ,, sodium acetate (20 per cent.)	10 ,,
Citric acid	1 ,,
Distilled water	50 ,,

Substantial advance in this process was made by Mr. Wilson, of the Paget Prize Plate Co., when he suggested the use of a solution of potassium bromide prior to development. The following is the precise method of working this modification of the process :—The paper should be exposed in the printing frame in the ordinary way, but the insolation is only continued till there is quite a faint image. It is advisable not to print too far, and as a good guide we may suggest that the details should just be visible in the half-tones. After printing, the paper should be taken from the frame, and placed without washing into a 10 per cent. solution of potassium bromide. The action of this bath is to convert the soluble silver salts into silver bromide, and if allowed to act for some time, there is no doubt it would also replace the chlorine in the silver salt forming the image. The time of immersion in the bromide solution is not very material, and we prefer to leave it for fifteen minutes. Great care must be taken that no bubbles adhere to the paper, or else spots will appear in the development. After being in the bromising solution the prints must be washed well for five or ten minutes in running water; if the washing is not pretty complete and thorough, so much bromide is left in the paper that development is enormously protracted, and there is a tendency to stain. The original developer recommended was—

I.

Hydroquinone	½ oz.
Sulphurous acid	¼ ,,
Sodium sulphite	¼ ,,
Potassium bromide...	60 grs.
Water, to	25 ,,

II.

Caustic soda...	¼ oz.
Sodium sulphite	½ ,,
Water, to	25 ozs.

III.

Ammonium bromide	1 oz.
,, carbonate	1 ,,
Distilled water, to	25 ozs.

Mix in equal parts. The following simpler developer is now suggested:—

I.

Hydroquinone	1 oz.
Sodium sulphite	1 ,,
Sulphurous acid	½ ,,
Water, to	40 ozs.

II.

Potassium bromide	2½ ozs.
Liq. ammonia (·880)	180 m.

or

Sodium carbonate	2 ozs.
Water, to	40 ,,

For use, mix one part of each, and add one part of water. For average negatives, use one part No. I., one part No. II., one part water. Whatever variations are made, make up always to bulk three parts, by adding or omitting water. If required to work slower, use less No. II., or make up the stock solution with less ammonia. If harder effect (more contrast) be desired, use less No. I.; if softer results (less contrast), use more. It may happen that we find that the print when finished is too dark, and has been over-printed. The question is how to reduce it. It is questionable whether it is worth the trouble, whether it is not almost as easy to make a fresh print altogether. The old ferridcyanide and hypo reducer has been suggested for gelatino-chloride prints; and reduce them it will, so energetically, even in weak solutions, that its action may be uncontrollable. Haddon suggested a mixture of sulphocyanide and ferridcyanide, and this certainly acts more slowly and evenly, but the sulphocyanide

makes the gelatine very soft. Valenta suggests, however, a mixture of hypo and uranium nitrate, and states that it gives very good results. He suggests a cold saturated solution of hypo diluted with four times the quantity of water, and to every 100 parts of this liquid one part of a 10 per cent. solution of uranium nitrate is added. This acts very evenly and slowly, and gives excellent results, as we can testify. Valenta states that prints treated with

Thiosinamine	5 parts
Water	100 ,,
Solution of uranium nitrate (10 per cent.)	5-10 ,,

assume a brilliant red tone, which gives place in toning to a rich sepia. All chloride papers can be toned with platinum, by observing the directions given under Platinum Toning (*q.v.*). Since the introduction of matt-surface chloride papers there has not been so much need for obtaining matt surfaces on glossy papers; but this can be done either by rubbing down the dry print with powdered pumice stone or squeegeeing to fine ground-glass or celluloid, both of which should be previously smeared with a little oil. To obtain a high glaze or polish, plate-glass, ebonite, metal plates, or wood-pulp slabs can be used; but the first gives the finest surface. Whichever material is used, it should be first rubbed with solution of wax, as used for the carbon tissue, encaustic paste, or a little oil, and the wet print well squeegeed down to it and allowed to dry, and then stripped. For mounting such prints it is advisable to paste on the back a sheet of the waterproof backing-paper, which can be obtained commercially, whilst the print is damp, and allowing the two to dry together, and then mounting with one of the gelatine mountants, now placed on the market, or a formula for which is given under Mountant (*q.v.*).

"Ghost" Photographs, How to make. See "SPIRIT" PHOTOGRAPHY.

Giphantia. The title of a Utopian romance, written in 1761 by Tiphaine de la Roche, in which there is an interesting forecast of photography; the author having apparently based his forecast on previous observations of Schulze (1727) and Beccarius (1757) regarding the darkening of chloride of silver when exposed to light. The following is an extract from an English translation

which dates from about the same period as the French original: "The rays of light reflected from different bodies make a picture on all polished surfaces—for instance, on water or glass. . . . They have composed a most subtle matter, very viscous, and proper to harden and dry, by the help of which the picture is made in the twinkle of an eye. They do over with this matter a piece of canvas, and hold it before the objects they have in mind to paint—the impression of the images is made the first instant they are received on the canvas, it is immediately carried away into some dark place; an hour after, the subtle matter dries, and you have a picture so much the more valuable as it cannot be imitated by art or damaged by fire."

Glass. Early specimens are a small tablet in the British Museum, about 1445 B.C., of Egyptian make, and a goblet found in Nineveh, of about 700 B.C. The manufacture was gradually improved, till, in Italy, 58 B.C., window glass was made; and at Pompeii glazed windows were found intact. As the Roman Empire declined, the glass industry tended to where Venice now stands; and until 200 years ago Venice was supreme in the manufacture of glass generally. Now the manufacture is widely spread all over Europe, Venice, however, retaining a first place as regards certain decorative styles. There are many kinds of glass, and the subject generally is of much interest to photographers. Crown glass is composed of a mixture of silicates of potassium and sodium, with a little calcium; also often aluminium. Flint glass is a mixture of silicates of potash and lead. It is much more refractive than crown. Coloured glasses contain metallic oxides or compounds which have specific colouring properties. Copper, according to the state of oxidation, may give many tints, running through green, blue, and purple, to red; the usual ruby glass of the shops being coloured with copper in the state of cuprous oxide. Silver gives a yellow, which appears as red when intense, the "stained red" glass recommended by Captain Abney for the dark-room window being coloured with silver. Gold gives a purplish red, useless for the dark-room window. Iron (ferrous) gives olive green, and (ferric) brownish yellow or orange, cobalt blue, uranium a greenish-yellow fluorescence, manganese an amethyst tint. Opal or milk glass contains phosphate of lime, oxide of tin, or

white arsenic. Glass coloured throughout by fusion with the colouring matter in the main pot is called "pot metal"; but when plated with a thin layer of coloured glass (the flashing) it is called "flashed." Ordinary copper ruby glass cannot be made as a "pot metal," and is therefore always flashed. In 1881 Drs. Abbe and Schott instituted a series of experiments at Jena, in Germany, on the improvement of the manufacture of glass for optical purposes, and, after some successful trial smeltings, in 1884 they received a handsome subsidy from the Prussian Bureau of Education, which enabled them to commence operations on a manufacturing scale. The old optical glasses were limited to practically few varieties, but the researches of these gentlemen have furnished opticians with new glasses of constant or standard quality; hence the manufacture of lenses has been much simplified, as it is no longer necessary to determine the refractive and dispersive properties of each mass of glass. About seventy kinds of optical glass are now made at the Jena Factory, ranging from 1·5063 to 1·9626 as regards refractive index, and of various dispersive power. In most cases the factory supplies masses roughly moulded to the shape required by the optician, and at a cost of from about 4*s*. to 30*s*. per lb. Most important among the glasses made at Jena is the silicate of barium glass—equivalent to a heavy flint glass—introduced by Baudrimont and Pelouze about 1850 as a commercial substitute for ordinary flint glass. Mr. Alfred Dawson about 1880 demonstrated the value of this glass for optical purposes, and prepared pure specimens, which he used in constructing objectives; and to him is due much of the credit of that modern development of optical glass-making which has put such new and considerable powers into the hands of opticians.

Glass, Black (mirror). Used sometimes as a mirror by which the weakened reflections of clouds are photographed; also by artists, as by viewing the reflection a better judgment can sometimes be arrived at of the effect in a picture. Photographers especially would find a small square of optically-worked black glass very convenient for this purpose, as the effect of colour is eliminated. The commercial "black" glass is usually a very deep amethyst colour, and contains about 10 per cent. of oxide of manganese.

Glass Silvering. The reversing mirror, or the hypotenuse of the reversing prism, is now always silvered by some modification of Liebig's chemical process. (For instructions, see MIRROR.)

Glass, Soluble. Basic alkaline silicates dissolve in water, and are sold as soluble glass. Used in preparing substrata for Collotype (*q.v.*) and in other cases where it is desirable that a gelatine film should adhere very firmly to a glass plate.

Glass Working. The following notes will be serviceable :—

Cutting with diamond. The main point is keeping the diamond at the same angle, when once the cutting angle is found—this involving a wrist action which requires some practice. When the true cut is being produced, a peculiar hissing sound can be distinguished, and most diamonds produce no perceptible scratching or abrasion of the glass when the best cutting angle is realised; so that the true cut can hardly be seen when looked at perpendicularly.

Filing. An ordinary file, kept moist with a saturated solution of camphor in oil of turpentine can be used with excellent effect.

Grinding. See FOCUSSING SCREEN.

Leading a crack. A crack will usually follow a heated iron rod as large as a pipe stem, the end of the rod being kept a quarter of an inch in advance of the crack. This process is often useful in making jars or funnels of broken bottles.

Drilling. A broken end of hard steel, as, for example, a small file well moistened with the turpentine-and-camphor mixture mentioned under "Filing."

Tubes, to bend or expand into bulbs. For making syphons, soft French flint glass, as made by Guilbert-Martin, of St. Denis (London warehouse: Falcon Street, Aldersgate Street), is convenient; or the soft German glass of the chemical apparatus shops may be used. Heated in the upper part of an ordinary gas burner, such tube will soften and can be readily bent, any deposit of soot being wiped off when the tube is cold. In a similar way it may be softened sufficiently for drawing to a fine point. Division at any required place by making a file scratch and breaking, the sharp edges being now rounded by incipient melting in the flame of a Bunsen burner. Rod of similar glass can be divided and the edges rounded in the same way. Blowing

into bulbs necessitates a blowpipe for heating, but is easy with a little practice.

Glucose (Ger., *Glucose, Stärkezucker, Traubenzucker;* Fr., *Glucose;* Ital., *Glucosio*). Synonyms: Grape Sugar, Dextrose. $C_6H_{12}O_6=180$. There are several kinds of glucose, which is preferably to be considered as a generic name. It occurs either in white crystals or a thick, syrupy liquid, and was used as a preservative in the collodion process, and is also employed in some powder processes.

Glycerine (Ger., *Glycerin;* Fr., *Glycérine;* Ital., *Glicerina;* Lat., *Glycerinum*). $C_3H_5(OH)_3$. A peculiar, sweet, viscid liquid, obtained from oils and fats as a bye product in saponification. Specific gravity, 1·260. It is extremely hygroscopic, and its non-drying properties are taken advantage of in photography to prevent the too rapid drying of some substances, and it is also used as a preservative of pyro. It is miscible in all proportions with water and alcohol. It has also been suggested as a restrainer in developing, its action being probably rather physical in this respect than chemical.

Gold (Ger., *Gold;* Fr., *Or;* Ital., *Oro;* Lat., *Aurum*). Au. 196. A yellow or yellowish-red metal soluble in nitro-hydrochloric acid. It occurs native in conjunction with quartz and sand in various parts of the world. It is used for the preparation of chloride of gold, a convenient source being current coin. A sovereign should weigh when new 123¼ grains, and contain 113 grains of pure gold, the commercial value of this being 20*s.*; no charge being made for mintage or alloy.

Gold, Chloride (Ger., *Goldchlorid, Chlorgold;* Fr., *Chlorure d'oro;* Ital., *Chloruro d'oro*). Synonyms: Auric Chloride, Trichloride or Perchloride of Gold. $AuCl_3=303$. A yellowish-brown crystalline mass, made by dissolving gold in *aqua regia*. Usually commercial chloride is obtained by solution as above and the evaporation of the acid liquid, in which case bright yellow crystals of $AuCl_3HCl$ are obtained, from which it will be seen that one equivalent of hydrochloric acid is combined with it. Preferably the double neutral salts of gold and potassium, sodium or calcium, are used.

Gold, Hyposulphite (Ger., *Natriumaurothiosulfat, Unterschwefligsäures Goldoxydulnatron;* Fr., *Hyposulfite double d'or et de sodium;* Ital., *Ipolsolfito d'oro e di sodio*). Synonyms; Sel d'or, Fordos and Gelis' salt. $Na_2S_2O_3$, $Au_2S_2O_3$, $4H_2O$. This salt was originally suggested for toning daguerrotypes, and later for albumenised paper, and more recently still for gelatino-chloride paper. It may be formed by gradually adding a neutral 2 per cent. solution of chloride of gold to a 6 per cent. solution of hyposulphite of soda. To obtain it in crystals, mix the solution formed above with alcohol, when the salt will crystallise out in fine white needles.

Gold, Potassio-Chloride (Ger., *Chlorgoldkalium;* Fr., *Chlorure double d'or et de potassium;* Ital., *Cloruro doppio d'oro e di potassio*). $AuCl_3KCl + 3H_2O$. The usual method of making this is to dissolve one part of pure gold in as small a quantity of *aqua regia* as possible, by the aid of heat. Evaporate gently, and then add 20 parts of distilled water, in which 0·51 parts of bicarbonate of potassium has been dissolved. Carbonic acid is given off, and the resulting solution should be evaporated to dryness. Lainer of Vienna has also suggested the following method for obtaining a stable and constant salt of gold, which can easily be prepared chemically pure and free from acid, which does not deliquesce or effloresce, and gives toning baths of constant and reliable action. One hundred parts of gold are dissolved in *aqua regia*, and hydrochloric acid added to the solution. To the solution of pure chloride of gold thus prepared are added 38 parts of chloride of potassium. The mixture thus obtained is carefully evaporated till crystallisation, when the dish or vessel is placed under a bell jar containing concentrated sulphuric acid or quicklime. The mother liquid is poured off, and this again evaporated and treated as above. The crystals thus obtained are dried under a bell jar, and heated to 100—110° C. to drive off the remaining traces of free hydrochloric acid. The salt thus procured forms yellow hexagonal needles, easily soluble in water.

Gold, Sodio-Chloride (Ger., *Chlorgoldnatrium;* Fr., *Chlorure double d'or et de sodium;* Ital., *Cloruro doppio d'oro e di sodio.* $AuCl_3NaCl + 2H_2O$. This is usually the commercial salt, and occurs as yellowish-brown needles, which are very deliquescent,

soluble in alcohol and water. It may be prepared by dissolving 5 parts by weight of gold chloride, and 1 part by weight of sodium chloride in as little water as possible, and allowing the solution to crystallise. Another method is to dissolve 1 part of gold in 10 parts of *aqua regia* by the aid of heat, dilute with 100 parts of water, filter through glass wool, precipitate the gold with saturated solution of sulphate of iron, and collect and wash the precipitate, which is pure gold; add 3 parts of sodium chloride to every 1 of gold; dissolve the mixture in *aqua regia* and evaporate. The following table shows the equivalent quantities of the various salts used in photography:—

Gold.	Gold Chloride.	Gold Potassio-Chloride.	Gold Sodio-Chloride.
1	1·5420	2·1048	2·0229
0·6485	1	1·3645	1·3119
0·4751	0·7326	1	0·9611
0·4943	0·7623	1·0405	1

The following calculation will show that home-made chloride may be cheaper than commercial if nothing is allowed for the work, and probably of loss. An Australian sovereign contains 113 grs. of pure gold, which will make 174¼ grs. of pure chloride, 237·9 grs. of potassio-chloride, and 228·6 grs. of sodio-chloride, and, assuming that the latter be the commercial salt, this is equivalent to 15¼ tubes.

Grain. See WEIGHTS AND MEASURES.

Gramme. See WEIGHTS AND MEASURES.

Green Fog. See FOG.

Ground-Glass. See FOCUSSING SCREEN.

Guaiacum. See GUM GUAIACUM.

Gum Arabic (Ger., *Gummi arabicum, Arabische Gummi;* Fr., *Gomme arabique;* Ital., *Gomma arabica*). A gummy exudation from the stems of various species of acacia. It is of peculiar bland taste, odourless, insoluble in alcohol and ether, but entirely soluble in water, in which form it is used as a Mountant (*q.v.*). It is also used in the powder process and photo-lithography. Its adhesiveness is increased by addition of aluminium sulphate, less so by ordinary alum. It is decomposed at a temperature of 300° and is converted into dextrine by the action of sulphuric acid.

Gum Bichromate Process. See CARBON PRINTING.

Gum Dammar. See DAMMAR.

Gum Dragon. See TRAGACANTH.

Gum Elemi (Ger., *Oelbaumharz:* Fr., *Gomme élémi.*) A resinous exudation from *Canarium commune,* imported from the Philippine Islands, and also obtained from *Amyris elemifera* in Central America. It is used in varnishes and encaustic paste. It is very soluble in alcohol, insoluble in water, and should have somewhat the colour and consistence of honey, but generally, from exposure to air and impurities, is more yellowish-brown and indurated.

Gum Guaiacum. A resinous exudation from *Guaiacum officinale,* a native of San Domingo and Jamaica, soluble to the extent of 90 per cent. in absolute alcohol, and when triturated with water forms a mucilage of pale greenish hue. It is used in some of the old collodion processes, and was used by Niepce as a sensitive resist for etching on metal plates.

Gun-Cotton. See PYROXYLINE.

Halation. A blurring of the image and an encroachment of the high-lights upon the surrounding shadows or darker portions. It is but too well known as a source of trouble in photographing an interior in which a brilliantly lighted window appears ; or again, when photographing landscapes in autumn or winter, halation is very likely to make its appearance when the leafless boughs of the trees appear against a bright sky, or in any case where extreme contrasts of light and shade exist. It is caused by reflection from the back of the plate. The rays of light are scattered by the particles of silver salt, and, obeying certain laws of reflection, are reflected from the surface and back of plate. The remedies are Backing the Plate (*q.v.*), the use of thickly-coated and matt-surfaced plates, and plates containing iodide of silver, the latter being advantageous, chiefly because the iodide of silver emulsion is more opaque than a bromide ; but if an emulsion could be obtained absolutely transparent, there would be practically no halation. When photographing interiors, it has been recommended to cover the window with some slightly opaque substance, such as pale yellow linen or

unbleached calico, so as to reduce the intensity of the light; and, again, it has been recommended to cut small shapes of black velvet, and hang on wires in front of the camera, so as to exclude the windows themselves from the focussing screen, removing them only a short period before the close of exposure. When halation does mar a negative, local Reduction (*q.v.*) may be resorted to, or the process described under Harmonising Harsh Negatives (*q.v.*) may be used with great success, or the dense deposit may be partially removed by careful rubbing down with wash-leather and methylated alcohol.

Half-Plate. The size of plate $6\frac{1}{2}$ by $4\frac{3}{4}$. The true half-plate, $6\frac{1}{2}$ by $4\frac{1}{4}$, is seldom known commercially as half-plate, and is often called "double quarter."

Halogens. This term has been applied to the group of the four elements—chlorine, bromine, iodine, fluorine.

Hardening of Gelatine Films. See FORMALIN.

Harmonising Harsh Negatives. This process is a very valuable one, and should be far more frequently used than it is. It will reduce the dense parts of a harsh negative and intensify weak parts. By means of this process it is possible to obtain a really decent print from a negative of a church interior which is almost a mass of halation, and passable prints may be obtained from harsh under-exposed negatives. It was suggested first by Eder in 1883. The negative, after being fixed and well washed, should be soaked in a solution of

Potassium bichromate	1 part.
Hydrochloric acid	3 parts.
Alum	5 „
Water	100 „

In this the negative gradually turns white, and care must be exercised that it is thoroughly bleached from the back as well as the front. The negative must now be thoroughly washed in running water for at least two hours, or repeated soaking, film downwards, in frequently changed water for at least four hours. The bleached plate may now be redeveloped, either with an old hydroquinone developer or with ferrous oxalate. This is the important point in this process, for development

must only be carried on till the details in the shadows are fully developed, and not till the high lights are developed right through, or in the latter case no improvement will be seen. As soon, then, as the details in the shadows and half-tones are developed, the plate may be rinsed and refixed. There being still some undeveloped chloride of silver at the back of the dense parts, this is fixed out, and the negative will be found by no means so hard as before. I have stated that this process intensifies the shadows, and this is only, strictly speaking, true when the bleached plate is exposed to daylight for some time and then developed, the chloride of silver image then being converted into a more nonactinic character than previously. An alternative method due to Mr. J. McIntosh is the following. Prepare the following solution :—

Bichromate of potassium	10 grs.
Bromide of potassium	5 ,,
Water	1 oz.

Bathe the plate and allow the solution to permeate the film. Pour the solution off and add to it five drops of nitric acid. Again flood the plate and the image will be converted into bromide of silver. Allow the action to proceed through the film. Bathe in three changes of alum, a 5 per cent. solution of potassium metabisulphite, to remove the bichromate and harden the film, and wash thoroughly in water. As the operations are carried out in white light, such as that of gas or a lamp, the plate is amply exposed by the time the washing is completed. The following pyro developer was found quite suitable. Any preservative may be used, but as there is nothing on the plate but the image to be affected by the developer, there is no necessity to use a bromide. A small trace may be useful to control development, but if any bichromate of potassium remains in the film it will unite with the bromide, and convert the image back into bromide of silver as fast as it developed.

Pyro	2 grs.
Ammonia	2 mins.
Bromide of potassium (if used at all) ...	¼ gr.

As the shadow detail lies on the surface it will first be developed, the half-tone will follow, and the high lights will remain white

when viewed from the back of the plate for some time. As the surface of the film will veil over as soon as the developer begins to act, the progress must be judged entirely from the back of the plate. The only judgment required in the process is in stopping the development at the right time. If stopped too soon, the negative will be flat; if carried too far, the negative will still be hard. Mr. McIntosh says: "It will be well to have ready for reference a print from the negative in which the shadows have been printed to their proper depth. When the lightest half-tone which shows in the print is nearly, but not quite, blackened through by the developer, on viewing the plate from the back the action should be stopped, the plate washed and transferred to the hypo, which will speedily dissolve out the undeveloped silver in the high lights, leaving the negative much thinner in the high lights than it originally was. A little practice with waste negatives will give the required power of judgment. A negative which is hard from under-exposure, and one which has been fully exposed but is hard from over-development, will not present the same appearance during redevelopment, after rehalogenisation. If the former be redeveloped right through, the high lights will appear black at the back of the plate; the high light in the fully exposed negative will never appear black, however far the redevelopment may be pushed, and as the layer of white-coloured silver present in this case will not be dissolved out by the hypo, an allowance for this must be made in redevelopment, or the negative will still be too dense. There is no theoretical objection to the negative being again treated by the process to obtain the required reduction, but in practice there is an additional risk of stains appearing the second time. It is better to err on the side of under-development and intensify if necessary. In this process, as in all others, great cleanliness is required, and the plate must have been thoroughly freed from hypo before proceeding to rehalogenise. If hypo or other chemicals be present, thin patches and dark spots will show. If there are grease-spots or finger-marks on the plate, irregular action will take place. It is best to take but one trial print from the negative, and exercise great care in doing so if rehalogenisation be thought needful. When operating on old negatives I wash them gently with dilute ammonia to get rid of, if possible, grease-spots before beginning the process."

Head-Rest. An apparatus used for maintaining an exact position and steadiness of a sitter during exposure. Great prejudice exists in the minds of most people against it, due to its use having been abused to such an extent as to become an absolute instrument of torture. In all cases the head-rest should be adapted to the position of the sitter's head and applied gently, and the head should never be strained to the position of the head-rest.

Hectogramme (*ἑκατον*, a hundred, and *γράμμα*, a letter). One hundred grammes. (See WEIGHTS AND MEASURES.)

Hectolitre (as above, and *λίτρα*, a pound). One hundred litres. (See WEIGHTS AND MEASURES.)

Hectometre (as above, and *μέτρον*, a measure). One hundred metres. (See WEIGHTS AND MEASURES.)

Heliochromy (*ἥλιος*, the sun, *χρῶμα*, the complexion, or *χρωματικός*, coloured). See PHOTOGRAPHY IN NATURAL COLOURS.

Heliography (as above, and *γραφω*, I draw or write). Synonymous with Photography.

Heliogravure (as above; second syllable through the French). See PHOTOGRAVURE.

Heliostat (as above, and *στάσις*, a fixed position or station). An instrument consisting of a mirror driven by clockwork, for making the sun virtually stand still, as in observing or photographing.

Heliotype (as above, with *τύπος*, an impression or print, as of a seal). A collotype process of Mr. Ernest Edwards, in which a stripped pellicle is printed from. (See COLLOTYPE.)

Hermetic, or -al. According to the art of the Egyptian Hermes, the reputed first public teacher of the experimental sciences. The hermetic seal is the closing of a glass vessel by melting, as in the case of the ordinary tubes of chloride of gold.

High-Lights. The brightest parts of a picture, which are represented by the greatest density or opacity, in the negative, as the face in portraits, the sky and other bright portions in the landscape.

History of Photography. See PHOTOGRAPHY.

Hurter and Driffield, Method of. See EXPOSURE, and ACTINOGRAPH.

Hyalography, Photographic (ὑαλος, glass or crystal). Numerous processes for photographic etching on glass come under this heading, many being due to Mr. Duchochois. The following is a simple method, giving good results. Paper is coated with the following:—

Water	1 oz.
Sugar	50 grs.
Gum arabic	50 ,,
Ammonium bichromate	50 ,,

Expose under a transparency and dust with fine bitumen, as in Powder Process (*q.v.*). Transfer to warm glass so as to soften bitumen, soak off paper, dry glass, and etch with vapour of Fluorhydric Acid (*q.v.*).

Hydrates. Speaking strictly, the salts in which the group HO, or hydroxyl, acts as an acid group; thus, H.HO (water) is hydrogen hydrate, or it may be called hydroxyl mono-hydride. Popularly, a hydrate, or hydrated substance, is a compound of water with another substance. Thus, slacked lime may be regarded as calcic hydrate, $Ca(HO)_2$, or as hydrated lime, $CaO.H_2O$.

Hydrazine. An alkali differing from ammonia by containing a smaller proportion of hydrogen, and which may be used in the developer. Formula N_2H_4.

Hydriodic Acid and Hydriodates (Ger., *Iodwasserstoffsäure;* Fr., *Acide iodhydrique;* Ital., *Acido iodidrico*). HI=128. An acid which is easily decomposed with the liberation of iodine. It forms salts called iodides, or, when the base is non-metallic like aniline, the salt is called a hydriodate. In the case of ammonia both usages obtain.

Hydrobromic Acid (Ger., *Bromwasserstoffsäure;* Fr., *Acide hydrobromique;* Ital., *Acido idrobromico).* HBr=81. An acid which is somewhat more stable than hydriodic acid, but less stable than hydrochloric acid; its salts (bromides or hydrobromates, see HYDRIODIC ACID) are largely used in photography.

Hydrocarbons. Compounds of carbon and hydrogen—which are very numerous—are so called. Those of special interest to photographers are benzine or benzole and Acetylene (*q.v.*).

Hydrochloric Acid (Ger., *Chlorwasserstoffsaure;* Fr., *Acide chlorhydrique;* Ital., *Acido chloridrico*). HCl=36·5. Synonyms: Muriatic acid, Spirits of salts. Made by decomposing common salt with sulphuric acid. Specific gravities of the aqueous acid of various strengths are given under the heading HYDROMETERS AND HYDROMETRY. It reacts with alkalies and hydrates of basylous radicles to form chlorides or hydrochlorates.

Hydrofluoric Acid. See FLUORHYDRIC ACID.

Hydrogen. H = 1. (ὑδωρ, water, and γεννάω, I beget. The prefix hydro- or hydr- of technical words is often a secondary derivative from hydrogen.) A gaseous element of very frequent occurrence in nature in a combined state, especially in the form of water. It is taken as the unit of atomic weights. It is used for the production of the lime-light.

Hydrogen Peroxide (Ger., *Wasserstoffsuperoxyd;* Fr., *Eau oxygénée;* Ital., *Acqua ossigenata*). $H_2O_2 = 34$. Synonyms: Hydroxyl, Hydrogen dioxide. A powerful oxidiser and bleaching agent, sometimes used to free prints and negatives from the last traces of hypo, which it does by oxidising it into sulphate; but it must be used very weak (about 2 drms. to 5 ozs.), or the density of the negatives and the tones of the prints may be reduced and sulphur deposited. Also acts on silver oxide as a reducing agent, and with an alkali will develop the latent image —a matter of some theoretical interest.

Hydrometer and Hydrometry. The hydrometer is a spindle-like float, generally made of glass, and with a graduated stem which indicates the specific gravity of a liquid by the depth to

which it sinks. Hydrometers, graduated for special use so as to give the strengths of alcohol, ether, acids, or saline solutions at once, can be obtained from dealers in chemical apparatus; but the most generally useful graduation is that which gives the specific gravity. Several arbitrary hydrometer scales are in use. Twaddell's degrees are converted into specific gravities by multiplying by 5, adding 1000, and cutting off 3 figures by the decimal point. Other conversions by the following tables:—

A. For liquids lighter than water. Temperature 12·5° C.

Beaumé.	Specific Gravity.	Cartier.	Beck.	Beaumé.	Specific Gravity.	Cartier.	Beck.
0	...	...	1·0000	31	·8742	·8707	·8457
1	...	...	·9941	32	·8690	·8652	·8415
2	...	...	·9833	33	·8639	·8598	·8374
3	...	...	·9826	34	·8588	·8545	·8333
4	...	...	·9770	35	·8538	·8491	·8292
5	...	...	·9714	36	·8488	·8439	·8252
6	...	...	·9659	37	·8439	·8387	·8212
7	...	...	·9604	38	·8391	·8336	·8173
8	...	...	·9550	39	·8343	·8286	·8133
9	...	...	·9497	40	·8295	...	·8095
10	1·0000	...	·9444	41	·8249	...	·8061
11	·9932	...	·9392	42	·8202	...	·8018
12	·9865	...	·9340	43	·8156	...	·7981
13	·9799	...	·9289	44	·8111	...	·7944
14	·9733	·9764	·9239	45	·8066	...	·7907
15	·9669	·9695	·9189	46	·8022	...	·7871
16	·9605	·9627	·9139	47	·7978	...	·7834
17	·9542	·9560	·9090	48	·7935	...	·7790
18	·9480	·9493	·9042	49	·7892	...	·7763
19	·9420	·9427	·8994	50	·7849	...	·7727
20	·9359	·9363	·8947	51	·7807	...	·7692
21	·9300	·9299	·8900	52	·7766	...	·7658
22	·9241	·9237	·8854	53	·7725	...	·7623
23	·9183	·9175	·8808	54	·7684	...	·7589
24	·9125	·9114	·8762	55	·7643	...	·7556
25	·9068	·9054	·8777	56	·7604	...	·7523
26	·9012	·8994	·8673	57	·7565	...	·7489
27	·8957	·8935	·8627	58	·7526	...	·7456
28	·8902	·8877	·8585	59	·7487	...	·7423
29	·8848	·8820	·8542	60	·7449	...	·7391
30	·8795	·8763	·8500				

B. For liquids heavier that water. Temperature 12·5° C.

Beaumé.	Specific Gravity.	Beck.	Beaumé.	Specific Gravity.	Beck.
0	1·0000	1·0000	39	1·3619	1·2977
1	1·0068	1·0059	40	1·3746	1·3077
2	1·0138	1·0119	41	1·3876	1·3178
3	1·0208	1·0180	42	1·4009	1·3281
4	1·0280	1·0241	43	1·4143	1·3386
5	1·0353	1·0303	44	1·4281	1·3492
6	1·0426	1·0366	45	1·4421	1·3600
7	1·0501	1·0429	46	1·4564	1·3710
8	1·0576	1·0494	47	1·4710	1·3841
9	1·0653	1·0559	48	1·4860	1·3934
10	1·0731	1·0625	49	1·5012	1·4050
11	1·0810	1·0692	50	1·5167	1·4167
12	1·0890	1·0759	51	1·5325	1·4286
13	1·0972	1·0828	52	1·5487	1·4407
14	1·1054	1·0897	53	1·5652	1·4530
15	1·1138	1·0968	54	1·5820	1·4655
16	1·1224	1·1039	55	1·5993	1·4783
17	1·1310	1·1111	56	1·6169	1·4912
18	1·1398	1·1184	57	1·6349	1·5044
19	1·1487	1·1258	58	1·6533	1·5179
20	1·1578	1·1333	59	1·6721	1·5315
21	1·1670	1·1409	60	1·6914	1·5454
22	1·1763	1·1486	61	1·7111	1·5596
23	1·1858	1·1565	62	1·7313	1·5741
24	1·1955	1·1634	63	1·7520	1·5888
25	1·2053	1·1725	64	1·7731	1·6038
26	1·2153	1·1806	65	1·7948	1·6190
27	1·2254	1·1888	66	1·8171	1·6346
28	1·2357	1·1972	67	1·8398	1·6505
29	1·2462	1·2057	68	1·8632	1·6667
30	1·2569	1·2143	69	1·8871	1·6832
31	1·2677	1·2230	70	1·9117	1·7000
32	1·2788	1·2319	71	1·9370	1·7172
33	1·2901	1·2409	72	1·9629	1·7347
34	1·3015	1·2500	73	1·9895	1·7526
35	1·3131	1·2593	74	2·0167	1·7708
36	1·3250	1·2687	75	2·0449	1·7895
37	1·3370	1·2782	76	...	1.8085
38	1·3494	1·2879			

The following Hydrometric tables require no special explanation.

TABLE SHOWING THE SPECIFIC GRAVITIES OF VARYING STRENGTHS OF ALCOHOL IN DEGREES OVER AND UNDER PROOF.

Over Proof.	Specific Gravity.	Over Proof.	Specific Gravity.	Under Proof.	Specific Gravity.
Per cent.		Per cent.		Per cent.	
67·0	·8156	28·0	·8825	8·0	·9295
65·0	·8199	27·0	·8840	9·0	·9306
64·6	·8221	26·0	·8854	10·0	·9318
63·1	·8238	25·0	·8869	11·0	·9329
62·0	·8259	24·0	·8883	12·1	·9341
61·1	·8277	23·0	·8897	13·1	·9353
60·0	·8298	21·9	·8912	14·2	·9364
59·1	·8315	20·9	·8926	15·3	·9376
58·0	·8336	19·9	·8940	16·0	·9384
57·1	·8354	19·1	·8951	17·1	·9396
56·0	·8376	18·0	·8966	18·2	·9407
55·0	·8366	16·9	·8981	19·3	·9419
54·1	·8413	15·9	·8996	20·0	·9426
53·1	·8431	15·0	·9008	21·2	·9437
52·1	·8448	13·9	·9023	22·2	·9448
51·1	·8465	13·1	9034	23·1	·9456
50·1	·8482	12·0	·9049	23·9	·9464
49·1	·8499	11·1	·9060	25·1	·9476
48·0	·8516	10·0	·9075	26·3	·9488
47·0	·8533	8·9	·9089	27·1	·9496
46·0	·8550	8·0	·9100	28·0	·9503
45·0	·8566	7·1	·9111	29·2	·9515
43·9	·8583	5·9	·9126	30·1	·9522
43·1	·8597	5·0	·9137	35·1	·9565
42·0	·8615	3·9	·9152	40·1	·9603
41·1	·8629	3·0	·9163	45·0	·9638
40·0	·8646	1·9	·9178	50·3	·9674
39·1	·8660	1·0	·9189	54·8	·9701
38·0	·8678	Proof spirit	·9200	60·4	·9734
37·1	·8692			65·3	·9762
35·9	·8709	Under proof		70·1	·9790
35·0	·8723	1·3	·9214	75·4	·9822
34·1	·8737	2·2	·9226	80·4	·9854
32·9	·8755	3·1	·9237	85·2	·9886
32·0	·8769	4·0	·9248	90·2	·9922
31·0	·8783	5·0	·9259	95·4	·9962
30·0	·8797	6·0	·9270	100·0	1·0
29·0	·8811	7·0	·9282	...	...

Acetic Acid.

Quantities of Crystallisable Acid in Mixtures of Acetic Acid and Water of various Densities at 15° C.

Parts of Crystallisable Acid in 100.	Specific Gravity.	Parts of Crystallisable Acid in 100.	Specific Gravity.	Parts of Crystallisable Acid in 100.	Specific Gravity.	Parts of Crystallisable Acid in 100.	Specific Gravity.
100	1·0553	75	1·0746	50	1·0615	25	1·0350
99	1·0580	74	1·0744	49	1·0607	24	1·0337
98	1·0604	73	1·0742	48	1·0598	23	1·0324
97	1·0625	72	1·0740	47	1·0589	22	1·0311
96	1·0644	71	1·0737	46	1·0580	21	1·0298
95	1·0660	70	1·0733	45	1·0571	20	1·0284
94	1·0674	69	1·0729	44	1·0562	19	1·0270
93	1·0686	68	1·0725	43	1·0552	18	1·0256
92	1·0696	67	1·0721	42	1·0543	17	1·0242
91	1·0705	66	1·0717	41	1·0533	16	1·0228
90	1·0713	65	1·0712	40	1·0523	15	1·0214
89	1·0720	64	1·0707	39	1·0513	14	1·0201
88	1·0726	63	1·0702	38	1·0502	13	1·0185
87	1·0731	62	1·0697	37	1·0492	12	1·0171
86	1·0736	61	1·0691	36	1·0481	11	1·0157
85	1·0739	60	1·0685	35	1·0470	10	1·0142
84	1·0742	59	1·0679	34	1·0459	9	1·0127
83	1·0744	58	1·0673	33	1·0447	8	1·0113
82	1·0746	57	1·0666	32	1·0436	7	1·0098
81	1·0747	56	1·0660	31	1·0424	6	1·0083
80	1·0748	55	1·0653	30	1·0412	5	1·0067
79	1·0748	54	1·0646	29	1·0400	4	1·0052
78	1·0748	53	1·0638	28	1·0388	3	1·0037
77	1·0748	52	1·0631	27	1·0375	2	1·0022
76	1·0747	51	1·0623	26	1·0363	1	1·0007

N.B.—The density of the mixture increases until nearly 25% of water is present, after which it again decreases. Acetic Acid is therefore better tested volumetrically with a standard solution of alkali.

Table of Specific Gravities and Strengths of Chromic Acid.

Specific Gravity at 17°5.	Per cent. CrO_3.	Specific Gravity at 17°5.	Per cent. CrO_3.
1·037	5	1·258	30
1·076	10	1·373	40
1·118	15	1·512	50
1·162	20	1·665	60
1·208	25		

TABLE OF SPECIFIC GRAVITIES AND PER CENT. STRENGTHS OF FORMIC ACID AT 15° C.

Specific Gravity.	CH_2O_2.	Specific Gravity.	CH_2O_2.
1·025	10	1·142	60
1·053	20	1·161	70
1·080	30	1·180	80
1·105	40	1·201	90
1·124	50	1·223	100

TABLE OF SPECIFIC GRAVITIES OF SOLUTIONS OF PHOSPHORIC ACID AT 15° C.

Specific Gravity.	PO_4H_3. Per Cent.	P_2O_5. Per Cent.
1·476	64·04	47·10
1·442	60·90	44·13
1·418	58·22	42·61
1·384	55·40	40·12
1·356	52·46	38·00
1·328	50·93	36·15
1·293	45·05	32·71
1·268	41·60	30·13
1·236	37·69	27·30
1·197	32·10	23·23
1·162	27·24	19·73
1·136	23·41	16·95
1·109	18·30	13·25
1·066	11·91	8·62
1·031	5·73	4·15
1·006	1·10	0·79

Hydrochloric Acid.

Quantities of Liquid and of Anhydrous Acid and of Chlorine in Mixtures of Hydrochloric Acid and Water at different Densities.

Specific Gravity.	Liquid Acid, sp.gr. 1·20, in 100.	H. Cl. in 100.	Cl. in 100.	Specific Gravity.	Liquid Acid, sp.gr. 1·20, in 100.	H. Cl. in 100.	Cl. in 100.
1·2000	100	40·777	39·675	1·1000	50	20·388	19·837
1·1982	99	40·369	39·278	1·0980	49	19·980	19·440
1·1964	98	39·961	38·882	1·0960	48	19·572	19·044
1·1946	97	39·554	38·485	1·0939	47	19·165	18·647
1·1928	96	39·146	38·089	1·0919	46	18·757	18·250
1·1910	95	38·738	37·692	1·0899	45	18·349	17 854
1·1893	94	38·330	37·296	1·0879	44	17·941	17·457
1·1875	93	37·923	36·900	1·0859	43	17·534	17·060
1·1857	92	37·516	36·503	1·0838	42	17·126	16·664
1·1846	91	37·108	36·107	1·0818	41	16·718	16·217
1·1822	90	36·700	35·707	1·0798	40	16·310	15·870
1·1802	89	36·292	35·310	1·0778	39	15·902	15·474
1·1782	88	35·884	34·913	1 0758	38	15·494	15·077
1·1762	87	35·476	34·517	1·0738	37	15·087	14.680
1·1741	86	35·068	34·121	1·0718	36	14·679	14·284
1·1721	85	34·660	33·724	1·0697	35	14·212	13·887
1·1701	84	34·252	33·328	1·0677	34	13·863	13·490
1·1681	83	33·845	32·931	1·0657	33	13·456	13·094
1·1661	82	33·437	32·535	1·0637	32	13·049	12·697
1·1641	81	33·027	32·136	1·0617	31	12·641	12·300
1·1620	80	32·621	31·745	1·0597	30	12·230	11·903
1·1599	79	32·213	31·343	1·0577	29	11·825	11·506
1·1578	78	31·805	30·946	1·0557	28	11·418	11·109
1·1557	77	31·398	30·550	1·0537	27	11·010	10·712
1·1537	76	30·990	30·153	1·0517	26	10·602	10·316
1·1515	75	30·582	29·757	1·0497	25	10·194	9·919
1·1494	74	30·174	29·361	1·0477	24	9·786	9·522
1·1473	73	29·767	28·964	1·0457	23	9·379	9·136
1·1452	72	29·359	28·567	1·0437	22	8·971	8·729
1·1431	71	28·951	28·171	1·0417	21	8·563	8·332
1·1410	70	28·544	27·772	1·0397	20	8·155	7·935
1·1389	69	28·136	27·736	1·0377	19	7·747	7·538
1·1369	68	27·728	26·979	1·0357	18	7·340	7·141
1·1349	67	27·321	26·583	1·0337	17	6·932	6·745
1·1328	65	26·913	26·186	1·0318	16	6·524	6·348
1·1308	65	26·505	25·789	1·0298	15	6·116	5·951
1·1287	64	26·098	25·392	1·0279	14	5·709	5·554
1·1267	63	25·690	24·996	1·0259	13	5·301	5·158
1·1247	62	25·282	24·599	1·0239	12	4·893	4·762
1·1226	61	24·874	24·202	1·0220	11	4·486	4·362
1·1206	60	24·466	23.805	1·0200	10	4·078	3·968
1·1185	59	24·058	23·408	1·0180	9	3·670	3·571
1·1164	58	23·650	23·012	1·0160	8	3·262	3·174
1·1143	57	23·242	22·615	1·0140	7	2·854	2·778
1·1123	56	22·834	22·218	1·0120	6	2·447	2·381
1·1102	55	22·426	21·822	1·0100	5	2·039	1·984
1·1082	54	22·019	21·425	1·0080	4	1·631	1·588
1·1061	53	21·611	21·028	1·0060	3	1·224	1·191
1·1041	52	21·203	20·632	1·0040	2	0·816	0·795
1·1020	51	20·796	20·236	1·0020	1	0·408	0·397

Nitric Acid.

Quantities of Liquid and of Anhydrous Acid contained in Mixtures of Nitric Acid and Water at different Densities (Ure). Temperature 60° F.

Specific gravity.	Liquid acid, sp.gr. 1·5, in 100.	Anhydrous acid in 100.	Specific gravity.	Liquid acid, sp.gr. 1·5, in 100.	Anhydrous acid in 100.	Specific gravity.	Liquid acid, sp.gr. 1·5, in 100.	Anhydrous acid in 100.
1·500	100	79·700	1·378	66	52·602	1·189	33	26·301
1·498	99	78·903	1·373	65	51·805	1·183	32	25·504
1·496	98	78·106	1·368	64	51·068	1·177	31	24·700
1·494	97	77·309	1·363	63	50·211	1·171	30	23·907
1·491	96	76·512	1·358	62	49·414	1·165	29	23·113
1·488	95	75·715	1·353	61	48·617	1·159	28	22·316
1·485	94	74·918	1·348	60	47·820	1·153	27	21·579
1·482	93	74·121	1·343	59	47·023	1·146	26	20·722
1·479	92	73·324	1·338	58	46·226	1·14	25	19·925
1·476	91	72·527	1·332	57	45·429	1·134	24	19·128
1·473	90	71·730	1·327	56	44·632	1·129	23	18·331
1·470	89	70·933	1·322	55	43·835	1·123	22	17·534
1·467	88	70·136	1·316	54	43·038	1·117	21	16·737
1·464	87	69·339	1·311	53	42·241	1·111	20	15·940
1·460	86	68·542	1·306	52	41·444	1·105	19	15·143
1·457	85	67·745	1·300	51	40·647	1·099	18	14·346
1·453	84	66·948	1·295	50	39·850	1·093	17	13·549
1·450	83	66·155	1·289	49	39·053	1·088	16	12·752
1·446	82	65·354	1·283	48	38·256	1·082	15	11·955
1·442	81	64·557	1·276	47	37·459	1·076	14	11·158
1·438	80	63·760	1·270	46	36·662	1·071	13	10·361
1·435	79	62·963	1·264	45	35·865	1·065	12	9·564
1·431	78	62·166	1·258	44	35·068	1·059	11	8·767
1·427	77	61·639	1·252	43	34·271	1·054	10	7·970
1·423	76	60·572	1·246	42	33·474	1·048	9	7·173
1·419	75	59·775	1·240	41	32·677	1·043	8	6·376
1·415	74	58·978	1·234	40	31·880	1·037	7	5·579
1·411	73	58·181	1·228	39	31·083	1·032	6	4·782
1·406	72	57·384	1·221	38	30·286	1·027	5	3·985
1·402	71	56·587	1·215	37	29·489	1·021	4	3·188
1·398	70	55·790	1·208	36	28·692	1·016	3	2·391
1·395	69	54·993	1·202	35	27·895	1·011	2	1·594
1·388	68	54·196	1·196	34	27·098	1·005	1	0·797
1·383	67	53·399						

Sulphuric Acid.

Quantities of Liquid and Anhydrous Acid in Mixtures of Sulphuric Acid and Water at different Densities.

Specific Gravity.	Liquid acid, sp.gr. 1·8485, in 100.	Anhydrous acid in 100.	Specific Gravity.	Liquid acid, sp.gr. 1·8485, in 100.	Anhydrous acid in 100.	Specific Gravity.	Liquid acid, sp.gr. 1·8485, in 100.	Anhydrous acid in 100.
1·8485	100	81·54	1·5503	66	53·82	1·2409	33	26·91
1·8475	99	80·72	1·5390	65	53·30	1·2334	32	26·09
1·8460	98	79·90	1·5280	64	52·18	1·2260	31	25·28
1·8439	97	79·09	1·5170	63	51·37	1·2184	30	24·46
1·8410	96	78·28	1·5066	62	50·55	1·2108	29	23·65
1·8376	95	77·46	1·4960	61	49·74	1·2032	28	22·83
1·8336	94	76·65	1·4860	60	48·92	1·1956	27	22·01
1·8290	93	75·83	1·4760	59	48·11	1·1876	26	21·20
1·8233	92	75·02	1·4660	58	47·29	1·1792	25	20·38
1·8179	91	74.20	1·4560	57	46·48	1·1706	24	19·57
1·8115	90	73.39	1·4460	56	45·66	1·1626	23	18·75
1·8043	89	72.57	1·4360	55	44·85	1·1549	22	17·94
1·7962	88	71·75	1·4265	54	44·03	1·1480	21	17·12
1·7870	87	70·94	1·4170	53	43·22	1·1410	20	16·31
1·7774	86	70·12	1·4073	52	42·40	1·1330	19	15·49
1·7673	85	69·31	1·3977	51	41·58	1·1246	18	14·68
1·7570	84	68·49	1·3884	50	40·77	1·1165	17	13·86
1·7465	83	67·68	1·3788	49	39·95	1·1090	16	13·05
1·7360	82	66·86	1·3697	48	39·14	1·1019	15	12·23
1·7245	81	66·05	1·3612	47	38·32	1·0953	14	11·41
1·7100	80	65·23	1·3530	46	37·51	1·0887	13	10·60
1·6993	79	64·42	1·3440	45	36·69	1·0809	12	9·78
1·6870	78	63·60	1·3345	44	35·88	1·0743	11	8·97
1·6750	77	62·78	1·3255	43	35·06	1·0682	10	8·15
1·6630	76	61·97	1·3165	42	34·25	1·0614	9	7·34
1·6520	75	61·15	1·3080	41	33·43	1·0544	8	6·52
1·6415	74	60·34	1·2999	40	32·61	1·0477	7	5·71
1·6321	73	59·52	1·2913	39	31·80	1·0405	6	4·89
1·6204	72	58·71	1·2826	38	30·98	1·0336	5	4·08
1·6090	71	57·89	1·2740	37	30·17	1·0268	4	3·26
1·5975	70	57·08	1·2654	36	29·35	1·0206	3	2·45
1·5868	69	56·26	1·2572	35	28·54	1·0140	2	1·63
1·5760	68	55·45	1·2490	34	27·72	1·0074	1	·82
1·5648	67	54·63						

Specific Gravities of Caustic Alkali Solutions.

Per Cent.	NH_3.	KHO.	NaHO.	Per Cent.	KHO.	NaHO.
1	·9959	1·009	1·012	36	1·361	1·395
2	·9915	1·017	1·024	37	1·374	1·405
3	·9873	1·025	1·035	38	1·387	1·415
4	·9831	1·033	1·046	39	1·400	1·426
5	·9790	1·041	1·058	40	1·412	1·437
6	·9740	1·049	1·070	41	1·425	1·447
7	·9709	1·058	1·081	42	1·438	1·457
8	·9670	1·065	1 092	43	1·450	1·468
9	·9631	1·074	1·103	44	1·462	1·478
10	·9593	1·083	1·115	45	1·475	1·488
11	·9556	1·092	1·126	46	1·488	1·499
12	·9520	1·101	1·137	47	1·499	1·509
13	·9484	1·110	1·148	48	1·511	1·519
14	·9449	1·119	1·159	49	1·525	1·529
15	·9414	1·128	1·170	50	1·539	1·540
16	·9380	1·137	1·181	51	1·552	1·550
17	·9347	1·146	1·192	52	1·565	1·560
18	·9314	1·155	1·202	53	1·578	1·570
19	·9283	1·166	1·213	54	1·590	1·580
20	·9251	1·177	1·225	55	1·604	1·591
21	·9221	1·188	1·236	56	1·618	1·601
22	·9191	1·198	1 247	57	1·630	1·611
23	·9162	1·209	1·258	58	1·642	1·622
24	·9133	1·220	1·269	59	1·655	1·633
25	·9106	1·230	1·279	60	1·667	1·643
26	·9078	1·241	1·290	61	1·681	1·654
27	·9052	1·252	1·300	62	1·695	1·664
28	·9026	1·264	1·310	63	1·705	1·674
29	·9001	1·276	1·321	64	1·718	1·684
30	·8976	1·288	1·332	65	1·729	1·695
31	·8953	1·300	1·343	66	1·740	1·705
32	·8929	1·311	1·353	67	1·754	1·715
33	·8907	1·324	1·363	68	1·768	1·726
34	·8885	1·336	1·374	69	1·780	1·737
35	·8864	1·349	1·384	70	1·790	1·748

TABLE OF SPECIFIC GRAVITIES OF VARIOUS SALTS.

Salt, per cent.	Sodium Hyposulphite.	Barium Nitrate.	Strontium Nitrate.	Magnesium Nitrate.	Lead Nitrate.	Potassium Oxalate.	Potassium Chromate.	Platinic Chloride.	Potassium Ferrocyanide.
2	1·0105	1·017	1·017	1·0078	1·0163	1·0134	1·0161	1·018	1·0116
4	1·0211	1·034	1·034	1·0158	1·0331	1·0268	1·0325	1·036	1·0234
6	1·0317	1·050	1·049	1·0239	1·0502	1·0401	1·0492	1·056	1·0356
8	1·0423	1·069	1·068	1·0321	1·0682	1·0529	1·0663	1·076	1·0479
10	1·0529	1·087	1·085	1·0405	1·0869	1·0656	1·0837	1·097	1·0605
12	1·0639	...	...	1·0490	1·1059	1·0784	1·1014	1·119	1·0734
14	1·0751	...	...	1·0577	1·1257	1·0912	1·1196	1·141	1·0866
16	1·0863	...	...	1·0663	1·1463	1·1043	1·1380	1·165	1·0999
18	1·0975	...	...	1·0752	1·1677	1·1175	1·1570	1·188	1·1136
20	1·1087	...	1·181	1·0843	1·1902	1·1306	1·1765	1·214	1·1275
22	1·1204	...	...	1·0934	1·2132	...	1·1964	1·242	...
24	1·1322	...	...	1·1026	1·2372	...	1·2169	1·270	...
26	1·1440	...	...	1·1120	1·2620	...	1·2379	1·300	...
28	1·1558	...	...	1·1216	1·2876	...	1·2592	1·330	...
30	1·1676	...	1·292	1·1318	1·3140	...	1·2808	1·362	...
32	1·1800	...	...	1·1410	1·3416	...	1·3035	1·395	...
34	1·1924	...	...	1·1508	1·3702	...	1·3268	1·431	...
36	1·2048	...	...	1·1608	1·3996	...	1·3505	1·469	...
38	1·2172	...	...	1·1709	...	...	1·3746	1·500	...
40	1·2297	...	1·422	1·1811	...	...	1·3991	1·546	...
42	1·2427	...	...	1·1914	...	...	...	1·591	...
44	1·2558	...	...	1·2019	...	...	...	1·641	...
46	1·2690	...	...	1·2126	...	...	...	1·688	...
48	1·2822	...	...	1·2231	...	...	...	1·736	...
50	1·2954	...	...	1·2340	...	...	...	1·785	...

Salt, per cent.	Ammonium Chloride.	Potassium Chloride.	Sodium Chloride.	Potassium Carbonate.	Potassium Bichromate.	Salt, per cent.	Potassium Carbonate.
1	1·0032	1·0065	1·0072	1·0091	1·007	27	1·2679
2	1·0063	1·0130	1·0145	1·0163	1·015	28	1·2789
3	1·0095	1·0195	1·0217	1·0274	1·022	29	1·2900
4	1·0126	1·0260	1·0290	1·0366	1·029	30	1·3010
5	1·0158	1·0325	1·0362	1·0457	1·037	31	1·3126
6	1·0188	1·0392	1·0436	1·0551	1·043	32	1·3242
7	1·0218	1·0458	1·0511	1·0645	1·050	33	1·3358
8	1·0248	1·0525	1·0585	1·0740	1·056	34	1·3473
9	1·0278	1·0591	1·0659	1·0834	1·065	35	1·3588
10	1·0308	1·0658	1·0733	1·0928	1·073	36	1·3708
11	1·0337	1·0727	1·0810	1·1026	1·080	37	1·3828
12	1·0366	1·0796	1·0886	1·1124	1·090	38	1·3948
13	1·0395	1·0865	1·0962	1·1222	1·097	39	1·4067
14	1·0432	1·0934	1·1038	1·1320	1·103	40	1·4187
15	1·0452	1·1004	1·1115	1·1418	1·110	41	1·4310
16	1·0480	1·1075	1·1194	1·1520	...	42	1·4434
17	1·0509	1·1146	1·1270	1·1622	...	43	1·4557
18	1·0537	1·1218	1·1352	1·1724	...	44	1·4681
19	1·0565	1·1289	1·1431	1·1826	...	45	1·4804
20	1·0593	1·1361	1·1511	1·1929	...	46	1·4931
21	1·0620	1·1435	1·1593	1·2034	...	47	1·5059
22	1·0648	1·1509	1·1675	1·2140	...	48	1·5186
23	1·0675	1·1583	1·1758	1·2246	...	49	1·5313
24	1·0703	1·1657	1·1840	1·2352	...	50	1·5441
25	1·0730	...	1·1923	1·2457	...	51	1·5573
26	1·0737	...	1·2010	1·2568	...	52	1·5705

Table of Specific Gravities of Chlorides.

(See previous table for NH_4Cl, KCl, and NaCl.)

Salt, per cent.	Al_2Cl_6 at 15°.	$BaCl_2$ at 15°.	$CaCl_2$ at 15°.	$CoCl_2$ ($NiCl_2$) at 17°5.	$CuCl_2$ at 17°5.	Fe_2Cl_6 at 17°5.	$MgCl_2$ at 15°.	$SnCl_2 + 2\,aq$ at 15°.	$SrCl_2$ at 15°
2	1·0144	1·0183	1·0170	1·0198	1·0182	1·0146	1·0169	1·013	1·0181
4	1·0288	1·0367	1·0341	1·0396	1·0364	1·0292	1·0338	1·026	1·0363
6	1·0435	1·0557	1·0515	1·0595	1·0548	1·0439	1·0510	1·040	1·0548
8	1·0584	1·0754	1·0682	1·0795	1·0734	1·0587	1·0684	1·054	1·0738
10	1·0734	1·0951	1·0869	1·0997	1·0920	1·0734	1·0859	1·068	1·0929
12	1·0890	1·1164	1·1056	1·1228	1·1178	1·0894	1·1040	1·083	1·1133
14	1·1047	1·1378	1·1243	1·1460	1·1436	1·1054	1·1220	1·097	1·1337
16	1·1207	1·1600	1·1433	1·1711	1·1696	1·1215	1·1404	1·113	1·1549
18	1·1379	1·1830	1·1628	1·1977	1·1958	1·1378	1·1592	1·128	1·1769
20	1·1537	1·2061	1·1822	1·2245	1·2223	1·1542	1·1780	1·144	1·1989
22	1·1709	1·2317	1·2028	1·2547	1·2501	1·1746	1·1978	1·161	1·2225
24	1·1881	1·2574	1·2234	1·2849	1·2779	1·1950	1·2175	1·177	1·2462
26	1·2058	...	1·2445	...	1·3058	1·2155	1·2378	1·194	1·2708
28	1·2241	...	1·2662	...	1·3338	1·2365	1·2586	1·212	1·2964
30	1·2422	...	1·2879	...	1·3618	1·2568	...	1·230	1·3220
32	1·2615	...	1·3104	...	1·3950	1·2778	...	1·249	1·3495
34	1·2808	...	1·3330	...	1·4287	1·2988	...	1·268	...
36	1·3007	...	1·3561	...	1·4615	1·3199	...	1·288	...
38	1·3211	...	1·3797	...	1·4949	1·3411	...	1·309	...
40	1·3415	...	1·4033	...	1·5284	1·3622	...	1·330	...
42	...	...	...	...	...	1·3870	...	1·352	...
44	...	...	...	...	...	1·4118	...	1·374	...
46	...	...	...	...	...	1·4367	...	1·397	...
48	...	...	...	...	...	1·4617	...	1·421	...
50	...	...	...	...	...	1·4867	...	1·445	...
52	...	...	...	...	...	1·5153	...	1·471	...
54	...	...	...	...	...	1·5439	...	1·497	...
56	...	...	...	...	...	1·5729	...	1·525	...
58	...	...	...	...	...	1·6023	...	1·554	...
60	...	...	...	...	...	1·6317	...	1·582	...
62	...	...	...	...	...	...	...	1·613	...
64	...	...	...	...	...	...	...	1·644	...
66	...	...	...	...	...	...	...	1·677	...
68	...	...	...	...	...	...	...	1·711	...
70	...	...	...	...	...	...	...	1·745	...
72	...	...	...	...	...	...	...	1·783	...
74	...	...	...	...	...	...	...	1·821	...

TABLE OF SPECIFIC GRAVITIES OF SOME ACETATES.

Per cent.	Sodium Acetate.	Calcium Acetate.	Barium Acetate.	Lead Acetate.	Per cent.	Lead Acetate.
2	1·0116	1·0132	1·0174	1·0127	32	1·2395
4	1·0232	1·0264	1·0348	1·0255	34	1·2578
6	1·0341	1·0362	1·0500	1·0336	36	1·2768
8	1·0439	1·0426	1·0628	1·0520	38	1·2966
10	1·0539	1·0492	1·0758	1·0654	40	1·3163
12	1·0644	1·0562	1·0902	1·0796	42	1·3376
14	1·0750	1·0632	1·1046	1·0939	44	1·3588
16	1·0856	1·0708	1·1201	1·1084	46	1·3810
18	1·0910	1·0792	1·1363	1·1234	48	1·4043
20	1·1074	1·0874	1·1522	1·1384	50	1·4271
22	1·1194	1·0976	1·1694	1·1544	...	...
24	1·1314	1·1078	...	1·1704	...	...
26	1·1440	1·1139	...	1·1869	...	...
28	1·1572	1·1307	...	1·2040	...	...
30	1·1706	1·1426	1·2402	1·2211	...	...

Hydroquinone (Ger., *Hydrochinon;* Fr., *Hydroquinone;* Ital., *Idrochinone*). $C_6H_4(OH)_2 = 110$. Synonyms: Hydrokinone, Hydrochinone, Quinol. It is prepared commercially by oxidising aniline sulphate with bichromate of potassium. Solubility: 58 per cent. in water 0°C., 10 per cent. in water at 30°; soluble also in alcohol, ether, and glycerine. It is allied to pyrogallol in chemical composition, pyro being a trihydroxylbenzine, $C_6H_4(OH)_3$; and quinol, or hydroquinone, being a dihydroxylbenzine. It was first suggested as a developer by Captain Abney, and attracted but little attention in consequence of the unsuitable character of the accelerator,—ammonium hydrate, or liq. ammoniæ,—which was recommended, and also from the prohibitive price of hydroquinone; but, as more experiments were made with it, and better formulæ were given for its use, it crept gradually into general favour, and an enormous reduction in price has led to its widespread adoption. When used with the carbonates of potassium and sodium its action is somewhat slow, and only since the general use of the hydrates of these alkalies has it given satisfaction. The question as to whether it is better than pyro is one that cannot be decided, so much depending upon the personal bias of the user. Many old operators who have used alkaline pyro since its first introduction still cling to it,

and refuse to believe that quinol is as good; whereas many others state that it is decidedly preferable. For some conditions of work it undoubtedly is far superior to pyro. The number of formulæ given is enormous, almost every worker seemingly suggesting some slight modification. The author has made a great number of experiments, and believes that with the following formulæ good results can always be obtained. For negative work :—

No. 1.

Quinol	154 grs.
Sodium sulphite (pure recryst.)	154 „
Sulphurous acid	17 mins.
Distilled water, to make	10 ozs.

Dissolve the sulphite in the water and add the acid, and lastly the quinol.

No. 2.

Sodium carbonate (pure)	1,300 grs.
Potassium hydrate (caustic potash in sticks)	154 „
Distilled water, to make	10 ozs.

For use mix equal parts of each, and dilute with twice or three times the quantity of water. About 4 drms. of each will be ample for a ½-plate which has received a normal exposure. The image should make its appearance in about thirty to forty-five seconds, and development be completed in four or five minutes. For under-exposure soak the plate first in the accelerator for one minute, and then add the quantity of No. 1. For over-exposure add 1 drm. of a 10 per cent. solution of sodium sulphite, or 5 mins. of bromide of potassium, and reduce the quantity of accelerator No. 2. The following mode of preparing the developer is satisfactory.

No. 1.

Quinol	4 grs.
Sodium sulphite	24 „
Distilled water	1 oz.

No. 2.

Potassium bromide	60 grs.
Distilled water, to make 10 drms. of solution.	

No. 3.

Potassium hydrate	2 ozs.
Distilled water	1 oz.

For normal exposure add 5 drops of No. 2 and No. 3 solutions to 1 oz. of No. 1, and allow development to continue for some minutes; then add another portion of No. 3 to obtain the required density. For under-exposure omit No. 2, and gradually increase the accelerator No. 3; for over-exposure increase No. 2 to 10 drops to the ounce. The above quantities are for a ¼-plate. The following is recommended by a well-known firm of plate-makers:—

No. 1.

Quinol	160 grs.
Sodium sulphite	2 ozs.
Citric acid	60 gr.
Potassium bromide	30 „
Distilled water to	20 ozs.

No. 2.

Sodium hydrate	160 grs.
Distilled water to	20 ozs.

To develop, mix equal parts of each. It is recommended to use the alum bath after development. May be used for negative or positive work. For positives, whether on glass or paper, the author recommends the following when black tones are wished for:—

No. 1.

Quinol	154 grs.
Sodium sulphite	437 „
Sulphurous acid	20 mins.
Distilled water to make	10 ozs.

No. 2.

Sodium carbonate	1,300 grs.
Potassium hydrate	154 „
„ bromide	20 „
Distilled water to make	10 ozs.

Mix in equal parts, and dilute with three times the quantity of water. The following will give good purplish tones to transparencies on glass, and brownish tones to bromide paper:—

Quinol	2 grs.
Ammonium carbonate	24 „
„ bromide	½ „
Distilled water...	1 oz.

Mix immediately before using. As a convenience for travelling, the following dry powder developer will be found simple and convenient :—

I.

Quinol	90 grs.

II.

Sodium sulphite (granular)	2 ozs.

III.

Carbonate of soda (*dried*)	1 oz.

Wrap each salt in waxed paper and tinfoil. Dissolve these quantities in a quart of water. As a further convenience they may be subdivided into four or eight packets each, so as to make sufficient quantities for 10 or 5 ozs. of developer. Although a one-solution developer is not the best form, it may be found convenient for travelling, and then the following will answer well :—

Quinol	90 grs.
Sodium sulphite	2 ozs.
Carbonate of soda	2 „
Distilled water to make	10 „
Eosin...	1 gr.

This solution will keep at least two months, and when required for use should be diluted with four times the quantity of water. For over-exposure use old developer, for under-exposure new developer, and for normal half old and half new. In using quinol as a developer several precautions are necessary. Absolutely clean dishes must be used, as any trace of pyro produces a brown stain. For negative work fresh developer should be used for each plate ; but the used developer may be kept and used for bromide paper and transparencies. Both negatives and positives should be well washed after development prior to fixing ; and if either of the caustic hydrates of the alkalies are used, then an alum bath should be used after development to prevent frilling. All plates and papers developed by quinol require clearing and

thoroughly washing after being fixed, to dissolve out the slight precipitate of carbonate of lime deposited from the water. Numerous researches have been made on the subject of this reducing agent and more numerous still the formulæ that have been recommended, one of the most complete papers was by Lainer, who summarises his experiments as follows :—

A Concentrated Rapid Hydroquinone Developer.

A.	Water	100 c.cm.
	Sodium sulphite	25-30 grms.
	Hydroquinone	10 ,,

Dissolve these by the aid of heat, and add to the solution 25 grms. of potassium ferrocyanide dissolved in 100 c.cm. of water.

B.—Dissolve 50 grms. of potassium hydrate in 100 c.cm. of water, or 30 grms. of sodium hydrate in 90 c.cm. of water.

For development, take 60 parts of A, 6 to 8 parts of the potash solution, and 40 parts of water; the potash solution may be replaced by 10 parts of the solution of caustic soda. The two original solutions may be mixed, and should then be diluted with thrice its bulk of water.

Other Formulæ.

		1	2	3	4	5	
A.	Water	600	900	950	1,000	550	parts.
	Hydroquinone	10	10	10	10	10	,,
	Neutral sodium sulphite	25	40	30	35	35	,,
	Potassium ferrocyancide	—	120	90	25	25	,,
B.	Potassium hydrate ...	50	50	—	50	—	,,
	Sodium hydrate ...	—	—	30	—	60	,,
	Water	100	100	90	550	550	,,

Developer 1.—60 c.cm. of A and 3 c.cm. of B, brought out a sensitometer image in three-quarters of a minute to 24°; but is apt to produce fog with some kinds of plates. The addition of about 12 per cent. of potassium ferrocyanide is found to have a very beneficial effect. Developer 2.—60 c.cm. of A and 6 c.cm. of B permits exposures to be shortened, gives excellent details in the shadows, and allows very rapid development. Developer 3.—60 c.cm. of A and 12 c.cm. of B gives negatives of a softer character than those given by Developer 2. Developer 4 is a slower developer, 60 c.cm. of A being mixed with from 6 to 9 c.cm.

of a 50 per cent. solution of sodium hydrate and diluted with 60 c.cm. of water. Developer 5.—Equal bulks of these solutions are mixed immediately before use. It resembles Developer 4 in its action. Acetic acid and acetates act strongly as restrainers, yellow prussiate of potash acts as an accelerator. The great fault with incautious use of hydroquinone is that one is very liable to obtain negatives with very great contrasts.

Hydrotype. A kind of reversed collotype. (See COLLOTYPE.) The plate is exposed under a positive, and the gelatine is allowed to swell in a coloured solution; a printing surface being thus obtained which will yield impressions on paper.

Hydroxyl, Hydroxyl Monohydride. See HYDROGEN PEROXIDE; also HYDRATES.

Hydroxylamine Hydrochlorate (Ger., *Salzsäures Hydroxylamin;* Fr., *Chlorhydrate d'hydroxylamine;* Ital., *Cloridrato d'idrossilimina*). $NH_2.OH.HCl$. Prepared by the reduction of nitrite and nitrate of ammonia. It is very soluble in water and alcohol; it has been recommended as a new developing agent; its price is at present against it, but recent improvements in the manufacture provide hope of a speedy reduction in price. It is absolutely non-staining, but is subject to the disadvantage that it causes the film to blister by the disengagement of nitrogen. It has, however, been stated that this can be prevented by adding thiosinnamine or glucose to the developer. The following is the form recommended by Messrs. Egli & Spiller:—

I.

Hydroxylamine	32 grs.
Citric acid	15 ,,
Distilled water	1 oz.

II.

Carbonate of potash	480 grs.
Carbonate of soda	480 ,,
Distilled water	10 ozs.

Developer.

Solution I.	30 mins.
Solution II.	120 ,,
Distilled water	1½ oz.

Sufficient for half-plate. It is especially recommended for chloride plates, bromide and Alpha papers.

Hygrometer. (*ὑγρός*, moist, and *μετρον*, a measure). An instrument for measuring the moisture of the atmosphere, and sometimes used by carbon printers. That known as a wet and dry bulb thermometer is convenient; but a long strip of unsensitised carbon tissue, hanging up in the apartment, gives a sufficient indication to the expert.

Hypo. An abbreviation of Sodium Hyposulphite (*q.v.*).

Image. In optics a simulation of an object—*real* when it can actually be received on a screen, as a camera image; *virtual* when the eye sees it as in the prolongation of bent rays entering the eye.

Image, Latent. The action of light upon the sensitive salts of silver has always been a question with scientific photographers, and it would be impossible within reasonable limits to give all the arguments *pro* and *con*. For some considerable time past, and even now, a few photographers hold that the action of light upon the sensitive salts is to set up a vibratory motion, which the developer takes advantage of, reducing these vibrating molecules to a metallic state. This theory, however, is generally considered erroneous. It is now generally believed that sub-haloid salts are formed by the action of light. Carey Lea has formed these by purely chemical reactions, and he calls them photo-salts, and they would seem to be compounds of a lower haloid salt, with the normal haloid in varying proportions. In all cases there seems to be an evolution of the haloid element. It seems unlikely that all the molecules of haloid salt are reduced; on the contrary, but a very minute portion.

Confirmation of the dissociation of the molecule of bromide of silver by light has been given by the researches of Guntz, who has been able to prepare the sub-haloid salts of silver.

Indiarubber Solution. This is used for edging plates or as a substratum for the collodion process, and also for mounting gelatino-chloride prints. Pure unvulcanised indiarubber (sold as masticated rubber or "cut sheet") may be dissolved in benzole, chloroform, or carbon bisulphide, the two former being preferable, in the proportion of 10 grains to the ounce.

Ink Process. Under this title several processes may be included, but Lemling's process is the one usually meant by this term now; the procedure being as follows:—

Bichromate of potash	1 part.
Distilled water	20 parts.

Dissolve and render neutral with ammonia. To every three parts of this add

Powdered gum-arabic	1 part.

Transfer to a bottle and shake frequently till dissolved; it should then be filtered and spread evenly over a sheet of albumenised paper with the aid of a Blanchard brush. The paper should then be laid, film up, on a sheet of plate-glass, a good-sized pool of the solution poured on to it and made to cover it evenly, the excess poured off, and the paper hung up to dry. The difficulty in this process is to prevent the albumenised paper from curling; therefore it is preferable to hold it paper-side down over a jet of steam, so as to partially coagulate the albumen next the paper, and then lay on the glass; or the glass may be wetted and the paper squeegeed to it with a rubber roller and then coated as described above. Exposure behind a negative in the usual way, the paper being then laid face downwards on water and allowed to soak for some time with repeated changing of the water, after which it should be soaked in alum solution and again washed. It is then drawn over the surface of the following solution:—

Pyrogallol	1 part.
Distilled water	... 50-80 parts.

Or it may be floated on the same for two minutes, then thoroughly washed and floated on a solution of

Sulphate of iron	10 parts.
Distilled water	100 ,,

and again washed. If not dark enough the process may be repeated.

Another process sometimes used by artists and others for preparing drawings for reproduction is as follows. A print is obtained in the usual way either on albumenised, bromide, or plain paper, the latter being preferable; and failing this an image

may be obtained on the back of albumenised paper. As long as the details are there the depth of printing should be very slight; no toning or fixing is required. The image is then traced over with Indian ink, with the aid of a crowquill or fine pen. Allow this image to dry thoroughly and immerse in

Saturated solution of iodine (see below)...	10	parts.
Saturated „ „ potassium cyanide ...	15	„
Distilled water	500	„

when the silver image will disappear and the print may then be washed and dried. The saturated solution of iodine can be prepared by saturating a 10 per cent. aqueous solution of potassium iodide.

Inks. *Indian Ink*, used in carbon printing and other similar process, appears to contain a special fine lampblack.

Ink for Writing on Glass.—An ounce of ordinary shellac is dissolved in 7 fluid ozs. of methylated spirit, and strained through muslin ; and to this is added, a little at a time, and with agitation, a solution of 1½ oz. of borax in 12 ozs. of water. The pigment or colour used should be mixed in with the borax solution; Indian ink or any finely ground water colour being suitable.

Indestructible Ink for Labels.—As above, with Indian ink as pigment.

White Ink for Lantern Slides.—Chinese white, gum and water to suitable consistency.

Insensitiveness. When, by reason of faulty chemicals or manipulations, the sensitive surface refuses to record any action of light.

Instantaneous Lens. A term incorrectly applied to lenses when intended to convey a particular construction, as all types of lenses would, in a sufficiently powerful light, enable instantaneous photographs to be taken.

Instantaneous Photography is the obtaining of negatives by exposures of a small fraction of a second. The following tables and rules may be found useful :—

A man walking	3	miles per hour	moves	4½ft. per second.
„	4	„	„	6 „

A vessel travelling	9	knots	per hour	15	per second.
„	12	„	„	19	„
„	17	„	„	28	„
„	20	„	„	35	„
A trotting horse ...	...	...	„	39	„
A galloping horse ...	...	...	„	50	„
An express train at	38	miles	per hour	59	„
Flight of a pigeon ...	...	...	„	61	„
Waves during a storm	...	...	„	65	„
Express train at	60	miles	per hour	88	„
Flight of the swiftest birds	...		„	264	„
A cannon ball ...	...	...	„	1,625	„
An object moving	1	mile	per hour moves	1½	ft.
„	2	miles	„	3	„
„	3	„	„	4½	„
„	4	„	„	6	„
„	5	„	„	7½	„
„	6	„	„	9	„
„	7	„	„	10½	„
„	8	„	„	12	„
„	9	„	„	13	„
„	10	„	„	14½	„
„	11	„	„	16	„
„	12	„	„	17½	„
„	13	„	„	19	„
„	14	„	„	20½	„
„	15	„	„	22	„
„	20	„	„	29	„
„	25	„	„	37	„
„	30	„	„	44	„
„	35	„	„	51	„
„	40	„	„	59	„
„	45	„	„	66	„
„	50	„	„	73	„
„	55	„	„	80	„
„	60	„	„	88	„
„	75	„	„	110	„
„	100	„	„	147	„
„	125	„	„	183	„
	150	„	„	220	„

To find the distance moved by the image of an object on the ground glass, multiply the focus of the lens in inches by the distance in inches moved by the object in one second, and divide the result by the distance of the object in inches.

Example.—Find the displacement of image on ground-glass of an object moving 20 miles an hour, with a lens of 8½-in. focus, and the object 150 yds. distant.

$8\frac{1}{2} \times 348 \div 5{,}400 = \frac{2958}{5400} = \frac{1}{2}$ in. per sec. practically.

To find how quickly a shutter must act to take an object in motion, that there may be a circle of confusion less than 1-100th inch in diameter, divide the distance of the object by 100 times the focus of the lens, and divide the rapidity of motion of object in inches per second by the result, when you have the longest duration of exposure in fraction of a second. All measurements in inches.

Example.—Required the speed of a shutter to take an object moving 20 miles per hour, with a lens of 8½-in. focus, the object being 150 yards distant.

The object moves 29 feet = 348 in. per second.

5,400, distance of object in inches, $\div$ ($8\frac{1}{2} \times 100$)

$$= 5{,}400 \div 850 = \frac{108}{17}$$

348, speed of object per second, $\div \frac{108}{17} = \frac{348 \times 17}{108}$

$$= \frac{493}{9} = 55 \text{ practically.}$$

$\therefore$ the shutter must work at $\frac{1}{55}$ of a second

Knowing the rapidity of shutter and moving object, required to find the distance to place the camera to give an image with a circle of confusion less than $\frac{1}{100}$ of an inch in diameter. Multiply 100 times the focus of the lens in inches by the space through which the object would pass during the exposure, and the result is the nearest distance in inches between object and camera.

Example—A shutter works at $\frac{1}{60}$ sec., object moves four miles an hour; how near must camera be placed with an 8½-in. lens?

An object moving four miles per hour moves 72 in. per second.

$\therefore$ an object moving four miles per hour moves $1\frac{1}{11}$ in. in $\frac{1}{100}$ sec.

$$8\tfrac{1}{2} \times 100 \times 1\tfrac{1}{11} = \frac{17 \times 100 \times 12}{2 \times 11} = 927 \text{ in.} = 25 \text{ yds.}$$

Dr. Eder gives the following table ("Jahrbuch," 1887):—

	Sec.		Sec.	Sec.
Laughing children, etc., probably require ...	$\frac{1}{8}$	to	1	
Dogs and cats	$\frac{1}{2}$	,,	$\frac{1}{100}$	
Street scenes, according to size of figures ...	$\frac{1}{20}$	,,	$\frac{1}{50}$	
Cattle feeding, sheep, etc.	$\frac{1}{20}$	,,	$\frac{1}{30}$	
Moving ship 500 to 1,000 yards off... ...	$\frac{1}{20}$	,,	$\frac{1}{30}$	
Moving ship nearer	$\frac{1}{60}$	,,	$\frac{1}{150}$	
Animals which appear on focussing screen from one to two inches high	$\frac{1}{60}$	,,	$\frac{1}{100}$	
Trotting and jumping horses, birds, etc. ...	$\frac{1}{100}$	,,	$\frac{1}{400}$	to $\frac{1}{1000}$

Pizzighelli ("Anleitung zur Photographie," p. 83) gives the following useful little table:—

Distance of the moving object, expressed in multiples of focus of lens	Men at ordinary walking pace.	Men walking quickly.	Men running.	Horse walking.	Horse trotting.	Horse galloping.	Horse jumping.	Steamship in distance.	Train 35 miles an hour.	Express train 60 miles per hour.
	Moving a distance in yards per second of									
	1·5	1·6	2·3	1·8	3·8	5·7	12	7	10	16·7
	Requires an exposure in seconds									
100 times focus	—	—	—	—	—	—	—	—	—	—
200 ,,	$\frac{1}{100}$	$\frac{1}{100}$	—	—	—	—	—	—	—	—
300 ,,	$\frac{1}{50}$	$\frac{1}{50}$	$\frac{1}{100}$	$\frac{1}{100}$	—	—	—	—	—	—
400 ,,	$\frac{1}{50}$	$\frac{1}{50}$	$\frac{1}{100}$	$\frac{1}{50}$	$\frac{1}{100}$	—	—	—	—	—
500 ,,	$\frac{1}{33}$	$\frac{1}{33}$	$\frac{1}{50}$	$\frac{1}{50}$	$\frac{1}{100}$	—	—	—	—	—
600 ,,	$\frac{1}{25}$	$\frac{1}{25}$	$\frac{1}{50}$	$\frac{1}{33}$	$\frac{1}{100}$	$\frac{1}{100}$	—	—	—	—
700 ,,	$\frac{1}{25}$	$\frac{1}{25}$	$\frac{1}{33}$	$\frac{1}{25}$	$\frac{1}{50}$	$\frac{1}{100}$	—	$\frac{1}{100}$	—	—
800 ,,	$\frac{1}{20}$	$\frac{1}{20}$	$\frac{1}{33}$	$\frac{1}{25}$	$\frac{1}{50}$	$\frac{1}{100}$	—	$\frac{1}{100}$	—	—
900 ,,	$\frac{1}{16}$	$\frac{1}{20}$	$\frac{1}{33}$	$\frac{1}{20}$	$\frac{1}{50}$	$\frac{1}{100}$	—	$\frac{1}{100}$	—	—
1,000 ,,	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{25}$	$\frac{1}{20}$	$\frac{1}{50}$	$\frac{1}{100}$	$\frac{1}{125}$	$\frac{1}{100}$	$\frac{1}{100}$	$\frac{1}{100}$

Major Pizzighelli wisely adds that fractions of a second smaller than $\frac{1}{100}$ have not been introduced into the above table,

probably because the shutters giving shorter exposures than this are not met with every day. In the first column above, the distances of the object are expressed as multiples of the focal length; the distance in yards is easily reckoned out by multiplying by the focus of lens. Thus, an object is 200 times the focus of lens distant, and using an $8\frac{1}{2}$-in. lens, then:

$$8\tfrac{1}{2} \times 200 = 1{,}700 \text{ in.} = 44\tfrac{1}{2} \text{ yards.}$$

These distances must be estimated by measurement or guess work. This latter is by no means difficult to reach; thus the following table, compiled by the same writer, will be of assistance. We assume that the mean height of a man is 5 ft. 9 in. that of a horse 5 ft. 3 in., that when the height of the image of horse and a man appears on the ground-glass as:

Man.	Horse.	The Object is distant from the Camera.
$1\frac{1}{2}$ in. ...	$1\frac{1}{4}$ in. ...	50 times the focal length.
$\frac{3}{4}$ " ...	$\frac{3}{4}$ " ...	100 " "
$\frac{3}{8}$ " ...	$\frac{3}{8}$ " ...	200 " "
$\frac{1}{4}$ " ...	$\frac{1}{5}$ " ...	300 " "
$\frac{3}{16}$ " ...	$\frac{3}{16}$ " ...	400 " "
$\frac{1}{7}$ " ...	$\frac{1}{8}$ " ...	500 " "
$\frac{1}{8}$ " ...	$\frac{1}{10}$ " ...	600 " "
$\frac{1}{12}$ " ...	$\frac{1}{10}$ " ...	700 " "
$\frac{3}{32}$ " ...	$\frac{3}{32}$ " ...	800 " "
$\frac{1}{16}$ " ...	$\frac{1}{16}$ " ...	900 " "
$\frac{1}{18}$ " ...	$\frac{1}{18}$ " ...	1,000 " "

Another table compiled by MM. Henry Hermagis and Rossignol is also convenient:—

Distance. in yards	Subject.	Approx. speed of shutter in seconds.	Approx. Reduction.	Approx. height of man in inches.
$3\frac{1}{4}$	Standing children or half-length men with heads about $\frac{3}{4}$ inch from top to chin	$\frac{1}{10}$	$\frac{1}{10}$	—
$7\frac{1}{2}$	See-saw, skipping children, etc.*	$\frac{1}{20}$ to $\frac{1}{60}$	$\frac{1}{25}$	$2\frac{1}{4}$ to $2\frac{3}{4}$
12 to $16\frac{1}{4}$	Horse walking, dancers †	$\frac{1}{60}$ to $\frac{1}{100}$	$\frac{1}{40}$ to $\frac{1}{60}$	$1\frac{1}{8}$ to $1\frac{1}{2}$

* The exposure to be made at the moment of partial rest or least movement.
† Object moving across the field of view.

Distance in yards.	Subject.	Approx. speed of shutter in seconds.	Approx. Reduction.	Approx. heighth of man in inches.
12 to 24	Acrobats, clowns, dancers, etc.†	$\frac{1}{60}$ to $\frac{1}{100}$	$\frac{1}{40}$ to $\frac{1}{80}$	$\frac{3}{4}$ to $1\frac{1}{2}$
15 to 20	Moving people, but not walking about—crowds, bathers	$\frac{1}{40}$ to $\frac{1}{60}$	$\frac{1}{50}$ to $\frac{1}{70}$	1 to $1\frac{1}{8}$
$18\frac{1}{2}$ to 30	People walking, soldiers quick-marching †	$\frac{1}{100}$	$\frac{1}{60}$ to $\frac{1}{100}$	$\frac{1}{2}$ to $1\frac{1}{8}$
22 to 32	People, troops, yachts, tramcars ‡	$\frac{1}{100}$	$\frac{1}{70}$ to $\frac{1}{100}$	$\frac{1}{2}$ to $\frac{3}{4}$
27	Horse trotting, infantry charging, runners ‡	$\frac{1}{10}$ to $\frac{1}{20}$	$\frac{1}{110}$	$\frac{1}{2}$
33	Calm sea, ships, at rest or moving ‡	$\frac{1}{60}$	$\frac{1}{100}$	$\frac{1}{2}$
43	People or troops §	$\frac{1}{60}$	$\frac{1}{150}$	$\frac{2}{5}$
50	Galloping horse *	$\frac{1}{100}$	$\frac{1}{170}$	$\frac{1}{3}$
59	Train (35 miles per hour), tricycle, sledge †	$\frac{1}{100}$	$\frac{1}{200}$	$\frac{1}{4}$
70 to 75	Express train, balloon, storm waves, greyhound coursing, skater, racehorse, dynamite explosion	$\frac{1}{100}$ to $\frac{1}{180}$	$\frac{1}{250}$	$\frac{1}{5}$

One condition of obtaining the most successful results is to watch the moving object till it attains that position which is commonly called the dead point or position, and which is well seen in the case of a ball thrown perpendicularly up into the air. For some time the ball travels up, and then just for one almost inappreciable period of time it is stationary, and begins its downward course, and an exposure should be made just at the moment of reversal of motion. It will be found that with many moving objects some such dead point will occur, and the successful worker seizes this moment to expose. Too many amateurs

* The exposure to be made at the moment of partial rest or least movement.
† Object moving across the field of view.
‡ Object moving across the plate.
§ Object moving to or from lens or only slightly across.

allow their very laudable ambition to run away with their sense, and expect the combination of shutter, lens, and plate to do impossibilities. For very quick work, brilliant sunshine is absolutely necessary, and two important points should be taken into consideration—(1) That the nearer a moving object is, the more rapid must be the action of what is called the shutter, which, by way of parenthesis, might with equal force be termed an opener; (2) The longer the focus of the lens, the more rapidly the shutter should act. Another point is that when an object is moving across the field of view, or more or less obliquely to the axis of the lens, the shutter must act more quickly, whilst with an object moving parallel to the axis of the lens, or away from or towards the lens, the displacement on the ground glass or the difference between the size of the image at two points is by no means so great as in the first case; and to improve matters the theoretical impossibility, the depth of focus of the lens, is again of assistance. Many commercial shutters are fitted with an index showing the speed given by the shutter when certain levers, etc., are placed in certain positions, but strict reliance cannot always be placed upon such speeds. Methods of testing instantaneous shutters will be treated of under that heading.

Instantaneous Shutters. See SHUTTERS.

Intensification means the increasing of the deposit or the printing density of a negative. There are several methods of doing this; but many depend on the use of mercuric chloride, and a subsequent darkening. Before intensifying a negative with mercury it is absolutely essential that it should be completely free from hyposulphite of soda. It is, therefore, advisable to give the negative a thorough washing, and then immerse for 10 mins. in a 5 per cent. solution of hydrogen peroxide, and again wash. Negatives which have been allowed to dry should be well soaked in water before being bleached, and varnished negatives must of course have the varnish removed by means of methylated spirit, and then soaked. The mercuric solution is prepared as follows:—

Perchloride of mercury	2 parts.
Hydrochloric acid	1 part.
Water	100 parts.

The hydrochloric acid should be placed on the powdered mercuric chloride, and then the water added. The negative to be intensified, having been previously treated as above suggested, should be laid in the solution, and the dish gently rocked till on looking at the back of the plate it is seen to be quite white. It should then be thoroughly washed for at least 20 minutes in running water, and then immersed in one of the following solutions :—

I.

Sodium sulphite	1 part.
Water	6 parts.

II.

The ordinary ferrous oxalate developer.

III.

Hydroquinone developer.

IV.

Strong Liquid ammonia	1 part.
Water	10 parts.

V.

Silver nitrate	20 parts.
Distilled water	500 ,,

and add gradually

Potassium cyanide	20 parts.
Distilled water	500 ,,

Shake well after each addition, till only a small quantity of white flocculent precipitate remains. It is important that the solution should never be quite free from sediment.

VI.

Potassium cyanide	2½ parts.
,, iodide	2½ ,,
Mercuric chloride	2½ ,,
Distilled water	1000 ,,

VII.

Schlippe's salt	10 parts.
Distilled water	400 ,,
Ammonia	5 ,,

The ordinary method of intensifying is to adhere to the use of one solution as a blackening agent; but it frequently happens that the same degree of increment is neither desirable nor necessary, then choice may be made from the above solutions. Mr. Chapman Jones has tabulated in convenient form the action of many of these. He says:—"In the following series of operations each change is supposed to be thorough—that is, that the change of colour in every case shall be visible clearly at the back of the plate in the densest part of the negative. (1) Mercuric chloride, followed, after well rinsing, with sodium sulphite, gives the little addition of brilliancy sometimes wanted in a carefully made and successful negative; (2) mercuric chloride on the original negatives, followed, after thorough washing, by ferrous oxalate, gives about as much increase of density, as compared with No. I., as No. I. gives when compared with the original negative; (3) a repetition of the application of mercuric chloride and ferrous oxalate—that is, these re-agents applied to the result of No. II.—gives another step in the intensification;* (4) the result of No. III. may be treated again with mercuric chloride and ferrous oxalate, and so on, as may be necessary; (5) the fourth or fifth consecutive application of mercuric chloride and ferrous oxalate will probably give a result equal to that of the uranium intensifier acting upon the original negative; (6) if a still greater effect is desired, the lead intensifier may be used on the original negative." Continuing this series we may say that the action of No. V. is fully equal to, if not slightly greater than, mercuric chloride, followed by ammonia; whilst No. VI. gives as great increase as the lead intensifier if desired. No. VII. about the same as No. V. Instead of hydrochloric acid in the bleaching or mercuric chloride solution, many recommend potassium bromide or ammonium chloride; either may be used, without any difference in results being detected. Nos. II. and III. solutions give about the same density; Nos. V., VI., and VII. are all poisonous, as is also the mercuric chloride solution. The bleached negative should not be allowed to remain too long in No. V., or else the shadows are attacked. When the negative is placed in No. VI. it turns first bright yellow, then much darker brown. At this stage it is very dense, and only extremely thin

* The result of this treatment is about equal to the action of mercuric chloride, followed by ammonia, upon the original negative.

negatives should be removed now ; for normal work, the negative should be left in still longer, till it turns a lighter brown. No. VII. gives a bright reddish-brown negative. Whichever darkening solution is used, it should be allowed to act till the back of the image, as seen through the glass, is dark, and then thoroughly washed.

The Uranium Intensifier. This stains the image a bright reddish-brown. It is absolutely necessary that all hypo should be eliminated.

Potassium ferridcyanide (syn., ferricyanide) ...	1 part.
Uranium nitrate	1 ,,
Acetic acid, glacial	10 parts.
Water	100 ,,

The plate, after intensification, should be well rinsed and dried ; continuous washing, especially in ordinary tap water, removes the intensification bodily. This very defect makes this process useful, as by means of an alkali any part of a negative intensified with uranium can be bleached by treatment with ammonium carbonate.

The Lead Intensifier. This gives a very dense increment, and is, therefore, rarely necessary or used.

Potassium ferridcyanide	6 parts.
Lead nitrate	4 ,,
Acetic acid, glacial	10 ,,
Distilled water	100 ,,

Soak the negative in this solution till bleached, then wash thoroughly, and flood with ammonium sulphydrate ; then wash well and dry.

Silver Intensifiers. Whilst some operators still hold to this, the relic of old wet-plate days, it has not found its way into general practice. It is difficult to avoid the occurrence of stains, as silver nitrate so readily combines with gelatine. Several formulæ have been suggested.

A.

Pyrogallol	1 part.
Citric acid	2 parts.
Distilled water	300 ,,

B.

Silver nitrate	2 parts.
Distilled water	100 ,,

The plate should, first of all, be flowed over once or twice with Solution A, and then to every 50 parts of A 30 to 40 parts of B should be added. Belitzski suggests the following:—

A.

Gallic acid	1 part.
Hot distilled water	100 parts.

Dissolve and filter; when cold, add an equal volume of

Silver nitrate	1 part.
Acetic acid, glacial	1 ,,
Distilled water	50 parts.

The following has also been suggested:—

I.

Silver nitrate	22 parts
Distilled water	250 ,,

II.

Potassium bromide	10 parts.
Distilled water	25 ,,

Mix, collect the precipitate, wash thoroughly, and dissolve in

Sodium hyposulphite	60 parts.
Distilled water	170 ,,

The mixture is thoroughly stirred, allowed to stand for a few hours, and filtered, sufficient water being added to make the total bulk measure 450 parts. The plate is soaked in this solution for 5 minutes, drained, and a ferrous oxalate developer applied, and then washed and dried. The following intensifier has also been suggested for negatives of line work, but is also applicable to ordinary work:—

A.

Potassium bromide...	1 part.
Water	16 parts.

B.

Copper sulphate	1 part.
Water	16 parts.

Mix in equal proportions, and flow over the plate till the image is bleached, then wash well, and blacken with

Silver nitrate	1 part.
Water	16 parts.

or

Ammonium hyposulphite	1 part.
Water	4 parts.

Then wash and dry.

Interference Heliochromy. See PHOTOGRAPHY IN NATURAL COLOURS.

Interiors. See ARCHITECTURAL PHOTOGRAPHY.

Invisible Rays. See RADIOGRAPHY AND EFFLUVIOGRAPHY.

Iodine (Ger., *Iod;* Fr., *Iode;* Ital., *Iodio*). I = 127. One of the halogen elements. Is obtained from seaweed, and appears commercially in metallic bluish-grey scales. Solubility: 1 in 7,000 of water, 1 in 12 of alcohol, 1 in 4 of ether; very soluble in a solution of any alkaline iodide. Thirty grains of iodine and 30 grs. of potassium iodide will dissolve in one drm. of distilled water. The metalloid itself is of less photographic use than its compounds.

Iridescent Heliochromy. See PHOTOGRAPHY IN NATURAL COLOURS.

Iridescent Stain. See FOG.

Iris Diaphragm. See DIAPHRAGM.

Iron, Ammonio-Citrate of (Ger., *Citronensäures Eisenoxydammon;* Fr., *Ammonio-citrate de fer, Citrate ammoniacal de fer;* Ital., *Citrato di ferro ammoniacale*). Synonym: Ferric Ammonium Citrate. Is prepared by dissolving ferric hydrate in citric acid, and adding liq. ammonia till neutral. It should be in small transparent scales of a deep reddish-brown colour. Solubility: 1 in 0·5 parts of water.

Iron, Ammonio-Oxalate of (Ferric). $(NH_4)_3Fe(C_2O_4)_3$. By dissolving ferric hydrate in acid oxalate of ammonium solution.

and evaporating greenish-white crystals, which are partially reduced by light to a ferrous state. Ninety parts are soluble in 100 parts of cold water, and 126 parts in 100 of boiling water. Used in platinotype and blue-printing processes.

Iron, Ammonio-Sulphate of (Ger., *Schwefelsäures Eisenoxydulammon;* Fr., *Sulfate ferreux ammoniacal;* Ital., *Solfato di protossido di ferro e d'ammoniaca*). $Fe(NH_4)_2SO_4 6H_2O$ = 392. A double salt of iron and ammonium, proposed as a substitute for ferrous sulphate; but its action is much feebler, though the salt and its solution are more stable. One ounce of ferrous sulphate is equal to 1½ ozs of the double salt. Solubility: about 1 in 6 of cold water; insoluble in alcohol. Was frequently used for developing wet collodion plates.

Iron, Oxalate (Ferric) (Ger., *Oxalsäures Eisenoxyd, Ferridoxalat;* Fr., *Oxalate ferrique;* Ital., *Ossalato di perossido di ferro*). $Fe_2(C_2O_4)_3$. Obtained by precipitation, and nearly insoluble in water. Soluble in oxalic acid and alkaline oxalates.

Iron, Oxalate of (Ferrous) (Ger., *Eisenoxalat;* Fr., *Oxalate ferreux;* Ital., *Ossalato ferrico*). FeC_2O_4. Prepared by decomposition of sulphate of iron with oxalic acid. It is but rarely used dry, being generally prepared as wanted in solution by double decomposition by adding solution of sulphate of iron to solution of oxalate of potash. (See DEVELOPER.) It is sparingly soluble in water, more soluble in any solution of alkaline oxalate. It is the developing agent of the ferrous-oxalate developer.

Iron, Perchloride of (Ger., *Ferrichlorid, Eisenchlorid;* Fr., *Perchlorure de fer, Chlorure ferrique;* Ital., *Cloruro ferrico*). Fe_2Cl_6. Synonym: Ferric Chloride. Prepared by passing chlorine over hot iron filings, when the ferric chloride distils over. It can also be made by dissolving iron wire in hydrochloric acid, adding nitric acid, and heating till the ferrous chloride first formed is converted into ferric. It occurs in yellowish-red opaque masses, which are very deliquescent. Solubility: 160 per cent in cold water; soluble also in alcohol and ether. It is used for the reduction of negatives, for cyanotype paper, also for etching copper and zinc.

Iron, Sulphate of (Ger., *Eisenvitriol, Schwefelsäures Eisenoxydul;* Fr., *Sulfate ferreux;* Ital., *Solfato di ferro*).

$FeSO_47H_2O = 278$. Synonyms: Ferrous Sulphate, Protosulphate of Iron, Copperas, Green Vitriol. The crystals should be of a bluish-green colour, free from any adherent brownish rusty powder, which is caused by the action of the oxygen of the air, the product being an oxy-sulphate: to this action is also due the deteriorations of solutions of this salt. When this change in colour of a solution is noticed, it should be rejected and fresh solution used. Solubility: 1 in 1·5 of water; insoluble in alcohol and ether.

Isinglass. A crude gelatine, obtained from the swimming bladder or sound of the sturgeon. The finest is exported from Russia. Manufactured gelatines are generally preferred for photographic purposes.

Isochromatic, Orthochromatic, or Orthoskiagraphic Photography (*ισος*, equal; *χρωματικος*, coloured or suited for colour; *ὀρθός*, in sense of exact; *σκιαγράφεω*, I sketch or paint in light or shade). These terms are used to distinguish that branch of photography which attempts to render in correct or more truthful gradations the colours as seen by the human eye. The merest tyro is too soon aware that the sensitive salts of silver are incapable of translating colours into correct monochrome as seen by the human eye. Thus a bright yellow sunflower or skein of yellow wool is reproduced by photography as black, and many shades of blue are, though visually dark reproduced as nearly white. In the article upon the Spectrum (*q.v.*) it will be seen that a ray of white light is split up into its various constituent rays of different colours: the brightest of these colours to the human eye is yellow, and then orange, two colours which are reproduced by black. As the question of colour is so closely connected with this subject, a brief consideration of colour will not be out of place. No substance known possesses any colour of itself. Colour is caused solely by the action of the substance on the light which falls upon it. Natural bodies possess the power of absorbing the light which enters them, and they have this power in a selective manner; that is, some objects select and absorb certain of the coloured rays and reflect others. When all the light is wholly absorbed, the substance appears black; but when all the rays of light are equally but not entirely absorbed, grey is the resultant tint.

Colour, therefore, is due to the absorption or extinction of certain of the coloured rays of white light within the object, and the remaining rays are reflected to the eye, imparting to that object its characteristic colour. It must, however, be borne in mind, that all objects, irrespective of colour, reflect white light when illuminated by white light. An engraver, when translating into monochrome any coloured objects, gives not only a correct form, but also a correct idea of colour, by giving varying depths of deposit of the pigment used, so as to give to the eye, were a gamut of colours engraved, a steadily increasing depth of tint from absolute white to deepest black, so that each tint or colour receives its quantum of deposit that will accord to some extent at least with the colours as they affect the human eye. In the diagram on next page, fig. 53, are shown what are called the primary colours of the spectrum, traversed by numerous dark lines, which are called Fraunhofer's lines, after their discoverer. To give an idea of the relative luminosity of colours to the human eye, the following diagram has been prepared, from which it will be seen that the greatest luminosity is between D and E fig. 54, or in the yellow, shading off rapidly through orange on one side to the red, and through yellowish-green and green to the violet on the other. In fig. 55 is given the curve showing the luminosity of colours to the ordinary photographic dry plate. Thus it will be seen that the most luminous part to the dry plate or photographic retina is between F and H, and practically no luminosity between C and F, where the greatest visual luminosity resides. It is obvious, therefore, that to reproduce colours in correct gradation as seen by the human eye, we must in some way exalt the sensitiveness of the ordinary plate to green, yellow, orange, and orange red, and at the same time reduce the sensitiveness to blue. It has been found that the particles of silver haloid are most sensitive to those colours which they absorb, and numerous experiments have been undertaken to find a substance which would enable the silver salt to absorb the whole of the rays in same ratio as we see them; but this has been found so far to be impossible, and although means have been discovered to render the silver salts more sensitive to the less refrangible rays between C and F, which are most luminous to the eye, yet they still remain most sensitive to the blue rays about G. These colours are toned down or robbed of some of their actinic value by being

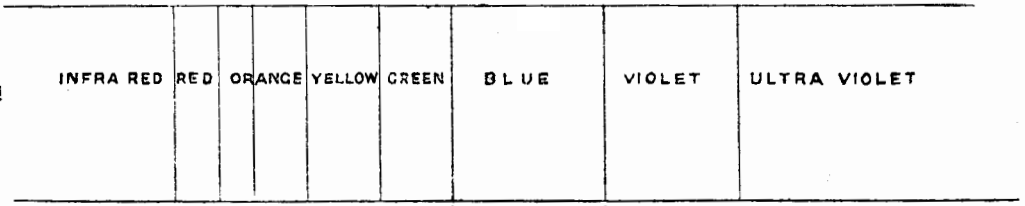


Fig. 53.

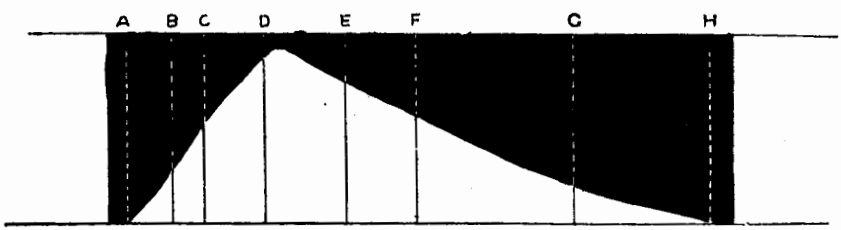


Fig. 54.

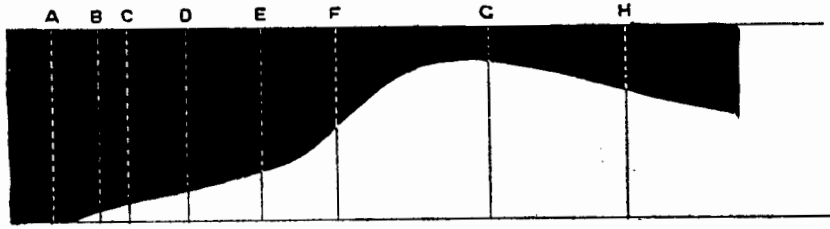


Fig. 55.

filtered through coloured media; but unfortunately the total sensitiveness of the whole plate is lowered in consequence. Colonel Waterhouse was the first to suggest the application of eosin, one of the coal-tar dyes. Numerous other experimentalists, such as Abney, Carey Lea, Eder, Vogel, and Bothamley,

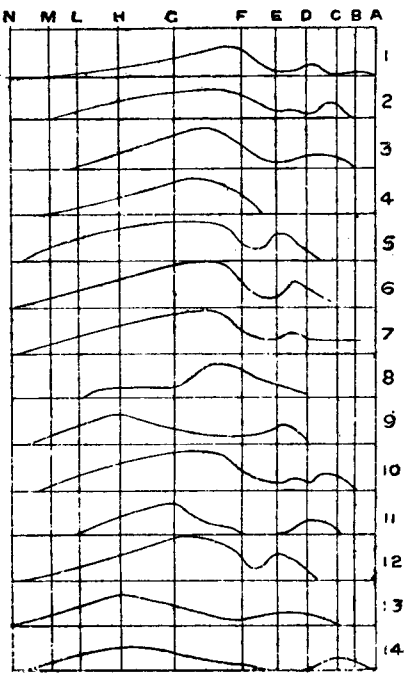


Fig. 56.

continued the researches in this direction. For information on this point the reader is referred to Professor Meldola's interesting work on "The Chemistry of Photography" (p. 288, *et. seq.*). Vogel was the first to formulate a workable process for using eosine dyes in 1873, but his researches were confined to the collodion process. In 1882, Attout Tailfer, a French chemist, successfully worked a process for the gelatine dry plates.

Tailfer's process consists of the use of eosin or erythrosin in conjunction with ammonia, and the same may be added to the emulsion at the moment of formation of the sensitive salt, or the previously prepared and coated plate may be bathed in such a solution; and these plates are thereby rendered more sensitive to yellow and yellowish-green. Dr. Vogel has introduced commercially a process in which "azaline" is used, and this is said to be a mixture of quinoline blue (cyanin) and quinoline red, by means of which the sensitiveness is still further increased for the orange, orange-red, and red rays. The chart of curves on p. 376 is taken from Meldola's work mentioned above, and is constructed from results given by Bothamley and Abney, and it shows the relative sensitiveness of the film dyed with various colouring matters. (1) Violet dyes; (2) green dyes; (3) iodine green; (4) cyanin; (5) eosin; (6) ammoniacal rose, Bengal; (7) cœrulein; (8) chrysaniline; (9) eosin on chloride of silver; (10) eosin and cyanin mixed; (11) erythrosin on iodide of silver and nitrate of silver; (12) erythrosin on bromide of silver; (13) erythrosin on chloride of silver; (14) cyanin on chloride of silver. Where the haloid is not specified bromide of silver has been used. It will be seen by an examination of the above chart that, although the sensitiveness of the haloid salts is increased towards the less refrangible rays beyond E in the yellow and red, yet the greatest sensitiveness is still in G and H in the blue; therefore, to obviate this, a coloured screen is used, usually of glass of a more or less deep tint of yellow, which was first suggested by Professor William Crookes, a pioneer of eminence, long before any iso- or ortho-chromatic process was thought of. The glass screens may be used either in front of the lens, between the combinations of a doublet, or behind the lens; and it should be of absolutely plain glass, with parallel surfaces, so as not to interfere with the definition of the lens; or a really serviceable makeshift may be made according to the plan proposed by Engler, in which glass plates are first of all waxed, and then polished and coated with a plain collodion, as free from structure as possible, and when thoroughly dry are coated with gelatine, stained to the desired tint with aurantia or Manchester yellow. For general use a good lemon tint should be made. When thoroughly dry the gelatine film may be stripped from the glass and cut into pieces, and enclosed between small brass plates or

cardboard, cut in the form of the ordinary diaphragm, in place of which it is used. In working iso- or ortho-chromatic plates extreme caution should be exercised as to the illumination of the dark-room; as little light as possible, and that of only a deep ruby, should be used, and the plate should be covered as far as possible during development. No special developers are required as the plates will work with any ordinary developer, whether pyro, quinol, or ferrous oxalate. Their sensitiveness to white light is generally about the same as other plates, and when used with a yellow screen require from three to ten times the ordinary exposures, according to the depth of tint. The value of colour-sensitive plates is seen in the better rendering of foliage, distance clouds, and water, and in portraiture in the suppression to a great extent of freckles, and the truer rendering of light or golden hair. For copying pictures or coloured objects of any kind these plates are now universally used, and are also of great benefit in photomicrography. The following are the formulæ for the principal baths for sensitising ready-prepared plates:—

Bothamley's Process.

Solution of erythrosin (1 in 1,000) ...	1 to 2 parts.
Ammonia (10 per cent.)	1 part.
Water	8 parts.

Dust the plate, and immerse for two or three minutes. Allow to drain on blotting paper, and dry in the dark. The conclusions drawn from a series of experiments, and given by Mr. Bothamley at the Photographic Convention, 1889, were: "(1) Alcohol up to 10 per cent. has no influence whatever, and may be dispensed with where the dye is soluble in water. Alcohol in larger proportion produces a distinct decrease in sensitiveness. (2) With a concentration of the dye up to 1 in 5,000, the washing after immersion is totally unnecessary. (3) A preliminary bath may be omitted."

Vogel's Formula.

Azaline solution (see p. 62)	1 oz.
Distilled water	3½ ozs.
Alcohol or methylated spirit	4 drms.
Liquid ammonia	1 drm.

Dust the plates, and immerse for one minute; rock during immersion. Drain on blotting paper, and dry in the dark.

Schumann's Cyanin Bath.

Soak the plate in 1 or 2 per cent. of ammonia solution for two or three minutes; then immerse in—

Alcoholic solution of cyanin (1 in 500)	...	168 mins.
Ammonia		68 ,,
Alcohol		168 ,,
Distilled water		7 ozs.

for not more than 100 seconds, drain and dry.

Bothamley's Sensitiser for Pictures.

Solution of rose Bengal (1 in 1,000)	...	10 parts.
Solution of cyanin (1 in 2,000) ...	...	10 ,,
Solution of erythrosin (1 in 2,000)	...	10 ,,

made alkaline with 1 per cent. of ammonia. These are the principal baths, and from these others may be used, which may be made on the above lines. Mr. F. E. Ives made numerous and early experiments on the colour sensitising of collodio-bromide, and found that the best results were obtained by flowing over the coated plate, as soon as the collodion has set, a strong alcoholic solution of chlorophyll, obtained by digesting blue myrtle or the periwinkle (*vinca major*) leaves in alcohol, then immersing the plates in water strongly tinted with blue shade eosin, and drying. This process is said to render the plate sensitive for the whole range of the spectrum.

Isotype. A term applied to a certain method of using a doubly perforated diaphragm with the screen (see FISH GLUE PROCESS) in process work.

IT. Captain Abney proposes the term "IT" (initials of intensity and time) as an expression of the unit of exposure. (See *The Amateur Photographer*, October 23rd, 1896, p. 339.)

Ivory. The teeth and tusks of the elephant and walrus. Photographs can be obtained on ivory by coating with an emulsion or by transfer as in the carbon process. Various artificial substitutes have been used, such as insoluble gelatine or celluloid containing a white pigment.

Ivory Black. Made by calcining ivory in close crucibles; used as an ingredient for black varnish and a pigment.

Japan Varnish. See VARNISH.

Kallitype. A printing process invented by Dr. J. Nicol, the principle of which is that ferric salts are reduced by light to ferrous, and in this condition can reduce to the metallic state a soluble silver salt. The paper is first sized, then coated with either of the following solutions, which contains

Sodio-citrate of iron solution ...	20 per cent.
Neutral potassium oxalate	5 „ „

The sodium salt can be replaced by the ammonium or potassium salts, or by the tartrate salt, or by mixtures of these compounds. The paper is printed in the same way as platinotype, and developed for bluish tones on a solution containing

Potassium oxalate	20 per cent.
Silver nitrate	1·5 „ „

to which sufficient ammonia is added to dissolve the precipitate first formed. For neutral black tones a solution containing

Potassium oxalate	10 per cent.
Silver nitrate...	1·5 „ „

and ammonia is used. For sepia tones a solution containing

Borax...	7 per cent.
Silver nitrate...	1·5 „ „

Ammonia as above, is used. Good results may also be obtained by sensitising with

Ferric oxalate	5 per cent.
Ferric tartrate	5 „ „
Oxalic or tartaric acid	1 „ „

For developing this, either of the two following solutions is used:—

I.

Potassium citrate	15 per cent.
Sodium acetate	10 „ „
Silver nitrate	1·5 „ „

Ammonia to dissolve the precipitate first formed.

Potassium citrate	15 per cent.
Potassium oxalate	10 „ „
Silver nitrate	1·5 „ „

Ammonia as above. After development the prints should be placed in a clearing bath of a 20 per cent. solution of citrate or tartrate of potassium, sodium or ammonium rendered alkaline by liquid ammonia. If greater contrasts are desired, 2 to 10 parts of a 5 per cent. solution of potassium bichromate should be added to every 1000 parts of the developer. A modification of the process was published later, in which the silver was incorporated with the sensitising solution, and applied to the paper, the solution being a mixture of ferric oxalate, ferric tartrate, oxalate and nitrate of silver, and free nitric acid. The prints were developed on the following solutions :—

For Black Tones.

Rochelle salts	10 parts.
Borax...	10 ,,
Water	200 ,,

For Purple Tones.

Rochelle salts	10 parts.
Borax...	2-5 ,,
Water	100 ,,

For Sepia Tones.

Rochelle salts	5 parts.
Borax...	1·75 part.
Water	100 parts.
Hydrochloric acid	a few drops.

To the developers a few drops of a dilute solution of potassium bichromate were added to keep the prints clean, and to increase contrasts ; after development, they were immersed in a solution of

Rochelle salts	10 parts.
Water	100 ,,

and then in

Water	80 parts.
Ammonia	1 part.

and subsequently washed and dried.

Kaolin. Synonym: China Clay. A very fine hydrous silicate of alumina, containing about 14 per cent. of water. It

is a decomposition product from natural decay of felspar. It was used in the wet process as a purifier of the silver bath.

Kata-Positive. A term occasionally used to distinguish a positive on an opaque base from a *diapositive* or transparency.

Kinetoscope, Kinematograph. See ZOETROPE.

Kite Photography. M. Batut has obtained photographs by means of a small camera attached to a kite; his arrangements being described in his book *La Photographie Aérienne par Cerf-Volant*, published by Messrs. Gauthier-Villars, of Paris.

Kodak. A name applied by the Eastman Company to their hand-cameras; and the word has come into use not only in reference to the Eastman cameras, but as a general term; also as a transitive verb, kodaking being now equivalent to taking unawares. A discussion having arisen in the *Amateur Photographer* as to its etymology, Mr. Allan Bayne wrote: "Remarks in the *Amateur Photographer* about the word Kodak made me wonder if it could not be found in Hebrew. Now קָדַח in that language means to burn, whence be bright or brilliant." We may, however, remark that the word קָדַח appears to occur but twice in the canonical books, and it seems rather to mean rekindle or relight than to burn; while in both cases the rekindling has reference to the fire of anger. The Alexandrian version of the LXX. (300—200 B.C.) contains one of those verses in which the word Kadak or Kahdak is used; and here it is rendered by the verb *ανακαίω*, which grammatically governs that fire (of anger) which is rekindled, and not the object against which the fire is directed. Whatever may have been the intention at the inception of the word, Mr. Allan Bayne's etymology is very appropriate, the fleeting image being caught, and rekindled by development.

Kromskop, Kromogram. Mr. Ives's Kromskop is a device for seeing simultaneously the system of three transparencies (this triplet being called the Kromogram), each transparency being backed by a screen of suitable tint. (See PHOTOGRAPHY IN NATURAL COLOURS.)

Lac. A hard resin resulting from a morbid vegetable growth, and largely imported from India. The brown lac occurs in

scales (shellac) and nodular masses (button lac), and should be used in all cases where its colour is not prohibitive, as the commercial bleached lac is often very much deteriorated. When bleached lac is used it should be obtained quite fresh. When old and easily brittle it is valueless. (See VARNISH.)

Lamp for Dark Room. All lamps should be fitted with one or more screens of ruby or orange glass, so as to decrease or increase the light as desired. Every amateur should comprise amongst his travelling paraphernalia one or two square feet of ruby or golden fabric; by means of this a lamp may be improvised from an ordinary candle, or night-light, or a Chinese lantern, or the side may be knocked out of a card-board hat-box. The author has before now changed plates when away from home by the aid of this little piece of ruby cloth by placing a candle in the empty fire-grate, and the ruby cloth over the bars.

Lampblack. The very light form of carbon produced by burning pitch, resin, or any other smoky substance with limited access of air, and collecting the soot formed.

Landscape Lens. See LENS.

Lantern, Magic or Optical. See MAGIC-LANTERN.

Lantern Slides. See LINE-DRAWINGS, TO COPY; HYDROQUINONE; EMULSION; AND ALBUMEN PROCESS; also see p. 172, *et. seq.*, for general instructions as to the development of lantern slide transparencies made on commercial plates.

Lanternoscope. An instrument for viewing lantern slides, similar to the Alethoscope and Pantoscope (*q.v.*).

Latent Image. See IMAGE, LATENT.

Latent Light. Many years ago Niépce de St. Victor found that if paper saturated with nitrate of uranium was exposed to sunlight and enclosed in an opaque tube or case for several months, it would still give off radiations capable of affecting a photographically sensitive surface. Plain white paper behaved somewhat similarly. (See LUMINOUS PAINT, and RADIOGRAPHY.)

Lavender Rays. The faintly luminous rays at the extreme end of the visible spectrum are sometimes so called.

Lead, Acetate of, (Ger., *Essigsäures Blei;* Fr., *Acetate de plomb;* Ital., *Acetato di piombo*). $Pb(H_3C_2O_2)_2 3H_2O = 379$.

Synonyms : Plumbic Acetate, Sugar of Lead. Made by dissolving litharge in an excess of acetic acid and subsequent purification and crystallisation. It is met with in white crystals usually massed together, and has an intensely sweet taste, and a faint smell of acetic acid. It is used as an addition to some combined toning and fixing baths, and has been suggested as a hypo-eliminator but the benefit is doubtful. Solubility; 60 per cent. in cold and 200 per cent. in hot water; 12 per cent. in alcohol; insoluble in ether.

Lead, Chromate of (Ger. *Bleichromat;* Fr., *Chromate de plomb;* Ital., *Cromato di piombo*). $PbCrO_4 = 323{\cdot}5$. Prepared by double decomposition of lead, acetate, and chromate or bichromate of potassium. It is a yellow insoluble powder, and is only used as colouring matter for certain dark-room fabrics.

Lead, Nitrate of (Ger., *Bleinitrat;* Fr., *Azotate de plomb;* Ital., *Azotato di piombo*). $Pb(NO_3)_2 = 331$. Synonym : Plumbic Nitrate. Made by dissolving litharge or white lead in nitric acid, evaporating and crystallising. It occurs in hard, white, opaque, octahedral crystals. It is used in Intensification (*q.v.*) and as a constituent of some combined toning and fixing baths.

Lead, Toning with. A solution of acetate of lead has been proposed as a toning bath for albumenised and gelatino-chloride papers. The following formula has been suggested:—

Lead acetate or nitrate	½ oz.
Sodium hyposulphite	4 ozs.
Distilled water	20 „

The toning action in any bath of this character is due to the formation of sulphide of lead.

Least Circle of Aberration is the smallest possible section of the cone of rays of light emergent from a lens.

Leimtype. A special process for the production of half-tone blocks invented by Husnik of Prague. A film of bichromated gelatine is exposed, then mounted by the exposed side on a rigid block, and developed by a solvent. The printing block is therefore somewhat similar in nature to a carbon print. (See CARBON PRINTING.)

Lens (Lat. *lens*, a small bean or lentil). An optical term given to discs of glass bounded generally by two spherical surfaces, or by a plane and a spherical surface. Sometimes, however, the surfaces are cylindrical, paraboloid, or hyperboloid. Lenses of a kind have been known from very remote antiquity, and Aristophanes (about 430 B.C.) writes of the transparent crystal (λιθος διαφανὴς) then used as a burning-glass to light fires. Whether this was of glass or of natural crystal is a matter of conjecture. Spectacle lenses are mentioned by Giordano da Rivalto in 1305, as having been invented only "twenty years ago." This will fix the date at 1285, when they were constructed by Salvino d'Armati, a Florentine. Alessandro della Spina, having seen some of Armati's spectacles, made some for himself, and published the method of manufacture. The manufacture was long almost confined to Italy, Sir Christopher Wren being one of the first to make satisfactory lenses in this country. In past times all lenses were made of crown or flint glass, the former being free from, and the latter containing, lead, the flint being slightly more refractive than the crown; but since the introduction of the Jena glasses (see GLASS) many of the optical glasses in use can neither be called flint nor crown. The sectional forms of the chief lenses are here given:—

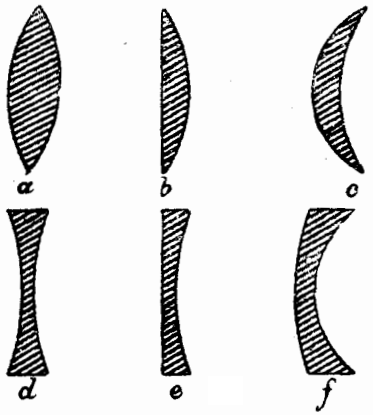


Fig. 57.—*a*, double-convex; *b*, plano-convex; *c*, concavo-convex, or converging meniscus; *d*, double-concave; *e*, plano-convex; *f*, divergent meniscus.

The first three, *a*, *b*, *c*, which are thicker at the centre than at the margins, are convergent or positive; and the second three, *d*, *e*, *f*, are divergent or negative. All lenses may, for theoretical purposes, be regarded as formed by the union of prisms, and therefore have to a great extent the properties of prisms. Fig. 58 will show the way in which the prisms are united to form a bi-convex lens, and the concentration of the rays of light by such

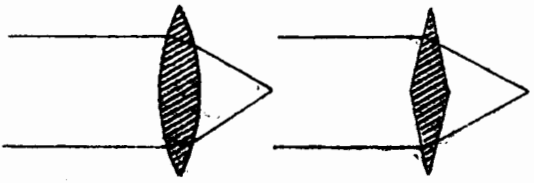


Fig. 58.

prisms or lens. Fig. 59 is the representation of the prisms forming a double-concave, and the divergent action of such prisms or lens upon the rays of light. It is obvious that by combining the two lenses the convergent or positive action of the one may be counteracted by the divergent or negative action of the other. It is upon these principles that the whole of the modern lenses are calculated. As soon as it was announced in 1830

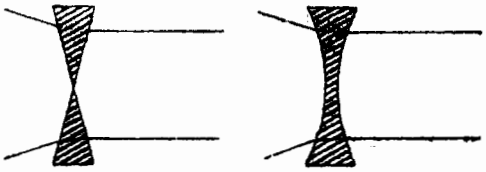


Fig. 59.

by Daguerre and Fox Talbot that they had been enabled to obtain a comparatively permanent image in the camera obscura, the ability and skill of mathematicians and opticians were brought into play to produce lenses which should be free from the objections common to the double-convex lens, which was that generally used in the camera obscura in those days. The single lens was replaced by the achromatic combination of the telescope. This was eventually reversed, and the plane side presented to

the object, as in fig. 60. Then Wollaston's meniscus (fig. 62) came to be recognised as a means of extending the definition; and in 1840, Chevalier, a Paris optician, still further improved it by a different method of achromatising the lens. But in the following

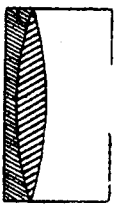


Fig. 60.

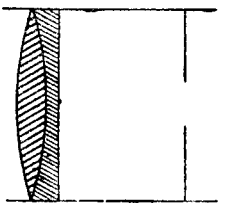


Fig. 61.

year, through the agency of Voigtländer, a practical optician, a lens designed by Professor Petzval, a mathematician of Vienna, was made and introduced commercially in 1841. This was the portrait lens; and it is a remarkable fact that it is the model for

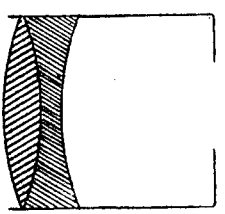


Fig. 62.

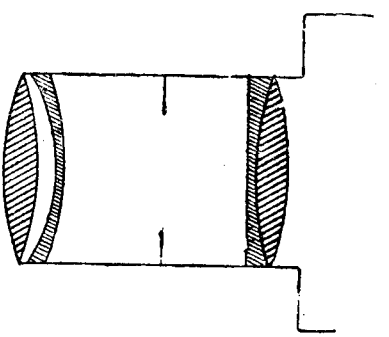


Fig. 63.

the finest portrait lenses of the present day. The above (fig. 63) is a sketch of Petzval's original portrait lens:—The dark shaded parts are crown, the light shaded parts are flint glass, and, as will be seen, the front combination exists of a double-convex crown cemented to a double-concave flint, and the back of a flint concavo-convex separated from a double-convex lens of

crown glass. This has been modified by Dallmeyer, by Grubb, and the noted American optician Morrison; but all are con-

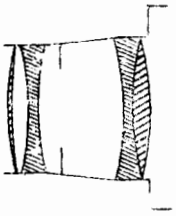


Fig. 64.

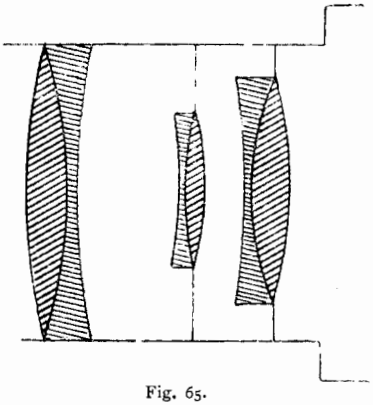


Fig. 65.

structed on the principle of the same lens (fig. 63). Professor Petzval calculated at the same time a landscape lens (fig. 64), which was not introduced commercially till 1857; and an English

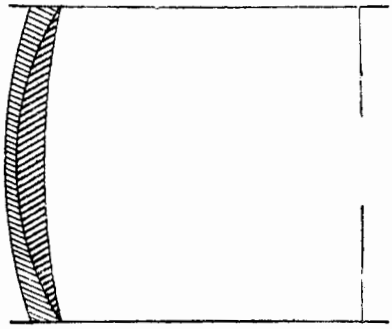


Fig. 66.

optician, in 1858, having suggested a lens with a concave glass in place of the diaphragm to lengthen the focus and flatten the field, Dallmeyer introduced his famous triplet (fig. 65),

which was much used and admired. Single lenses were first of all of the kind shown in fig. 61, with which extremely small diaphragms are necessary to reduce spherical aberration. This was improved on by Grubb, and his lens is shown in fig. 66, in

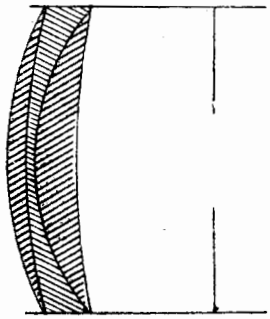


Fig. 67.

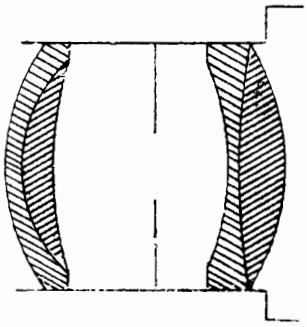


Fig. 68.

which a crown-glass lens of meniscus form is presented to the object, and is cemented to a flint meniscus. This gave a much flatter field, and spherical aberration was much reduced, allowing the use of larger diaphragms. Dallmeyer introduced his single lens (fig. 67), which consists of a negative flint enclosed

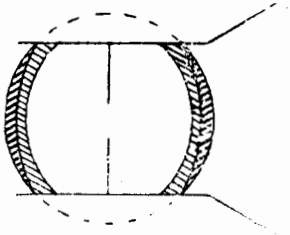


Fig. 69.

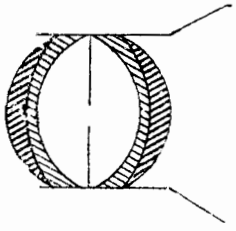


Fig. 70.

between two positive crown-glass lenses. This enabled a much larger aperture to be employed, and eliminated spherical aberration. Marginal definition and flatness of field were both improved. To obviate distortion, many doublet lenses were introduced, that of Mr. Ross being shown in fig. 68. This

instrument possesses a wide angle, giving splendid definition. In all doublets the diaphragm being placed between the combinations, the distortion of the one is cured by the distortion of the other. In 1860 Harrison of New York introduced his globe

Fig. 71.

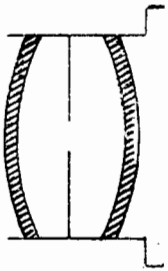


Fig. 72.

lens (fig. 69), which had an extremely wide angle, but which, from too close an adherence to the globe form, gave a flare. Busch improved upon this with the pantoscope (fig. 70), and Dallmeyer introduced his wide-angle rectilinear (fig. 71). Steinheil intro-

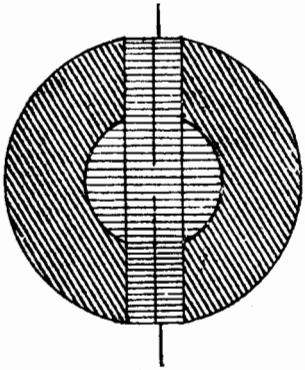


Fig. 73.

duced what he called his periscopic lens (fig. 72), which consists of two uncorrected meniscus lenses of crown glass; and chromatic aberration not being eliminated, the focussing screen had to be brought nearer to the lens after focussing and before exposing, by $\frac{1}{40}$ of the focal length of lens. Mr. Sutton's panora-

mic lens (fig. 73) consisted of two concavo-convex lenses, with spherical curvatures and a hollow space between filled with water. This possessed a wide angle, and gave no, or practically

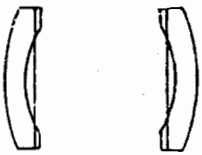


Fig. 74.

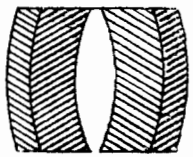


Fig. 75.

no, spherical or chromatic aberration, but from its peculiar construction, and the necessity of using curved plates, it has never

Fig. 76.

come into general use. In figs. 74, 75, and 76 are shown lenses by Steinheil, fig. 74 being an aplanatic rapid rectilinear, and figs.

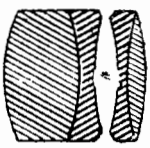


Fig. 77.

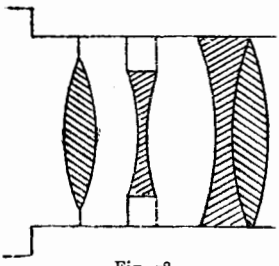


Fig. 78.

75 and 76 wide-angle aplanats, some of the finest lenses of the day; and in figs. 77 and 78 are shown two more of Steinheil's lenses, which work at $f/2{\cdot}5$, No. 77 being for groups, No. 78 for portraits. In fig. 79 we are enabled, by the kindness of Messrs,

Perken, Son, & Rayment, to give a sketch of their Euryscope lens, which is composed of two symmetrical combinations, and works at an aperture of *f*/6, a great gain for rapid work. These lenses are remarkably free from spherical and chromatic aber-

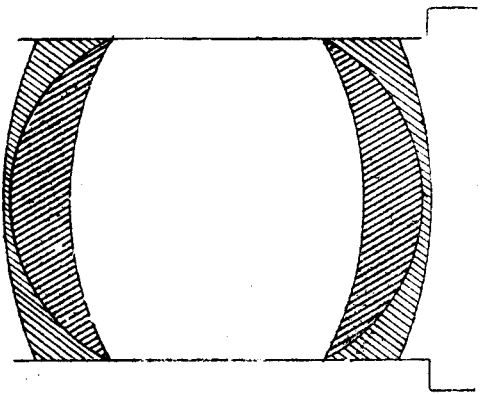


Fig. 79.

ration and distortion, and have an extremely flat field. Mr. Dallmeyer has introduced a rectilinear or non-distorting single lens, which works at a large aperture, which is free from distortion, without astigmatism, and has a very flat field (fig. 80).

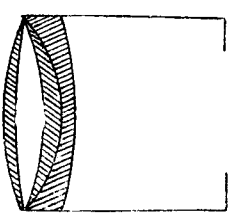


Fig. 80.

During the last few years great advances have been made, and new forms of lenses have been introduced, in the majority of which the optical glass manufactured at Jena is employed. Messrs. Swift & Sons' recent lenses are fig. 81, a universal paragon lens working at U.S. No. 2 or *f*/5·65, and fig. 82, Swift's portrait

paragon, a symmetrical lens, working at U.S. No. 1, or $f/4$. E. Suter of Basle has a series of aplanatic lenses, which work at

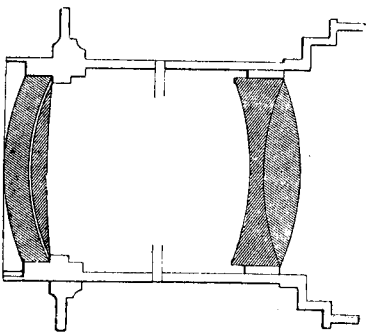


Fig. 81.

U.S. No. 2, and also a very fine lens of the symmetrical type, manufactured of the new glass, which works at No. 2 U.S., or $f/5{\cdot}5$.

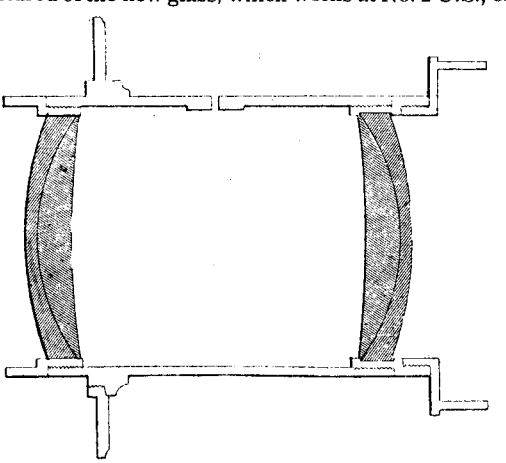


Fig. 82.

With these the flatness of field is much increased, the angle of sharpness being about 60°. He has also introduced a new wide-angle aplanat, which has an effective aperture of $f/12$ for an

angle of 60°, and *f*/16 and *f*/22 up to 90°, this being illustrated by fig. 83. The field of this lens is very flat, and the front lens may be used as a single landscape by unscrewing the same, and screwing into the place of the back lens. The front combination is of Jena flint combined with crown glass, and of great curvature, whilst the back glass is of much less power. Messrs. Taylor, Taylor & Hobson, Wray & Swift have introduced special lenses, which, in the smaller sizes, work at *f*/5·6 for detective cameras, although any of the above lenses of sufficiently short focus would answer well. Messrs. Perken, Son, & Rayment have issued a new wide-angle euryscope, working at *f*/9·5; and Messrs. Voigtländer & Son have introduced two new wide-

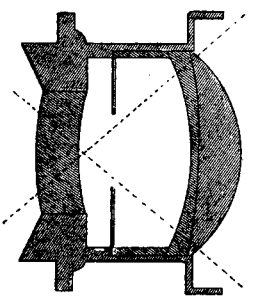


Fig. 83.

angle lenses, the one a landscape, composed of a bi-convex crown cemented to a bi-concave lens. Both glasses, of the new Jena material, are extremely light, and of little dispersive power, in great disproportion to the index of refraction; thus the bi-concave lens, which is usually a flint, is more like a crown glass lens. It subtends an angle of 76°, has an exceedingly flat field, and distortion of the marginal lines is reduced to a minimum; working aperture, *f*/16. The other lens is a new wide-angle euryscope, which works at *f*/6 (approx.), and includes an angle of 80°. This also is constructed of the new glass. From its large aperture and short focus it is eminently suited for group work in confined situations, and for instantaneous or hand cameras. In 1889 Ross & Co. obtained a patent for a new form of lens, which they called the "Concentric," from the fact that

the internal and external surfaces of each combination were struck from a common centre, as shown in fig. 84. It will be seen that these lenses are practically what would with the old glasses be negative lenses—that is, they are thinner in the middle than at the margins; but by the use of particular kinds of Jena glass the manufacture of such combinations with a positive focus was rendered possible. The advantage of these lenses lies in the fact that they are free from chromatic aberration and astigmatism; and a lens the focus of which is one-third less than the longer

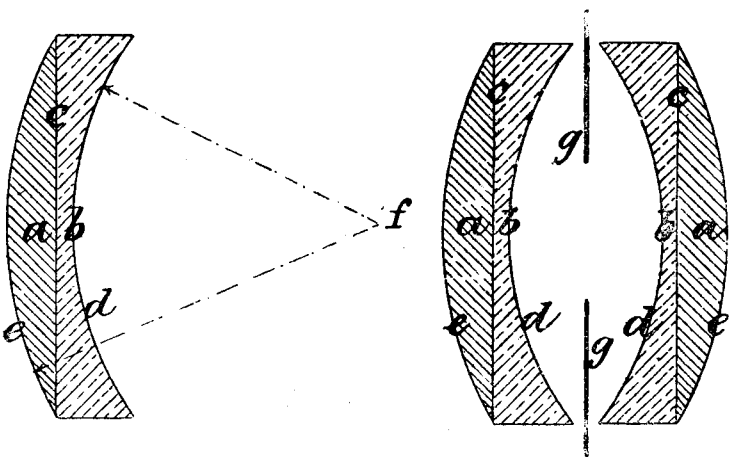


Fig. 84.

base line of the plate covers that plate sharply with *f*/19. Some of the lenses are made to work at *f*/16, and at this aperture they give a uniform softness of definition, arising from spherical aberration. The only disadvantage is that focussing must be done with the aperture which is to be used for exposing. These lenses possess a flatness of field which is very remarkable. Zeiss of Jena has introduced several new forms of lenses, all constructed of Jena glass, and possessing a freedom from astigmatism and chromatic aberration quite remarkable. Among the recent introductions of Mr. Dallmeyer may be mentioned the telephotographic lens, which is an adaptation of

the principle of the Galilean telescope, so that a short camera may be used with what is virtually a lens of long focus; a new power being thus placed in the hands of the tourist wishing to secure a large rendering of distant objects—architectural detail for instance. A special negative lens, corrected for colour and corresponding to the concave eye-piece of the Galilean telescope, is set at a determinate distance between an ordinary objective and the sensitive plate, and Mr. Dallmeyer supplies these negative lenses so as to work either with ordinary doublets or portrait lenses—thus it does not become necessary for the tourist, in all cases, to take with him a complete telephotographic

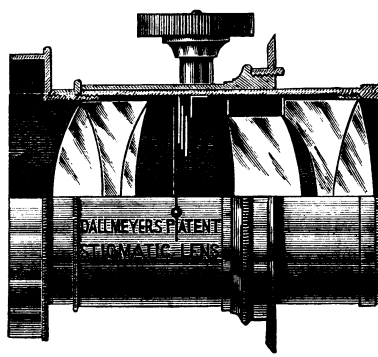


Fig. 85.

combination in addition to his ordinary lenses. For securing instantaneous pictures of distant or shy animals, however, it is very desirable to use the telephotographic system in which a portrait lens is the positive combination; and with this some very remarkable pictures of birds and other easily frightened animals have been secured. Another recent introduction by Mr. Dallmeyer is a double correcting lens behind such a combination as a portrait lens; the object of this being to eliminate the residual errors of astigmatism and curvature of field; this device being founded upon an older arrangement of Professor Piazzi Smyth, who used a simple concave (plano-concave) lens behind the portrait lens, and close to the plate; the portrait lens being adjusted to give a minimum of astigmatism at the expense

of much curvature of field. This latter aberration was corrected by the extra glass. Mr. Dallmeyer's astigmatic corrector is placed farther from the plate, and its essence consists in its being a negative *compound* lens, consisting of a negative lens, and a positive lens of higher dispersive material and refractive index. The Dallmeyer "Stigmatic" lens (fig. 85) is an entirely new portrait combination, which appears to have all the advantages, and perhaps more, than the older construction to which the astigmatic corrector is adapted. At the full aperture, *f*/4, spherical aberration is as perfectly corrected as in the best portrait lenses of the old or Petzval type, and a flat field is obtained with a mere trace of astigmatism; at the same time it includes an angle of 60°. The above statement will show how well the new lens is adapted for astronomical work or portraiture, and the construction of such a lens must be considered one of the optical triumphs of the time; but perhaps one which will be more appreciated by the astronomical photographer than the ordinary amateur or tourist, to whom a lens working at *f*/4 has but limited uses, owing to that lack of depth of focus which is intrinsically inherent to such an aperture; but to the professional photographer, or one wishing to obtain studies of animal life, the stigmatic lens gives new powers. The defining power of the stigmatic lens may be reduced by a provision for disturbing the correction of spherical aberration, in which case it gives a uniform softness all over the field. The above remarks apply especially to the stigmatic lens in its original form and working at *f*/4; but quite recently Mr. Dallmeyer has introduced a simplified and portable form (fig. 86), working at *f*/6, also including a wider angle. This instrument may well claim to be a universal lens, having all the advantages of the recent stigmatic and anastigmatic forms, together with greater rapidity than most of them. The freedom from spherical aberration makes the defining power quite independent of the diaphragm, and there is no shifting of the focus on altering the aperture. The angle included is about 85° on the diagonal of plate, and this most recent introduction should prove of great advantage to those who wish to have one instrument which is eminently adapted for all classes of work from portraiture to wide angle. Its large aperture, combined with its other special qualities, should make it useful in the developments of process work in which special,

"shaped," or multiple diaphragm apertures are required. Another new lens made by Mr. Dallmeyer—the Dallmeyer-Bergheim lens—is so corrected as to always give a soft focus; and, moreover, its construction involves the principle of the telephotographic lens, and the focal length is adjustable within certain limits. New lenses of the doublet type, in which astigmatism is very perfectly corrected, are the Voigtländer collinear lens, the Zeiss anastigmatic lenses, and the Goerz anastigmat. The Cooke triplet is another new introduction, but of a different character and construction. To enable the amateur to select a lens for his own use, several considerations are necessary, and although he may be to some extent guided by the vendor of the lens,

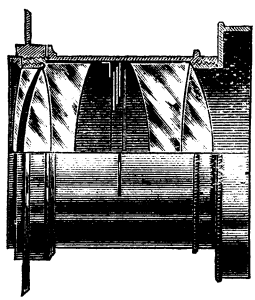


Fig. 86.

the following may be of assistance:—The glass should be absolutely free from striæ; these can be detected by placing the eye at the focus of a lens before a strong light such as gas or a lamp; bubbles can also be seen, but too much stress need not be laid on the presence of a few bubbles, as when not present in very large numbers they may be disregarded. For what purpose is the lens required? For ordinary landscape work, architectural subjects, interiors, or portraits? For landscape work pure and simple there are few lenses to equal the achromatic single landscape lens, which gives brilliant negatives; and although distortion is present it may be disregarded, and it is practically unnoticeable in small views. Some of these lenses are now made to work aplanatic with an aperture of *f*/8, and are therefore of nearly the same rapidity as the rapid rectilinear, which is, however, the lens most used by

amateurs. Few amateurs will require a portrait lens, as they are not only difficult to use properly, but are exceedingly limited in action, and also expensive. The question of how much view to include on a plate is another important consideration which should not be lost sight of (see ANGLE, WIDTH OF); for ordinary work it should never exceed 50° to 55°, and 45° is decidedly better. If a much greater angle be included, the resulting pictures have a distorted appearance, because it is extremely unlikely that the eye will be placed at a focal length of the lens from the picture. The glass of which lenses are made should be colourless; this can be tested by laying the lens upon a sheet of white paper and looking down through it. Some of the cheaper lenses are made of glass which is not colourless: and any colour, especially brown or yellow, will make the lens slow. Optical glass is made somewhat in the following manner:— Crucibles of fire-clay of particular form are raised to a white heat in a furnace, and when the fuel ceases to give off smoke, they are charged with the materials, and the heat is continued for eight or ten hours. The crucible is now raised to a white heat for four hours, and the mixture stirred with a bar of baked clay. Six times from hour to hour the mixture is stirred. The heat is then reduced, that the bubbles may rise, and again at the end of two hours the heat is raised to make the glass fluid; again stirred, and the crucible and the openings of the furnace closed and left for eight days to cool. The crucible is taken out and broken, and the glass is removed and divided into pieces. The divided glass is examined and sorted, the finest being retained for astronomical purposes, the second quality for photographic lenses, and the third for ordinary magnifying glasses, the rest being waste. The pieces are then softened in a muffle furnace, and formed into plates about two or two and a half inches thick. Sometimes the plates are then pressed, after being softened by heat, into rough moulds of clay or iron coated with sand so as to give them a rough form; but the best opticians prefer grinding, as striæ are not so liable to be formed. The rough-shaped glasses have now to be made into perfect lenses, for which purpose extreme care is necessary, approximate forms being given by grinding with emery in concave or convex tools of cast iron. It is in the following operations that the greatest skill and care of the optician are required.—The roughly shaped

lens is now to be ground with emery in spherical tools of brass or iron. These are given the necessary curves by means of accurate gauges. The roughly fashioned glass or lens is fixed to a plate of brass by means of pitch, and is then worked in the tool with rough emery moistened with water; when the glass is found to touch the tool at all points, finer emery is used, and it is worked a little more, the gauge being now frequently applied to the tool, to see that the radii of curvatures are not altered; then finer kinds of emery still are used, till at last some degree of polish begins to show; fine putty powder is then substituted for emery, and the polishing is commenced. The operation of polishing is really the test of a good optician, as this process may alter the sphericity of the lens to such a degree as to completely alter the character of the lens. The lens is fixed on to a block of wood by means of a pitchy cement, and a tool is coated with a resinous mixture, and fine rouge is sprinkled on the tool when cold and the polishing finished entirely by hand. When two lenses are required to be cemented together so as to present one common surface, they are slightly warmed, and a drop or two of Canada balsam is applied, and the two lenses pressed forcibly together, so as to squeeze out excess of balsam. When cooled, they present the appearance of one single piece of glass, and cannot be separated without heat. When two lenses have not a common surface, three small pieces of tinfoil are introduced at equal distances apart between their margins, or when the separation is greater, as in most portrait lenses, a ring of brass is used for the same purpose. When the lens is fixed in its brass ring, so that it cannot be taken out without raising the bent edge of the brass, it is said to be set. Under the article Focus will be found numerous rules and tables, which may be of some service. The lens is the most important and at the same time the most expensive part of a photographer's outfit; too much care cannot be taken in choosing or in keeping it. Lenses should always be kept, when not in use, in a leather case, or else in a tin box padded with wool or washleather to prevent the access of light, air, and dust. The inside of the lens-tube and the diaphragms should be occasionally re-blackened to avoid disturbing reflections. If the lenses become dusty or somewhat dim, they should be most carefully and tenderly wiped with a piece of soft silk or washleather, and when it is necessary

to clean the internal surfaces of lenses (doublets, portraits, etc.), it is advisable to remove one combination and clean it, and then replace it before unscrewing another combination to clean; by this means displacement of the combination cannot take place. With some old lenses a peculiar tree-like marking makes its appearance, which, to uninitiated eyes, appears to be in the middle of the glass. This is due to the balsam, which is used in cementing the glasses of the combination together, becoming old and starring. In such a case it is advisable, if the lens is worth anything at all, to send it to an optician, who will unset the lens and properly re-cement and reset it: if the lens is not of much value, and the owner is desirous of trying his hand at a practical remedy, the lens should be placed in some methylated spirit or turpentine in a water-bath and gradually heated, when the cement will be softened. The two glasses can then be taken apart, well wiped and cleaned, and re-cemented by a drop or two of Canada balsam, and gently warming. (For fuller directions see BALSAMING, RE-, OF LENSES.) If by accident one of the lenses should be scratched, it is preferable to fill the scratch with black varnish, as the loss of light is in this case preferable to the disturbing reflections of the scratch. The following notes on choosing and testing a lens are written from a practical standpoint, and if an accurate scientific examination is required, it would be advisable to send the lens to the Testing Department at Kew; but if a lens answers successfully to the tests described below, it may be accepted as *practically* satisfactory. The first point to decide in choosing a lens is to determine for what class of work it will be required; but presuming that my readers are amateurs, and that many of them will be, or have to be, content with one lens, then a doublet, such as one of the newer anastigmatic instruments, or a rapid rectilinear should be chosen. We have recommended the symmetrical doublet lens, or else the anastigmatic lens, for all-round work of the amateur as the most suitable lens, and it may be used for portraits, groups, architectural work, both exterior and interior, and landscapes. The next point to decide is the focal length of the lens; this is usually fixed by the optician at a certain length, which increases with the size of plate for which the lens is required. The following may be assumed to be the focal lengths of the majority of commercial lenses for the given-sized plates:—

For	$4\frac{1}{4}$	×	$3\frac{1}{4}$	or $\frac{1}{4}$-plate,	the lens	is usually	4	to	5-in.	focus.
For	5	×	4	,,	,,	,,	$5\frac{1}{2}$	,,	6	,,
For	$6\frac{1}{2}$	×	$4\frac{3}{4}$	or $\frac{1}{2}$-plate,	,,	,,	8	,,	9	,,
For	7	×	5	,,	,,	,,	9	,,	10	,,
For	$8\frac{1}{2}$	×	$6\frac{1}{2}$	or $\frac{1}{1}$-plate,	,,	,,	10	,,	11	,,
For	10	×	8	,,	,,	,,	12	,,	14	,,
For	12	×	10	,,	,,	,,	15	,,	16	,,

If more than one lens is required, the second lens may be a long-focus single or landscape lens of a focal length equal to $1\frac{1}{2}$ times that of the doublet. If a third lens is required, then a doublet of short focus may be chosen, the focus being about two-thirds that of the doublet. Thus, for a half-plate, we have first a rectilinear of 9-in. focus, then a single lens of $13\frac{1}{2}$-in. and lastly a second doublet of 6-in. focus. Such a set of lenses will will enable us to obtain pictures of almost every character, and to obtain the images of objects varying in size. See WIDE ANGLE. Many an amateur possessing a single or landscape lens, which he may have purchased at the outset with his outfit, yearns for a doublet, in the hope of improving his pictures, acting under the very general impression that far finer results are given by the latter lens. This, however, is a mistake. The sole superiority of a doublet consists in its working at a larger aperture, and in being free from distortion.

TESTING A LENS.—The first point to decide in testing a lens is its equivalent focus or focal length; the second point, the ratio aperture of the diaphragms; the third, covering power of the lens; (4) the flatness of the field; (5) the freedom from spherical and chromatic aberrations; (6) the freedom from flare and ghosts; (7) the accurate centring of the lenses; (8) the perfect polishing of the surfaces; (9) the freedom from striæ or waves.

(1) *To Determine the Equivalent Focus.*—Several methods are given under the heading FOCUS.

(2) *To Determine the Ratio Aperture of the Diaphragms.*—This is described under Diaphragms (*q.v.*).

(3) *The Covering Power of the Lens.*—To determine the covering power of the lens is by no means a difficult task, especially if the lens be used with a given-sized plate; that is, for the one for which it is advertised. Many lenses will, with small diaphragms, cover a much larger plate than that for which they

are designed, and all lenses will cover a smaller plate. If you wish to test whether a lens will cover a given-sized plate, all that you require to do is to affix the lens to the front of a camera which has a focussing screen of the given size, and then focus till you obtain a sharp image at the centre; it will be at once seen whether the lens will cover. But it is not only necessary that a lens should cover a given-sized plate, but most photographers require that, besides covering a plate, a lens should give good definition all over a plate, which is a totally different thing. Many a lens will cover a plate and yet give very poor definition at the margins, because either (*a*) the aberration for oblique pencils is not corrected, or (*b*) it has a very curved field. For special purposes such as hand-camera and instantaneous work it is now considered necessary that a lens shall give sharp definition over the entire surface of the plate for which it is intended. It is often suggested that to test for this in a lens the best plan is to set up a sheet of newspaper and, focussing sharply, to examine the definition with a compound focusser. We prefer to make a practical test as suggested by Mr. W. E. Debenham, as follows:—Take a sheet of printed matter that is always to be had of one-sized type (nonpareil), namely, "Births, Deaths, and Marriages" column of the *Standard* newspaper. This column is placed slantwise, the top of the column being farthest from the plate, but each particular line runs square across it as before directed, in the middle of the column, and at such a distance that when a printed line is focussed in the centre of the field, the image is one-eighth of the original size. The width of two columns in the focussing screen will be just over five-eighths of an inch. With a good portrait lens having an aperture of one-fourth of the focus, the standard adopted as unity by the Photographic Society of Great Britain up to, say, a 12-in. lens, at all events, the definition in the centre of the field should be such that the small type will, on examination with an eye-piece, be quite legible. The same test may be employed for all lenses, and those professing to be aplanatic will for the most part be found to pass it, though with different degrees of perfection. Of course, by stopping down, almost any lens may be made to define well, at all events, in the centre of the field; but we are speaking of lenses worked with the largest apertures with which they are supplied, and which, in most lenses of the Steinheil aplanatic

type—rapid rectilinear, rapid symmetrical, Euryscope, etc.—will be found from *f*/7 to *f*/9. In the newer forms of cemented aplanatic lenses, in which the glass from the Jena factory has been utilised, somewhat larger apertures have been practicable, but whatever the aperture is, it is to be supposed that good definition is obtainable with it, and therefore the test mentioned may be fairly employed. When we come to examining the defining power of the lens at some distance from the centre of the field, we shall find with rapid lenses that there is a very great falling off. Taking again as an example a portrait lens of 12-in. focus and of aperture *f*/4, and slewing round the camera so that the image is rendered at a distance of 2 in. from the centre of the focussing screen, we shall find that the small type of our newspaper column is no longer readable. The larger type used for the heading "Marriages," etc., should still be legible, but nothing more. Now insert diaphragm *f*/8, No. 4 on the universal system, and the small type again becomes distinguishable. With a Steinheil type lens of *f*/8 aperture the definition at this angle may be expected to be still satisfactory without further stopping down. This then is Mr. Debenham's method. It is convenient to cut out several of such columns as he mentions, and paste them on a piece of stout millboard, which is framed to keep it flat. Diagonally across the centre is pasted an ordinary inch tape. The whole arrangement is then hung up flat against the wall, and the camera set up and the image focussed till reduced to one-eighth in size, as suggested by Mr. Debenham. We may remark here that focussing is not effected in the ordinary way on the ground-glass of the camera, but on a specially prepared sheet of obscured glass inserted in the dark slide, which is slid into the grooves at the back of the camera. The specially prepared sheet of obscured glass was made by slightly etching the surface of a perfectly true piece of thin plate-glass by means of hydrofluoric acid, and this sheet, when looked through, shows merely a very thin milky haze, which shows no grain, the centre being marked by a cross in fine Indian ink. Focussing is easily effected by means of a magnifier, and the centre of the screen is made to coincide with the central division of the inch tape. The dark slide is now removed, a slow dry plate inserted in the dark-room, an exposure made, the plate developed, and the resulting negative, when dry, carefully examined by the magnifier. The

image of the inch tape at once affords a guide as to the limit of sharp focus, and it is therefore possible to state without trouble the extent of sharp focus expressed in terms of the focal length as suggested by Mr. Debenham. For example, a lens was received for examination which gave the following data :—

Equivalent focus	11½ in.
Working aperture	*f*/7·9.
Ratio aperture of largest diaphragm	*f*/8.
Limit of sharp focus	*f*/·825 = 9·5 in.

This lens would therefore cover any plate *sharply*, the diagonal of which was not more than 9½ in. In the case of small lenses, or lenses of short focus, a still more practical test may be preferred, and that is to focus sharply, as described above, on the bricks of the house opposite one's first-floor window, throwing the window open.

(4) *To Determine the Flatness of Field.* The foregoing tests are quite sufficient to determine this, but if an actual illustration is required of the amount of the curvature of the field we have only to use the newspaper again, and by marking on the base-board the focus for the centre, and then refocussing for the margins, and again marking, we can easily plot out a curve which shall show us exactly the form of the field of the lens.

(5) *The Freedom from Spherical and Chromatic Aberrations.* The tests for spherical aberration are comparatively easy ones. A steady, naked flame, such as a candle or small gas flame, may be focussed sharply at the centre of the screen, and the image examined with an eye-piece. If a halo is seen round the flame, it may be assumed that some spherical aberration is present. The objection to this method is that the fringes may not be due to spherical aberration, but to a kind of halation or ghosts. Another test, is to fix to a window two small, dark-coloured wafers, with their edges just in contact; the camera is set up at least ten times the focus of the lens distant, and then the images sharply focussed as stated above, with full aperture; on the insertion of a small diaphragm there should be no increase of sharpness. Another method is to proceed as above, and affix to the centre of the front lens of a doublet or the centre of a single lens a piece of black paper three-fourths of the diameter of the lens; the image which is now formed by the margins of

the lenses is sharply focussed. The black paper is removed, and a small diaphragm inserted, and the image examined; if it requires refocussing by racking in or reducing the distance between lens and screen, the lens suffers from negative spherical aberration; if the camera requires racking out, positive spherical aberration exists. Chromatic aberration, or practically non-coincidence of the visual and actinic foci, is rarely found in modern lenses. No lens is actually achromatic—*i.e.*, without colour—because the finest lenses corrected as much as is possible show fringes of colour, as may be at once practically proved by any one in the following manner:—Arrange a thermometer with a naked bulb, so that a spot of light is reflected from the mercury, and focus this spot of light (the optician's artificial star) on the focussing screen of plain glass by the aid of a magnifier; on racking the camera in slightly, a faint fringe of green is seen surrounding the spot, and by racking out beyond the focus a fringe of reddish purple comes into view. This is best seen with an eye-piece. To test, however, whether the visual and actinic foci actually coincide, place the newspaper previously described squarely opposite the lens, but leaning away from it; focus sharply, with full aperture, on one particular line of type—focussing must be effected by placing the screen in the dark slide, or the fact of non-coincidence of the plane of the focussing screen and sensitive plate may cause error; then on exposing a plate, if the same line of type as focussed does not come out the sharpest, it is proved that the lens possesses a distinct chemical focus, and we at once determine whether this is beyond or within the visual focus. (See also FOCIMETER.)

(6) *Freedom from Flare and Ghosts.* Flare is visible as a central patch of light, and arises from an incorrect position of the diaphragm in single lenses, and from reflections from the surfaces of the lenses in doublets. To test for the same, the plan suggested by Mr. Debenham may be adopted. A sheet of black velvet or deep red cloth is hung up in a room at night, and in front of it, at some little distance, eighteen to twenty-four inches, is placed a lighted candle. The image of the flame is sharply focussed, and there will be generally seen a halo or ring of diffused light surrounding the flame. The camera is now slightly slewed round, and the image watched; if the ring or halo of diffused light is steady at the centre of the screen, it may be

assumed to be "flare"; if, on the other hand, the halo moves with the image of the flame, it is due to a secondary image or ghost very much out of focus. To actually determine this, rack the camera in or out to about half or double the focal length, when a small image of the flame will be seen surrounded by a large disc of light, the small image being the previous flare, and the halo the real image formed at the focus. "Ghosts" are the images of a brightly lit object reflected by the surfaces of the lens on to another portion of the screen. These may be tested for as described for flare only; the image of the candle flame should be brought to one side of the screen, and the ghosts looked for on the opposite side. One or more ghosts may make their appearance, and will be easily visible in this way. Practically, "ghosts" are a source of trouble when photographing a dark interior which contains a brilliantly lit window, as a ghost of the window may make its appearance on the opposite side of the plate in a dark portion, and in portraiture a white shirt front may appear duplicated.

(7) *Accurate Centring.* To test a lens for accurate centring, it is advisable to mount the lens temporarily in the camera and focus on a naked candle or gas flame placed a little to one side, then turn back the focussing screen, and several images of the flame will be seen on looking into the camera. If the lens is correctly centred, these images remain stationary when the lens is unscrewed; if they do not, the lens should be returned to the maker.

(8) *Perfect Polishing of the Surfaces.* This is by no means an easy test for an amateur, but it is possible to determine this by examining the surfaces with a very powerful eye-piece, or by remembering that a highly polished surface is invisible.

(9) *Freedom from Striæ, or Waves.* The presence or absence of these defects may be observed by the method of holding the lens up to a flame, as already described.

In connection with lenses, the following, among other articles, may be consulted: ABERRATIONS, BALSAMING, FOCUS, SPHERICAL ABERRATION, CHROMATIC ABERRATION, COMPENSATOR MONOCLE, PINHOLE PHOTOGRAPHY, CURVATURE OF FIELD, AND LIGHT.

Leptographic Paper (λεπτός, delicate). A collodio-chloride

paper sold in France in the early days of collodio chloride (about 1866).

Letter-Press Printing, Photographic Substitute for. See AUTOMATIC PRINTING.

Levelling Slab. An even piece of glass, slate, or other material sufficiently thick not to bend when placed upon the levelling stand, which is preferably of a triangular form, having a fine screw at each foot to allow of the height being altered as required. The slab of glass, or slate, is placed upon the stand, and accurately adjusted by means of a spirit-level.

Lichtdruck. Synonymous with COLLOTYPE, which see.

Light is that principle which emanates from all luminous bodies, and the luminosity of such bodies is believed to be due to intensely rapid molecular vibration, which vibration is propagated in a supremely subtle elastic medium, termed the luminiferous ether. Light always travels in straight lines, unless deviated from its course by the action of some body through which it passes. Transparent substances allow light to pass through them, but when the incidence is oblique the course of the rays is deviated; translucent bodies whilst allowing some rays of light to pass through reflect others; whilst opaque bodies reflect some rays and absorb others, but the rays passing on each side of the opaque substance still continue their course, and leave behind the body a space which is not permeated by light rays, or is only partially so. The sectional image of this space received on a screen is termed shadow. Shadows, however, are not rigidly defined, as the shadow cast by any source of light other than a point may be regarded as an infinity of shadows partly overlapping, and the partial shade at the edges of a shadow is called the penumbra. The velocity of light is about 186,830 miles per second, and its intensity varies in inverse proportion to the square of the distance from the source. If rays of light fall upon a body which is opaque, and the surface of which is unpolished, certain portions of such light will be absorbed or enter to a certain depth, the remaining portion being reflected or scattered in all directions; but certain bodies absorb only certain of the constituent rays of light, and reflect one or more of the others, and thus we arrive at the

colours of objects. For example, an object which absorbs all the primary colours but red will appear red; one that absorbs all colours, black; and one that absorbs none, white; and so on. A ray of light is reflected from a polished surface at the same angle with a line drawn perpendicular to the surface of mirror, that the ray striking the mirror makes—*i.e.*, "the angle of incidence is equal to the angle of reflection." When a ray of light strikes a plane reflecting surface, it will, after reflection, seem to come from a point situated similarly behind the mirror—*i.e.*, the image of an object 10 ft. away from the mirror will be reflected from a point seemingly 10 ft. behind the mirror: the eye in no way recognising the bending of a ray, but seeing as if the ray were straight, and corresponding in direction to that portion striking the eye. When light passes from one transparent medium to another transparent medium, unless perpendicular to the surfaces of both, it is refracted or bent aside to a greater or less degree. This power of refraction differs for every different substance, but remains the same at all times for the same substance. It is expressed by the ratio of the sine of the angle of refraction to that of the angle of incidence. Thus from air to water it is 4 : 3. When a ray of light is refracted, it also suffers what is termed dispersion—*i.e.*, it is separated into its constituent rays. (See DECOMPOSITION OF LIGHT and the SPECTRUM.) The following table given by Eder, and showing the relative intensity of various sources of light, must obviously be taken as very approximate; still it may be useful from a practical point of view:—

	Candles.*
Arc light from dynamo	200 to 6000.
„ „ 40 Grove's cells ...	360.
„ „ 48 Bunsen's cells ...	380.
Lime light	90 to 790.
Magnesium wire	100 to 200.
Oil lamp	10 to 11.
„ „ fed with oxygen	60.
Gas flame	6 to 20.
Welsbach incandescent light... ...	60.
Sunlight	60,000.

Light of full moon $\frac{1}{300000}$ to $\frac{1}{600000}$ of sunlight.

* For ratio of German candles to English candles see p. 103.

Very many interesting facts about light, especially in its relations to electricity, might be here stated; but as nothing like exhaustiveness could be secured, the reader is referred to special treatises—the work of Mr. Lewis Wright on "Light" (Macmillan) being specially suited to the general reader. The photographic effects of certain radiations which do not affect the eye are described under RADIOGRAPHY.

Light-Fog. See FOG.

Lime, Chloride of (Ger., *Chlorkalk;* Fr., *Chlorure de chaux;* Ital., *Cloruro di calce*). Synonyms: Chlorinated Lime, Bleaching Lime, Bleaching Powder, Hypochlorite of Lime. See BLEACHING POWDER.

Lime Light. See OXYHYDROGEN LIGHT.

Lime Water. This is a solution of hydrate of lime made by agitating slaked lime $Ca(HO)_2$ with water. It is feebly alkaline, and contains only $\frac{1}{2}$ grain of lime (CaO) to the ounce of water. By heating, this quantity is still further reduced. A more powerful preparation, actually about fourteen times stronger, may be made by triturating one part of lime with twice its weight of pure sugar, manna, or glycerine; then adding 20 parts of water and decanting the clear solution. Lime water has been suggested as an accelerator for quinol development; but it is unsuitable, the action being very slow. It is also added to some toning baths to neutralise acidity.

Line. As a measure is equal to $\frac{1}{12}$ of an inch. Lens diameters are sometimes expressed in lines.

Line Drawings, To Copy. This is a subject about which many difficulties seem to hang, although actually there is no necessity for the same. It is generally desirable to use a slow plate, such as the commercial lantern plates and the photomechanical plates. The following directions will, it is hoped, make this an easy operation for any one. Having decided upon the size that the resulting negative shall be, the next question is to determine the focus of the lens to be used. If only one lens is possessed, then the size of the image is ruled by this, and the extension of the camera. Supposing we desire to reduce a plan or line drawing from 9×7 in., to $4\frac{1}{4} \times 3\frac{1}{4}$, the lineal reduction

is practically two; therefore by consulting the table given under ENLARGING, we shall find with a 5-in. focus lens that our lens must be 15 in. from the plan and 7½ in. from the focussing screen. Supposing our camera does not rack out sufficiently far, we must improvise an extension by means of a 3-in. or 4-in. cone, or else by adapting one of the cardboard cases used for sensitised paper. If we have a choice of lenses, we may pick that one which is of sufficiently short focus to enable us to use the camera without any additional extension. The next point is to place the axis of the lens exactly central with the print, and the focussing absolutely parallel with the plane of the line drawing. It is hardly necessary to dilate upon this, as any tyro can do it. Then comes the question of lighting. This should be so diffused that the grain of the paper does not show by casting a shadow. A short exposure should be given, if anything under-exposure, because we want to get hardness and contrast. No guide can be given for exposure, as it depends so entirely upon the actinic power of the light. The developer may may be either quinol, or Edwards's pyro redeveloper may be used; we prefer the former. Development should be continued as far as possible without any blocking of the lines showing; if this shows, immediately stop the development, wash, and fix. After thoroughly washing, the negative should be cleared till the lines show as absolutely bare glass, with the ground opaque. For this purpose we specially recommend Howard Farmer's reducer. (See REDUCTION OF DENSITY.) Then, after thoroughly washing, if not dense enough, intensify. (See INTENSIFICATION.)

Lithium (Ger., *Lithium;* Fr., *Lithium;* Ital., *Litio*). Li 7. A comparatively rare metal occurring in lepidolite, lithia-mica, petalite, and triphane. It can be obtained by decomposing lithium chloride by a galvanic current. It is a soft silvery-white metal which decomposes water, and is remarkable as the lightest solid element (Sp. Gr. 0·59).

Lithium Bromide (Ger., *Bromlithium, Lithiumbromid;* Fr., *Brômure de lithine;* Ital., *Bromuro di litio.*) LiBr = 87. This salt, which occurs in transparent white tablets or colourless needles which are very deliquescent, can be prepared by double decomposition of lithium sulphate and barium bromide. Solubility 143 per cent. in cold, 290 per cent. in hot, water. Very

soluble in alcohol and ether. Sometimes used in collodion emulsion making.

Lithium Chloride (Ger., *Chlorlithium, Lithiumchlorid;* Fr., *Chlorure de lithine;* Ital., *Cloruro di litio*). $LiCl,2H_2O = 78{\cdot}5$. This can be prepared in a similar manner to the bromide salt. It occurs in octahedral crystals which are very deliquescent. Solubility 82 per cent. in cold, 146 per cent. in hot, water, soluble in alcohol and ether. It is used in the preparation of collodio-chloride emulsions.

Lithium Iodide (Ger., *Iodlithium, Lithiumiodid;* Fr., *Iodure de lithine;* Ital., *Ioduro di litio*). $LiI = 134$. Made in a similar manner to the bromide salt. Occurs in yellowish crystals which are very deliquescent. Solubility, 100 per cent, in cold, 133 per cent. in hot water; freely soluble in alcohol. Used for iodising collodion.

Lithography, Photo-. A sheet of paper is coated with bichromated gelatine (see CARBON PROCESSES; also ANTHRAKOTYPE), exposed under a negative, covered by a very thin film of printing-ink, and then soaked in water. The unexposed portions of the gelatine film will now swell, and the ink can be wiped off these parts by a tuft of cotton-wool, leaving an image on the paper which can be transferred to stone, and treated by ordinary lithographic methods. There are many modifications of the above, and also methods based on the use of sensitive bitumen. Sometimes a collotype print (see COLLOTYPE) is transferred to the stone. Under BIBLIOGRAPHY will be found the title of a special work on COLLOTYPE AND PHOTOLITHOGRAPHY.

Litho-Photogravure. A method of Eckstein, in which the photolithographic transfer (see preceding article) is put down on a stone ruled with a system of very fine lines; these serving to break up the gradations into a printing grain, and provide for the rendering or half-tone.

Litmus (Ger., *Lackmus;* Fr., *Tournesol;* Ital., *Tornasole*). A blue colouring matter obtained from lichens by fermentation with potash and ammonia. It appears commercially as small cakes, being made into a mass with chalk. It is used to indicate the presence of an alkali or an acid, the latter turning

the solution red, and alkalies restoring the colour. It is usually met with in the form of small books made by steeping unsized paper in tincture of litmus.

Liver of Sulphur. See POTASSIUM SULPHIDE.

Loss of Tone in Fixing. See TONING.

Luminous Paint and Luminous Photographs. Under the heading LATENT LIGHT we mention experiments on absorbtion of light and its gradual return in a modified form; this phenomenon being generally termed fluorescence or phosphorescence: the latter term being generally used when the light is stored for a long period. A remarkably phosphorescent substance is the sulphide of calcium used as a pigment in the commercial luminous paint (sold by W. C. Horne, White Horse Alley, E.C.). A surface painted with this material exposed to light during the day retains sufficient luminosity to be visible all night; and if a transparent positive—as a carbon print—is transferred to such a surface a self-luminous photograph is obtained. The complete extinction of the luminosity only occurs after a painted surface has been kept for several weeks in darkness; but such a surface may receive an instantaneous exposure in the camera, and if then laid on a negative plate it will impress the plate. For an experiment like this it is better to use a glass plate covered with a melted mixture of the dry sulphide and paraffin wax than to use the commercial paint; and a similar mixture thinly spread on paper makes a good phosphorescent screen for use in experiments on Radiography (*q.v.*).

Lunar Caustic. See SILVER NITRATE.

Luxograph. A large lantern-like device with tissue paper front in which pyrotechnic or other compounds can be burned to give an artificial light for portraiture. (See PORTRAITURE and FLASH LIGHT.)

Macro-Photography. A term used to denote the enlargement of the negative.

Magic-Lantern, or Optical Lantern. An apparatus used to project a magnified image of a positive upon a white screen in a darkened room. Practically it consists of a tin box, in which is placed a lamp in the focus of a silvered reflector, the light being

condensed by a pair of plano-convex lenses, the positive being placed close to the condensers, and a special photographic lens being placed at the focus of the condensing lens. Very often a three- or four-wick lamp is employed to give the illumination, the edges of the flames being presented to the condensers; but limelight, acetylene, and the electric arc are also in use. The following rules and table will be found useful in determining the dimensions of the pictures thrown on the screen with various lenses :—

1. Knowing the length of room and diameter of picture desired, required to find the focus of front objective of lantern. Multiply the distance between the lantern and screen by the size of the opening in slide, and divide by the diameter of disc.

Example. Room length 50 feet, diameter of picture 20 feet; required to know focus of lens to be used. (Three inches is always taken as the size of opening of slide.)

$$\frac{50 \times 3}{20} = \tfrac{150}{20} = 7\tfrac{1}{2}\text{-in. focus lens.}$$

2. Having a given focus lens, and given diameter of picture, required to know what distance from screen to place lantern. Multiply the diameter of picture required by the focus of the lens, and divide by the diameter of the slide.

Example. Size of picture desired 15 feet; focus of lens 8 ins.

$$\frac{15 \times 8}{3} = \tfrac{120}{3} = 40 \text{ feet.}$$

3. Having a given focus lens, and given distance between lantern and screen, required to know diameter of picture that will be produced. Multiply the distance between lantern and screen by the opening of the slide, and divide by the focus of the lens.

Example. Lens of 9-in. focus, distance between lantern and screen 40 feet, required size of disc.

$$\frac{40 \times 3}{9} = \tfrac{120}{9} = 13 \text{ ft. } 4 \text{ in. diameter of disc.}$$

In connection with the Magic Lantern the following articles may be consulted:—Table of illuminants under LIGHT, OXY-HYDROGEN LIGHT, ACETYLENE, CONDENSER, APHENGOSCOPE; and

REFERENCE TABLE.

Distance between Lantern and Screen.	FOCUS OF LENS. 4 ins.	5 ins.	6 ins.	7 ins.	8 ins.	9 ins.	10 ins.	11 ins.	12 ins.	13 ins.	14 ins.
	DIAMETER OF DISC.										
	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.	ft. ins.
10 feet . .	7 6	6 0	5 0	4 3	3 9	3 4	3 0	2 9	2 6	2 4	2 2
11 „ . .	8 3	6 7	5 6	4 9	4 2	3 8	3 4	3 0	2 9	2 6	2 4
12 „ . .	9 0	7 2	6 0	5 2	4 6	4 0	3 7	3 3	3 0	2 9	2 7
13 „ . .	9 9	7 10	6 6	5 7	4 11	4 4	3 11	3 7	3 3	3 0	2 9
14 „ . .	10 6	8 5	7 0	6 0	5 3	4 8	4 2	3 10	3 7	3 3	3 0
15 „ . .	11 3	9 0	7 6	6 5	5 8	5 0	4 6	4 1	3 9	3 6	3 3
20 „ . .	15 0	12 0	10 0	8 7	7 6	6 8	6 0	5 6	5 0	4 7	4 3
25 „ . .	18 9	15 0	12 6	10 9	9 4	8 4	7 6	6 10	6 3	5 9	5 4
30 „ . .	22 6	18 0	15 0	12 10	11 3	10 0	9 0	8 2	7 6	6 11	6 5
35 „ . .	26 3	21 0	17 6	15 0	13 1	11 8	10 6	9 6	8 9	8 1	7 6
40 „ . .	30 0	24 0	20 0	17 2	15 0	13 4	12 0	10 10	10 0	9 2	8 6
45 „ . .	33 9	27 0	22 6	19 3	16 10	15 0	13 6	12 3	11 3	10 4	9 8
50 „ . .	37 6	30 0	25 0	21 5	18 9	16 8	15 0	13 8	12 6	11 6	10 9

as regards slides for the lanterns, see LINE DRAWINGS, TO COPY, HYDROQUINONE, EMULSION, ALBUMEN PROCESS, and LANTERNOSCOPE. On p. 172, *et. seq.* (DEVELOPMENT), will be found some instructions for making lantern slides on commercial plates.

Magic Pictures. These are prepared by a process discovered by Sir John Herschel. Print as usual on albumenised paper, fix without toning, and wash thoroughly; immerse the prints in a saturated solution of perchloride of mercury until the image is thoroughly bleached and disappears, wash and dry. To make these invisible images appear at the word of command, as if by magic, place over one a wetted sheet of blotting paper, which has been previously soaked in a saturated solution of hypo-sulphite of soda, and press the hand upon them, when the image will start up with more than its original vigour.

Maglip, or Meglip. An artist's material, made by mixing boiled linseed oil with mastic varnish. It is used for thinning oil colours and for glazing on delicate tints on finished oil-paintings.

Magnesium (Ger., *Magnesium;* Fr., *Magnésium;* Ital., *Magnesio*). Mg = 24. Occurs in large quantities as dolomite or mountain limestone—an impure carbonate. The metal is silvery white in colour, and is met with commercially in the form of wire, ribbon, and powder. It is now of common use for producing negatives by night, as the metal ignites at a comparatively low temperature, giving an extremely actinic and brilliant light. (See FLASH LIGHT and PORTRAITURE.) It has also been suggested as a means of precipitating silver from old fixing baths. (See RESIDUES.)

Magnesium Chloride (Ger., *Chlormagnesium;* Fr., *Chlorure de magnésium;* Ital., *Cloruro di magnesio*). $MgCl_2,6H_2O = 203$. White crystals or needles, very deliquescent. It has been employed in gelatino-chloride emulsions, and was proposed by Liesegang as a Fixing Agent. Solubility: 160 per cent. in cold, 370 per cent. in boiling water; 50 per cent. in absolute alcohol; 500 per cent. in boiling alcohol.

Magnesium Sulphate (Ger., *Magnesiumsulphat, Schwefelsäures Magnesium;* Fr., *Sulfate de magnésie;* Ital., *Solfato di*

magnesia). Synonyms: Sulphate of Magnesia, Epsom Salts. $MgSO_47H_2O$. Occurs naturally in certain springs, but is usually made by dissolving dolomite in dilute sulphuric acid, and subsequent purification and crystallisation. It has been recommended as a preventive of frilling. Solubility: 104 per cent. in cold, and 700 per cent. in hot, water; insoluble in alcohol.

Magnets, Photographic Action of. Reichenbach, about 1850, asserted that a magnetic pole was not only visible in the dark to some persons, but would also affect the sensitive (Daguerreotype) plate. More recently, Braham, Brooks, and others have obtained magnetographs on emulsion plates.

Manganese, Bin-oxide of (Ger., *Mangandioxyd, Braunstein;* Fr., *Peroxyde de manganese;* Ital., *Perossido di manganese*). $MnO_2 = 86$. Synonyms: Manganese Dioxide, Black Oxide of Manganese. Occurs native as the ore of manganese as a black crystalline powder. It is used to facilitate the evolution of oxygen from chlorate of potassium.

Manipulation. A term used to express the conduct, the handicraft part, of any operation or process.

Masking Skies. See PRINTING.

Masks and Discs. Pieces of opaque paper used in photographic printing, usually with albumenised paper. In the opaque paper shaped openings are cut; and the piece cut out is termed the disc, the margin being called the mask. The mask is placed between the negative and the paper, when it is obvious a print will result of the form given by the opening of the mask, and the margin where covered by the mask will be white. The print may be finished off at this stage, or the disc may be carefully and accurately placed over the print, and the margins exposed to light till they darken to the required tint. A good effect is sometimes given to portraits with light backgrounds by printing under a mask, then using a disc and blackening the margin, enamelling the print, and giving the centre portion a convexity, as mentioned under CAMEO.

Mastic, or Mastich. A resinous exudation from the stems of *Pistacia lentiscus*, grown in the island of Scio. It is usually met with in the form of whitish or yellowish-white drops or

tears, about the size of small peas. Insoluble in water; almost entirely soluble in alcohol, ether, chloroform, oil of turpentine, and benzole. It is used for preparing certain Varnishes (*q.v.*)

Matt Paper. Popular opinion, amongst photographers at least, has veered round towards printing papers with a dull or non-glossy surface. Several commercial makes of matt-surface gelatino-chloride paper have been placed on the market but require no different treatment to the ordinary glossy paper.

Matt Varnish. See Varnish.

Mealiness of Prints. A peculiar mottled appearance on the surface of prints, due to a weak paper-sensitising bath; and as this is also the cause of lack of vigour, contrast, and brilliancy, the term is frequently used to denote all these.

Measles. A peculiar defect in prints, which shows, when they are held up to the light, as opaque blotches, which are due to imperfect fixation and non-solution of the insoluble hypo-sulphite of silver. On keeping, these spots turn yellow, due to formation of sulphide of silver; whence the name, from a fancied resemblance to the human ailment. (See Fixing.)

Measures. See Weights and Measures.

Melanotype. A term sometimes applied to Ferrotype (*q.v.*).

Meniscus. See Lens.

Mercuric Chloride (Ger., *Quecksilberchlorid, Mercurichlorid, Sublimat;* Fr., *Bichlorure de mercure;* Ital., *Bicloruro di mercurio*). $HgCl_2 = 271$. Synonyms: Perchloride of Mercury, Bichloride of Mercury, Corrosive Sublimate, Sublimate, Muriate of Quicksilver. Can be prepared by heating mercury in an excess of chlorine, but it is prepared commercially by sublimation from a mixture of mercuric sulphate and common salt. It is usually met with in commerce in extremely heavy colourless crystalline masses or as a white powder. Specific gravity: 5·43. Solubility: 1 in 19 of cold, 1 in 3 of hot water, 1 in 5 of rectified spirit, 1 in 6 of ether. It sublimes without decomposition, and melts at 509° F. It is used for Intensification (*q.v.*). Its solution in water is liable to decomposition; but any soluble chloride tends to prevent this, and nearly all chlorides increase its solubility in cold water, a compound salt being formed. It is a powerful

poison, 3 grs. being the smallest fatal dose known. The antidote is albumen, or white of egg, with which its forms an insoluble compound, followed by emetics. As the salt is readily absorbed by the skin, it is advisable to exercise care. For a convenient method of preparing a solution of mercuric chloride, see CALOMEL.

Mercurous Chloride. See CALOMEL.

Mercury (Ger., *Quecksilber;* Fr., *Mercure;* Ital., *Mercurio*). Hg = 200. Synonym: Quicksilver. Occurs native, but is chiefly obtained by treating the ore cinnabar, which is an impure sulphide, obtained from China, Spain, California, and America. Mercury, at ordinary temperatures, is a brilliant silvery white metallic liquid, becoming solid at $-40°$ F. Specific gravity: 13·5. It has now but little photographic interest, but was used in the old daguerreotype days to develop the image.

Metagelatine. Gelatine so altered by heat or acids as to have altered its setting properties.

Metallic Spots. These sometimes occur on albumenised paper, and are due to impurities, usually metallic iron, in the substance of the paper itself.

Methylated Ether. See ETHER.

Methylated Spirit. See ALCOHOL, METHYLATED.

Metol. A salt of methyl-amido-cresol which has come largely into use as a developing agent for negatives, and more especially for positives on paper. Dr. Eder's standard solutions for metol development are as follows:—

A.

Water	100 parts.
Neutral sodium sulphite	10 ,,
Metol	1 ,,

B.

Water	10 parts.
Potassium carbonate	1 ,,

For sepia tones on gelatino-chloride paper Dr. Just recommends—

Solution A.	2 ozs.
10 per cent. bromide potassium solution...	20 drops.

For red tones—

Solution A.	1 oz.
Water	3 ozs.
10 per cent. bromide potassium solution...	8 drops.

Metric System. See WEIGHTS AND MEASURES.

Micro-Photography—the antithesis of macro-photography—consists of the reproduction of positives in a very minute size which require the use of a simple microscope or magnifying glass to examine. Micro-photographs are well known to the majority of amateurs, from the minute photographs which are usually sold at seaside places, the photographs being fixed behind a minute magnifying glass in the handle of some little but fancy article. Their production is comparatively easy, but the collodion process is employed. These are made chiefly by M. Dagron, of Paris, whose application of micro-photography to a means of communicating from inside besieged Paris to the outer world is mentioned under PIGEON POST. (For PHOTO-MICROGRAPHY, see the article under that heading.)

Minim. See WEIGHTS AND MEASURES.

Mirror, Reversing. A silvered mirror with the metal film outwards, placed in front of the lens when laterally reversed negatives are wanted. (See next article; also REVERSED NEGATIVES)

Mirror Silvering. As the worker may desire to resilver a mirror or a copper reflector, the following recipes may be found useful :—

For glass—

No. 1.

Nitrate of silver	175 grs.
Distilled water	10 ozs.

No. 2.

Nitrate of ammonia	262 grs.
Distilled water	10 ozs.

No. 3.

Pure caustic potash	437·5 grs.
Distilled water	10 ozs.

No. 4.

Pure sugar-candy	210 grs.
Distilled water	5 ozs.

Dissolve and add

Tartartic acid	50 grs.

Boil in a flask for ten minutes, and when cool add

Alcohol	1 oz.
Distilled water to	10 ozs.

For use: Mix Nos. 1 and 2 in equal parts; mix Nos. 3 and 4 in equal parts; then mix the two solutions, and suspend the glass in it. To silver copper or any metal it must first of all be cleansed with dilute acid to free from dirt, etc., then well washed, and one of the following applied:—Dissolve 60 grs. of nitrate of silver in 1 oz. of distilled water; add sufficient liq. ammonia to redissolve the precipitate first formed; add to this solution ½ drm. of caustic potash solution and ½ drm. of glycerine; apply to the metal; add a few drops of ether; rub with a tuft of cotton-wool; dry before the fire, and polish; repeat as often as desired to brighten it.

Or

Nitrate of silver	65 grs.
Liq. ammonia	60 mins.
Hyposulphite of soda	100 grs.
Prepared chalk	100 ,,
Distilled water	1,000 ,,

Mix, and apply with a flannel. Or

Nitrate of silver	60 grs.
Cream of tartar	120 ,,
Salt	120 ,,
Cyanide of potash	60 ,,

Make into paste with water and chalk, and apply with a flannel.

Monocle. Under this term have been introduced uncorrected spectacle lenses, which have been strongly recommended for portraiture and ordinary landscape work where softness of definition is desired. The usual form of lens employed is the periscopic of about 1½-in. diameter, and it may be obtained of any focus from about 6-in. and upwards. These lenses, being uncorrected, necessarily have two foci, a chemical and visual, and it is therefore necessary to make a correction after focussing and

before exposing. For ordinary landscape work the necessary correction may be made by means of the formula $\triangle f = f0{\cdot}02$, which is practically equal to $\frac{1}{50}$th of the focus. But this only applies when the lens is working at its equivalent focus.

Monocular Vision. As the term implies, it is seeing with one eye only. It was formerly supposed by many eminent opticians and physicists that one eye only was employed in vision; but Wheatsone, to whom the great invention of the principle of the stereoscope was due, proved the fallacy of this. In monocular vision objects on the true optical axis line are distinctly seen, but other objects less so, although they are in the circle of vision, and in this particular the similarity of the lens and the human eye is very evident. Monocular vision can judge the direction, but not the distance of an object.

Motoscope. See ZOETROPE.

Mountant. The substance used to make the print adhere to its mounts. It is absolutely necessary that the mountant should be free from acidity, in order to prevent the destruction of the delicate image. There are several kinds in common use—viz., starch paste, arrowroot, gum, dextrine, india-rubber solution, liquid glue, and gelatine.

Starch Mountant. Starch in powder 1 oz.; mix into a cream with 1 oz. of water, and add to it, constantly stirring, 8½ ozs. of boiling water in which 20 grs. of common alum and 5 drops of carbolic acid have been dissolved. The mixture should be now a clear translucent jelly free from lumps; if it is not, it should be gently heated in a dish or pan till it clears, constant stirring being an absolute necessity; then it should be squeezed through fine muslin. Ordinary household flour makes a more adhesive paste, but is liable to acidity. Both will keep fit for use about a week, after which they should be rejected.

Arrowroot Mountant, called Permanent Paste. Dissolve by the aid of gentle heat

Arrowroot	150 grs.
Gelatine	150 „
Distilled water	3 ozs.

When cool, add

Methylated spirit	2½ drms.
Carbolic acid	3 drops.

Gum Solution, or Mucilage. Pale-coloured gum arabic in clean lumps, 4 ozs.; distilled water, 8 ozs. Wash the gum by placing it in a half-pint cup or measure; add half-pint of water; stir briskly round twice or three times, and pour off the water: this carries off any dust or mechanical impurities. Now add the distilled water, and stir frequently at intervals till dissolved. It should be kept in bottles filled as full as possible, and the addition of a little carbolic or salicylic acid will help to preserve it; for without this it will keep only about ten or fourteen days, and when made with hot water about half that time. Powdered gum arabic should not be used.

Dextrine Solution. This can be made as follows:—

Pure white dextrine	1 oz.
Boiling distilled water	3 ozs.
Methylated spirit	½ oz.

Stir till dissolved, and strain through calico. It should show no sign of acidity when tested with litmus paper.

India-rubber Solution

Pure masticated rubber	80 grs.
Chloroform or benzole	8 ozs.

Digest till dissolved. Benzole is cheaper than chloroform, but the smell is rather unpleasant to some.

Gelatine. This, if properly made, is convenient and easy of application. The print can be mounted whilst still damp, and it can be shifted about on the mount, or any excess of mountant wiped off, without leaving any trace on the mount, even if highly enamelled. The following is a satisfactory method:—Soft gelatine, 200 grs.: soak in distilled water (6 ozs.) for an hour. Dissolve by the aid of a water bath, and add, in small quantities at a time, methylated spirit, 2½ ozs., stirring constantly; allow it to set. Should any spirit separate out, the mixture should be remelted, and a little more water added. The product should be a pure milk-white firm jelly. A little carbolic acid may be added if desired. When required for use, melt by the aid of hot water or a water bath.

Liquid Glue. This is sometimes used, but as many different preparations are sold under this name, each sample should be tested for acidity, as some consist of gelatine dissolved in acetic acid, which would soon cause fading. Another kind which we

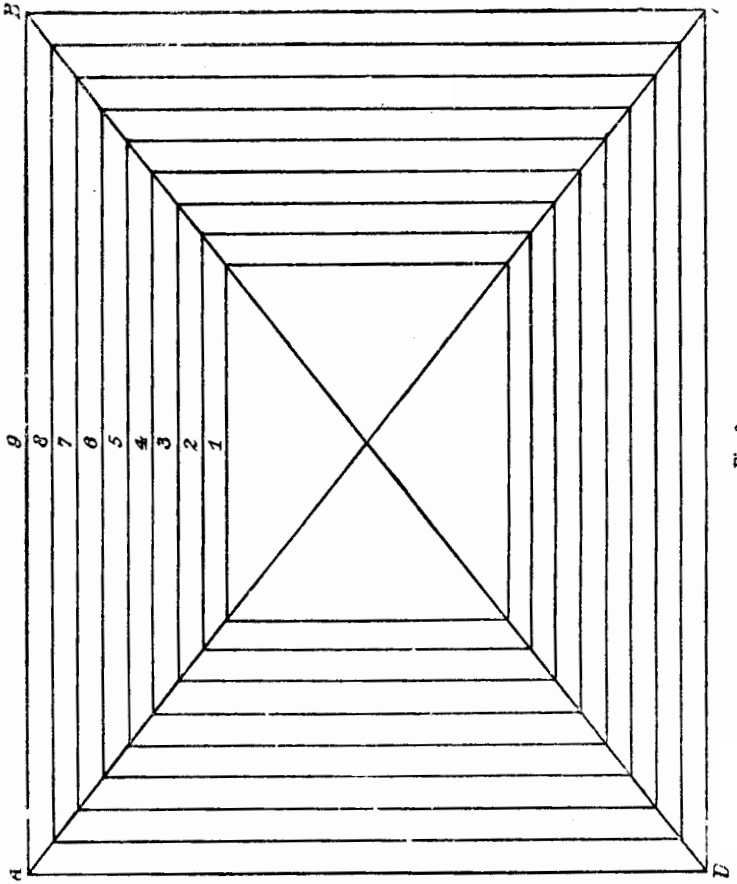


Fig. 87.

have used, but cannot highly recommend, is prepared by dissolving 120 grs. of shellac in 4 drms. of methylated spirit by the aid of heat. It is waterproof, but only available when the paper is thick, well sized, and impervious to a varnish-like material. Some adhesive mounts have been introduced into the market, which are rather convenient, although they are rather liable to stick together at the edges. To make self-adhesive mounts, a thick mucilage of gum tragacanth may be spread on the card. A damp print rolled against such a mount adheres firmly.

Mounting is the operation of causing prints to adhere to some substance, such as card, cloth, wood, or glass, either for ornament or the better protection of the print itself. As the mounting of a print is in many cases the making of it, great attention should be paid by amateurs to this subject. The following points should be chiefly regarded :—The mount should be of colour and size to suit the taste of the operator, rather than to meet any real or supposed convention. As the difficulty of placing prints equidistant from the margin is one likely to be met with by every amateur, the following hints may be found useful :—After applying the mountant, lay the print *face* downwards upon a mount exactly similar to that upon which it is desired to mount the print, shift the print about till it is exactly in the centre; now lay on top of the print another mount exactly the same size, making the edges of the two mounts coincide: rub the hand gently over the top mount, when it may be lifted up with the print in position. Another ingenious method, which is recommended by Mr. T. C. Hepworth, is as follows :—Procure a piece of stout cardboard—a mount will do—22 by 15; draw diagonals from corner to corner, AC, BD, in sketch (Fig. 87), cutting each other in centre, and on these lines are drawn rectangular figures of the usual dimensions of the trimmed prints. For instance, the smallest may be 4 by 3 or 3 by 3, the next $4\frac{1}{2}$ by $3\frac{1}{2}$, 5 by 4, 6 by 4, 6 by 5, 7 by $5\frac{1}{2}$, and so on. When it is desired to mount a print, place it face downwards upon this gauge, when it will be found that it will coincide with certain of the lines; note the number of figure, remove the print, apply the mountant, and replace upon the lines it covered before; then reverse upon it the mount which should coincide with some other set of lines; proceed as in the above case, lifting the

mount and its adhering print. A very convenient little instrument for those who do not possess either a burnishing or rolling machine is an india-rubber roller squeegee, which will cause good contact between the prints and mounts. For those who possess a copying press, sheets of zinc or tin may be placed between the mounted prints, and great pressure applied in the ordinary way; whereas those whose household appurtenances include a clothes-wringing machine, with india-rubber rollers, may use these; or the bevelled edge of the cutting glass drawn carefully over the print with some pressure will do all that is required. For mounting prints in optical contact with glass the following method answers well:—Make a solution of gelatine (Nelson's X opaque), 20 grs. to every ounce of water, and whilst still warm immerse the print face downwards in it; place the glass in it, and after a few seconds bring them into intimate contact, and withdraw from solution, and squeegee thoroughly, and allow to dry. To mount prints which have an extremely glossy surface, like Aristotype, etc., when it is desired to retain the high gloss which cannot be done by mounting in the usual way, squeegee the print on to an old negative glass, cutting shape, or ferrotype plate, and when nearly dry coat the back with the mountant, and apply to the mount; use the squeegee vigorously, and when dry the glass may be stripped off, leaving the print upon the mount. (For the usual size of mounts, see SIZES, PHOTOGRAPHIC.)

Muriatic Acid and Muriates. Muriatic acid is an old name for hydrochloric acid, and chlorides or hydrochlorates were called muriates.

Naturalistic Photography. Under this title has lately been published one of the most striking works ever written on photography, by Dr. P. H. Emerson. Naturalistic Photography is an attempt to render by means of the usual tools and operations of photography the same as given by the so-called "Impressionist" school of painting, of which Whistler is the leader. As perhaps the clearest exposition of the teaching and aim of this school, we cannot do better than refer to Dr. Emerson himself, who says that a picture "should be made just as sharp as the eye sees it, and no sharper; for it must be

remembered the eye does not see things as sharply as the photographic lens, for the eye has the faults due to dispersion, spherical aberration, astigmatism, aerial turbidity, blind spot, and beyond twenty feet it does not adjust perfectly for the different planes. All these slight imperfections make the eye's vision more imperfect than that of the optician's lens, even when objects in one plane only are sharply focussed; therefore, except in very rare cases, which will be touched upon elsewhere, the chief point of interest should be slightly—very slightly—out of focus, while all things, out of the plane of the principal object, it is perfectly obvious from what has been said, should also be slightly out of focus, not to the extent of producing destruction of structure or fuzziness, but sufficiently to keep them back and in place. . . . The rule in focussing, therefore, should be, focus for the principal object of the picture, but all else must not be sharp; and even that principal object must not be as perfectly sharp as the optical lens will make it. It will be said, But in Nature the eye wanders up and down the landscape, and so gathers up the impressions, and all the landscape in turn appears sharp. But a picture is not 'all the landscape'; it should be seen at a certain distance—the focal length of the lens used, as a rule ; and the observer, to look at it thoughtfully, if it be a picture, will settle on a principal object, and dwell upon it, and when he tires of this he will want to gather up *suggestions* of the rest of the picture."

Negative is the term applied to the image in which the lights and shades are reversed. These can be made by direct action of light in the camera, or by printing in a frame from a positive.

Negative Storing. To the amateur whose work is frequent and successful the stock of negatives soon becomes considerable, and storage a trouble. Many use the grooved negative boxes, but while these are convenient their bulk is a great objection. A good plan is to use paper negative bags, on which can be written the subject, date, and duration of exposure, aperture of diaphragm, mode of development, and any other remarks which may be considered necessary. The negatives in the bags can then be packed close together in boxes not grooved, and they will take up about one-fourth of the room of grooved

boxes. An index can be kept of them, and a list pasted inside the lid of each box for further reference.

Negatives, Stripping of. One of the most potent agents for removing the film from a glass plate is extremely weak hydrofluoric acid—half a fluid drachm of the strong acid to a pint of water being sufficient. In this bath the gelatine film will soon float off the glass plate, and the film, after rinsing in water, may be received and dried on a waxed glass plate, a sheet of ebonite, or a slab of celluloid, from which it will readily separate when dry. It is, however, more convenient to purchase the more manageable fluoride of potassium or sodium, and to dissolve a dram of either in a pint of water, then to acidify by a few drops of hydrochloric acid or sulphuric acid. During the above operation the film becomes enlarged; and if the separated film is allowed to soak for some time in water it may be readily enlarged to twice the original area, or nearly $1\frac{1}{2}$ linear. If, on the other hand, the film is immersed in methylated spirit, immediately it floats off it will be scarcely, if at all, larger than when on the original glass. Assuming the stripped film to have been floated off the original glass, and to be on the waxed glass, celluloid, or ebonite, a thick sheet of soaked gelatine may be squeegeed down upon it; and the edges of the latter being clamped down, the whole is allowed to dry, when the negative film, strengthened by the extra thickness of gelatine, may be stripped off, and used as a reversed negative for collotype or other photo-mechanical process.

Neomonoscope. An apparatus somewhat similar to the Alethoscope (*q.v.*) and other devices of a similar kind.

Nephograph. A contrivance for photographing and registering the height and position of clouds by photography (by electric release of shutter). Simultaneous exposure being made by two or more cameras at a considerable distance apart, data are obtained for the required determination.

New Photography. A term of shifting meaning. A few years ago it meant that class of work in which pictorial effect and excellence is more sought after than mere technical perfection; and at the time of writing Radiography (*q.v.*) is frequently referred to as the New Photography.

Niepceotype. (1) A term sometimes applied to the bitumen process, invented by J. N. Niépce about 1816, and the first method by which a camera picture was obtained. (2) The albumen process on glass (see p. 13) due, as far as its main features are concerned, to Niépce de St. Victor.

Nitric Acid (Ger., *Salpetersäure;* Fr., *Acide Nitrique*). $HNO_3 = 63$. Synonym: Aquafortis. Prepared by distillation from Chili saltpetre (nitrate of soda) and sulphuric acid. A heavy liquid fuming in the air. It is extremely corrosive—the antidote being any alkaline earthy carbonate, as chalk, lime, magnesia. (For a table giving the specific gravity of nitric acid of various strengths, see HYDROMETERS and HYDROMETRY.)

Nitro-Hydrochloric Acid (Ger., *Königswasser;* Fr., *Eau régale*). Synonym: Aqua regia. A mixture of 3 parts of hydrochloric acid with 1 part of nitric acid. It is used to dissolve gold for the preparation of gold perchloride, the agent being the chlorine liberated by the interaction of the acids.

Non-Actinic Rays. See SPECTRUM.

Obernetter's Process, or Lichtkupferdruck. A mechanical printing process of very ingenious idea and of extremely pleasing results. The silver image of a gelatine positive is converted into chloride of silver, and the film is then stripped and applied to the surface of a copper plate, and, under the influence of a voltaic current, the silver chloride is decomposed, and the chlorine unites with the copper and etches it to a greater or less degree, according to the depth of deposit of silver chloride. The result is a grained intaglio plate of extreme delicacy and beauty, which is inked and printed from the same as any other intaglio plate.

Objective. A term sometimes applied to the image-forming lens of an optical instrument, as for example the lens used with the photographic camera. (See LENS.)

Oil of Lavender. This and the oil of the spike lavender were used as solvents in the early forms of the bitumen process.

Oil of Spike. See OIL OF LAVENDER.

Oil Paintings, to Copy. See COPYING.

Opacity. See DENSITY.

Opalotype. A term applied to pictures on opal glass. They can be made by coating opal glass with a plain gelatino-bromide emulsion, or by using a printing-out emulsion. The exposure and development are the same as for bromide paper. Either polished or ground opal glass may be used, the latter giving very pleasing pictures of a matt surface. Another method of obtaining pictures by the printing-out process is by the use of a collodio-chloride emulsion, which may be made as follows:—

No. 1.

Silver nitrate	31 grs.
Methylated alcohol	28 drms.

Dissolve by the aid of heat immediately before using.

No. 2.

Strontium chloride	31 grs.
Methylated alcohol	28 drms.

No. 3.

Citric acid	31 grs.
Methylated alcohol	28 drms.

No. 4.

Pyroxyline or celloidin	62 grs.
Methylated alcohol	28 drms.
„ ether	28 „

To make the emulsion

Take of No. 2	150 mins.
„ No. 3	150 „
„ No. 4	28 drms.

Mix, and add gradually, with constant agitation,

No. 1	75 mins.

Give the plates an edging of albumen or india-rubber solution a quarter of an inch broad, and, after coating, allow them to dry thoroughly. The prints should be washed, toned, and fixed in the same way as ordinary silver prints, or the sulpho-cyanide toning bath may be used with better effect. (See TONING.) As it is necessary to examine the opal during the operation of printing, it is obvious that some arrangement must be made for replacing it in exactly the same position. Printing frames may be obtained commercially specially adapted for this work, but

an ordinary printing frame may be utilised in the following manner:—Replace the hinged back by a solid piece of wood $\frac{1}{16}$ of an inch less in thickness; coat the inside of this back with a composition of gelatine made as follows:—

Gelatine (Nelson's X opaque)	1 oz.
Water	4 ozs.
Glycerine	2 „

Soak the gelatine in water, and dissolve by the aid of heat; add the glycerine last. The opals will adhere to this on being damped, or a thick india-rubber solution, with a little castor oil added, may be used:—

Pure masticated rubber	40 grs.
Castor oil	10 drops.
Benzole	1 oz.

A small spot of this at each corner will cause the opal to adhere firmly to the wood. To keep the negative in position, a screw may be driven through one end of the printing frame, and the point of the screw cut off; a groove cut in it in which to fit the negative. To the back affix three or four small tongues of metal pierced with holes, which holes may drop over pins driven into the sides of frame, or the back may be permanently fixed by a hinge to one end of the frame.

Optical Centre. A point in the principal axis of a single lens which may be found as follows:—Draw a line to represent

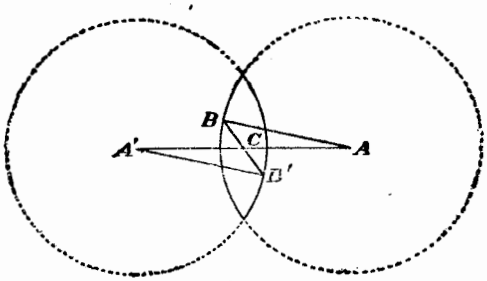


Fig. 88.

the principal axis, A C A′ (fig. 88); then from the centres of curvature draw two radii, AB and A′B′, parallel to one another,

but oblique to the central axis; join their extremities, B, B′, and the point C at which the principal axis is cut by this line is the optical centre. To find the optical centre of a meniscus lens prolong B B′ till it meets the principal axis; the optical centre of plano-concave and plano-convex lenses is found by the intersection of the spherical surfaces by the principal axis.

Optical Glass. See GLASS.

Optical Lantern. See MAGIC LANTERN.

Optics (ὄπτομαι, obsolete synonym of ὁράω, I see). That branch of science relating to the nature and laws of vision. The subject is too comprehensive to treat here. For further study the reader is referred to Glazebrook's "Physical Optics."

Orange Light. Actinic light filtered through any medium which absorbs all but the orange rays. It is frequently used for the illumination of the dark-room, and is sufficiently safe if not too brilliant.

Oroheliograph. See PANORAMIC CAMERA.

Orthochromatic. See ISOCHROMATIC.

Orthographic and Orthoscopic. Two fanciful titles given to certain classes of lenses.

Osmose. An action that takes place when two liquids of differing densities are separated by a permeable medium. (See DIALYSER.)

Over-Exposure is the undue prolongation of the exposure of the sensitive surface. The effect of over-exposure on the sensitive surface is that the image starts up quickly, and the plate shows signs of fogging [see FOG] before proper density is obtained, the resulting negative being thin, but full of detail.

Oxalate Developer. See DEVELOPER and BROMIDE PAPER.

Oxalic Acid (Ger., *Oxalsäure;* Fr., *Acide Oxalique*). $H_2C_2O_4$, $2H_2O = 126$. Prepared by oxidation of sugar or sawdust by nitric acid. It is recommended for acidifying the oxalate of potash solution for ferrous oxalate developer, but its chief use is in the preparation of oxalate of potash, ferric oxalate, and other stable salts. It is poisonous (60 grs. being often sufficient to cause death); its antidote, chalk, or lime in any form, with

which it forms insoluble oxalate of lime. Solubility: 1 in 15·5 of cold water, 1 in 1 of boiling; sparingly soluble in alcohol.

Ox-Gall. The fresh gall of the ox purified, and evaporated to a suitable consistency. It is used photographically to make water-colours take to the surface of albumenised prints. It can be obtained from the artist's colourman as a sticky, rather offensive-smelling mass. It is soluble in water and spirit, and can be dissolved in either, or, preferably, a mixture of both, and applied to surface of print with camel's-hair pencil.

Oxygen. O = 16. A gaseous element, forming $\frac{8}{9}$ by weight of water, and $\frac{23}{77}$ of the air; it is the most abundant element known, entering into the composition of all animal and vegetable tissues, and forming about half the weight of the solid earth. It is used in the oxy-hydrogen light, and is usually prepared on a small scale by heating a mixture of chlorate of potash and black oxide of manganese.

Oxy-Hydrogen, Oxy-Calcium, or Drummond's Light. A cylinder or ball of lime is heated by a blowpipe flame fed with oxygen, and glows with an exceedingly intense light; this light, in one form or another, being the chief illuminant for high-class magic-lantern effects. It can also be advantageously used for enlarging.

Packing Plates. Several methods are employed by commercial firms to preserve dry plates from accidental injury and fracture whilst travelling, and a convenient method for the tourist is that practised by a well-known London firm. Pure tissue paper is cut the exact width of the plates, but sufficiently long to enclose five or six; the end of a strip is placed in the box, then a plate is laid in face downwards, and the tissue paper folded over the back of it; then another plate is laid face downwards on the tissue paper, and this is continued till the case is full, when the box is wrapped in black paper, slipped into another case, and that into an outer box or travelling case. By alternating the plates and paper in this manner, any number of plates may be safely carried by road or rail without much fear of fracture. Custom-house officers seldom give trouble to tourists who are reasonably civil; but it may be sometimes desirable, when the above method of packing is adopted, to

interpose here and there a black card exactly fitting the box, and also to put a spoiled plate on the top. Even should such a package be opened for inspection, the damage may be little or nothing. Some tourists attach great importance to covering the outsides of each package with long inscriptions printed in various languages, and intended to caution custom-house officers. Such long inscriptions are seldom read; and a short caution, boldly printed, in the four leading languages is far more likely to be practically useful, thus—

Photographic Plates.
Plaques Photographiques.
Photographische Platten.
Teme la Luce.

In practice the one word **PHOTOGRAPHIC,** on a label covering the whole length of the package, will convey a sufficient hint to any Custom-house officer willing to take a hint; this word being so universal in one form or another as scarcely to require translation, even to the average fiscal officer of countries where the Roman alphabet is not used.

Palladium, Palladiotype. Palladium is a metallic element sometimes found native in the nearly pure state, and frequently with platinum, which it much resembles. It has been recommended for toning transparencies and enamels, but its use is limited. Palladiotype is a method similar to platinotype, but with palladium in place of platinum. (See PLATINOTYPE.)

Panel. The style of a commercial photograph, size about 4 by 8½ ins.

Panoram. See PANORAMIC CAMERA.

Panoramic Camera. Generally a camera is so called when it includes a wider angle than can be included by a lens, the lens of widest angle being Sutton's concentric and spherical water lens (fig. 73, p. 390), with which curved plates were used. The principle of the most usual type of panoramic camera is perhaps sufficiently explained in the article CYLINDROGRAPH (p. 155); but it should be understood that rigidly attached to the lens setting and inside the camera is a tube which terminates in a vertical slot near the surface of the curved film, thus limiting the exposure at each instant to that portion of the plate well

covered by the lens. The panoramic camera best known in this country is that of Johnson & Harrison, in which the lens moves on a vertical axis, as in Mœssard's cylindrograph, and the lens setting carries with it a casing with vertical slot. Instead, however, of the sensitive surface being curved, a long plate is used and this plate is so moved by gearing that the portion actually under the action of the lens always has a position corresponding to a tangent on the circle described by the vertical slot. With the long plate, mechanical limitations make it difficult to construct the camera so that it shall describe a complete circle. Damoiseau's cyclograph and Colonel Stewart's panoram are constructed on a similar principle, but instead of a long plate a band of film is used, and a complete circle—or, indeed, several circles in succession—may be photographed on a band of film. Other forms of panoramic camera, by which 360° may be included, are Chevalier's plane table, in which an image is reflected downwards from a revolving lens to a circular plate, and M. Noë's oroheliograph, in which the lens looks upwards at a convex paraboloid reflector. These, however, give distorted images, but are serviceable in connection with photogrammetric observations. Mr. A. H. Smith has constructed a form of camera, which he calls by the same name as M. Damoiseau's instrument above mentioned, and it photographs the whole circumference of a cylindrical object which revolves in front of it.

Pantoscope. (1) An apparatus for viewing photographs, and generally similar to the Alethoscpe and Lanternoscope (*q.v.*). (2) A wide-angle lens manufactured by Busch, and shown in section (fig. 70, p. 389).

Pantoscopic Camera. See PANORAMIC CAMERA.

Paper, Albumenised. See ALBUMENISED PAPER.

Paper Negatives. The first negatives made by Talbot were on a basis of paper, and were made sufficiently transparent by waxing. Any of the more sensitive development papers may be used in the camera for negative making.

Papyrotype, Papyrography, or Papyrotint. Modifications of photo-lithography, in which paper is used as material on which the original transfer is made.

Parabola is the curve described by a moving point, which is always at the same distance from a fixed line, its directrix, that it is from a fixed point, its focus. The chief use in photography of the parabola is in the construction of mirrors or reflectors for artificial light, their value being based on the fact that the rays of a luminous point in the focus of a parabolic mirror will be reflected as a parallel bundle.

Paramidophenol. See AMIDOL.

Paste. See MOUNTANT.

Paste, Encaustic. See ENCAUSTIC PASTE.

Pearlash. A synonym for impure Potassium Carbonate (*q.v.*).

Pellet's Process. See CYANOTYPE.

Pellicle. Literally a thin skin or film, and in this sense applied to the emulsion when the solvents are evaporated. (For the making of pellicular negatives, see NEGATIVES, STRIPPING OF.)

Pencil of Light. A term applied to the rays of light proceeding from any luminous body. When the object is near, the pencil or rays of light are divergent rays; when the object is very distant, the pencils may be considered parallel. A pencil, the rays of which lessen as it proceeds, is said to be convergent.

Perspective is the art of representing solid bodies on a plane surface. It is divided into two branches—linear perspective which shows the apparent forms of objects on the prospective outlines; and aerial perspective, which distinguishes the distance of objects by the relative brilliancy of their colour.

Phenakistoscope. See ZOETROPE.

Phosphorescence. See LUMINOUS PAINT and RADIOGRAPHY.

Phosphorus. P = 31. A non-metallic element widely distributed throughout the animal and vegetable kingdom, but never occurring in the free state. It is insoluble in water, soluble in ether, chloroform, benzine, turpentine, and other oils, and bisulphide of carbon. It is altered by light, and methods rather curious than practical have been based on this fact.

Photoaquatint. See CARBON PRINTING, and for photoaquatint in colours see PHOTOGRAPHY IN NATURAL COLOURS.

Photochromoscope. Synonymous with KROMSKOP.

Photocrayon. Sarony, in 1870, used a paper backing, shaded or hatched with cross lines, and placed under a transparency to simulate a crayon effect.

Photo-Engraving. Numerous processes are in everyday use. See PHOTOGRAVURE, OBERNETTER'S PROCESS, FISH GLUE PROCESS, GALVANOGRAPHY, and DAGUERREOTYPE.

Photofiligrane. See FILIGRANE.

Photogalvanography. See GALVANOGRAPHY.

Photogene. (1) A name applied by Gaudin to a sensitive emulsion. (2) A bichromated gum mixture for the powder process.

Photoglyph. A photo engraving.

Photoglyptie. Synonymous with WOODBURYTYPE.

Photogram. (1) Synonymous with Photograph. (2) A record obtained by Photogrammetry.

Photogrammetry. The art of making surveys or geodetical measurements by the aid of photography. (See CYLINDOGRAPH, and reference to Plane table and Oroheliograph under PANORAMIC CAMERA.) Standard works on Photogrammetry are Dr. C. Koppe's "Die Photogrammetrie," Weimar, 1889; Commander V. Legros' "Elements de Photogrammetrie," Paris, 1892; and Dr. Le Bon's "Les Levers Photographiques," Paris, 1889 (2 vols.).

Photography (*φωτός*, genitive of *φαος* or *φως*, light, and *γράφω*, I draw) is the art of obtaining the representation of objects by the agency of light upon sensitive substances. The following is a short history of the rise and progress of the art:— In the sixteenth century Baptista Porta, a Neapolitan, invented the Camera Obscura (*q.v.*), and this was used to obtain sketches by hand of the objects projected by the lens. In 1777 Scheele, the great chemist, discovered the important fact that chloride of silver blackened in sunlight, the chief action lying in the violet end of the spectrum. In 1802, Thomas Wedgewood, son of the famous potter, published in the "Journal of the Royal Institution" an account of a method of copying paintings on glass, and of making profiles by the agency of light upon nitrate of silver.

In the experiments which are thus described he was assisted by Sir Humphrey Davy. They managed to obtain images upon paper and white leather by means of the solar microscope, but were unable to fix them; therefore the image was soon obliterated by the darkening of the whole surface. In 1814 Nicéphore de Niépce commenced a series of experiments, but although he managed to obtain images upon a bituminous film, the process was impracticable for ordinary purposes, from the inordinate exposure (several hours) which was required. He then, in partnership with Daguerre, carried on his experiments; but it was not until 1839, six years after Niépce's death, that Daguerre communicated to the Académie des Sciences at Paris the process so well known as Daguerreotype. Early in 1839 Fox Talbot, previous to Daguerre's communications, announced to the Royal Society a method of "photogenic drawing," in which pictures were produced upon paper prepared with chloride of silver. Fox Talbot effected the fixation of these pictures by saturated solutions of chloride of sodium and bromide of potassium. The use of hyposulphite of soda, however, soon became general, Sir Humphrey Davy having, in 1821, published the action of this salt upon the salts of silver. In 1841 Fox Talbot patented his process called Talbotype or Calotype (*q.v.*). To the Rev. J. B. Reade is due the credit of first recommending a developer, although Fox Talbot was the first to use a restrainer. Up to this point paper negatives alone were in use; but in 1848 a cousin of the original Niépce, M. Niépce de St. Victor, proposed the use of albumen on glass as a vehicle for the sensitive salts of silver. These plates, however, were very insensitive, and numerous substances, such as starch, gelatine, gum, etc., were proposed; none, however, were successful. In 1851 Le Gray, of Paris, and Scott Archer, of London, proposed the use of collodion, the latter publishing such a complete description of the wet collodion process that but little improvement has ever been effected. A great disadvantage, however, of this process was the necessity of exposing the film whilst wet, necessitating the use of bulky and heavy impedimenta for the landscape photographer, in the shape of dark tent, etc. It was then discovered that the application of certain organic substances to the washed film would allow of the plates being used in the dry state. In 1862 Major Russell discovered the use of alkaline

pyrogallol as a developer, and his accidental discovery of the restraining power of the soluble bromides gave the first impetus to the manufacture of bromide of silver films, which could be exposed dry. In 1864 Messrs. Sayce and Bolton described the process of making collodion emulsion, which was poured upon glass plates, and then washed to free from inert salts. In 1874 it was discovered that the emulsion might be washed previous to use, and in 1871 Dr. R. L. Maddox published a notice of a gelatine emulsion, and from that, in 1878, Mr. Charles Bennet realised the capabilities of the process and power of increasing the sensitiveness by digestion at high temperatures. Since then the process has been made more rapid, the ammonia process becoming known, rapid films and plates being of every-day occurrence. During the last few years film photography has become quite a standard process. Of the application of photography in everyday life it would be almost impossible to treat; the various mechanical printing methods, the use of photography for supplying pictures for illustrated papers, catalogues, price lists, etc., are too well known to need any description. Its uses in astronomy for making charts of the celestial bodies, in the interests of justice for the detection of criminals, for the purposes of experimental warfare and as an assistant in scientific research, for sounding the depths of the sea and for pathological study in medicine, seem almost unlimited.

Photography in Natural Colours. The methods of reproducing objects in the colours of nature may practically be divided into three heads: (1) by the use of subchloride of silver; (2) by Lippmann's process, or the production of interference waves; and (3) by the three-colour sensation process. The first process is that which was experimentally studied by Seebeck, Becquerel, Niepce de St. Victor, Poitevin, Kopp, etc., and practically consists of exposing subchloride of silver to the coloured rays, either of the spectrum or beneath a coloured glass positive, etc. The disadvantage of this process is that there are no very satisfactory means of fixing the colours which are thus obtained, and consequently the results will not bear a prolonged exposure to light. Some of the most successful results can be obtained by using commercial gelatino- or collodio-chloride paper, and treating it as suggested by Kopp. The paper should be exposed to

diffused light whilst immersed in the following solution till it turns blue-green :—

Chloride of zinc	2 grs.
Sulphuric acid	2 drops.
Water	5 ozs.

The paper can then be well washed and dried between blotting paper and kept in the dark. It will keep in this state for some time. The following solution should be prepared :—

Potassium bichromate (pure)	$\frac{1}{2}$ oz.
Cupric sulphate (pure)	$\frac{1}{2}$,,
Water	$3\frac{1}{2}$ ozs.

If necessary the ingredients should be dissolved with heat. Mercurous nitrate, $\frac{1}{2}$ oz., should also be dissolved in as small a quantity of water, acidulated with nitric acid, as possible; the

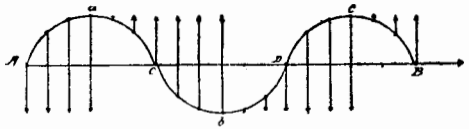


Fig. 89.

two solutions mixed, both being at 212° F.; the mixture filtered, and the total bulk of the solution brought up to 100 c.cm. The blue-green paper is bathed in this for a minute, well drained, and then immersed in a 3 per cent. solution of zinc chloride or nitrite of soda till it turns blue again, then blotted off between blotting paper, and exposed whilst damp under the coloured object. After exposure it will be seen that the green and yellow will be visible, but the other colours require developing, and for this the green and yellow must be covered with a varnish, and then the paper immersed in a dilute 2 per cent. solution of sulphuric acid. In order to fix the print to some extent, it should be immersed in the mercury bath, then into the chloride of zinc; wash and dry between blotting paper, and then coat with a solution of gum arabic with 5 per cent. of sulphuric acid added. The explanation of the theory of the formation of these colours is, according to Zenker, precisely the same as that involved in the following process :—2. The interference method of Lippmann

was announced by him in February 1891. This is founded on the theory of stationary waves, propounded by Zenker and Wiener. Let us assume *a b c d*, fig. 90, to be a ray of light proceeding in the direction of *a d*, and the small dots to be the particles of ether vibrating or in rapid motion, and on its reaching *d* it meets with some reflecting surface which sends the ray back. We shall have the second ray proceeding along the same line but in the opposite phase, and at *b* and *c* the pull or vibratory motion of the ether particle will be equal in both directions, as shown by the small arrows; so that at these points there will be no light, whilst in the loops in between there will be increased light. Now in fig. 89 we see a ray of light proceeding in the direction AB; and the arrows represent the vibratory motion of the particles of ether. AD or CB is a complete wave length. Now by referring to fig. 90 it is obvious that the point *b* is exactly half a wave-length from *a* and *c*, and *c* exactly half a

Fig. 90.

wave-length from *b* and *d*; so that we get no light at points which are exactly half a wave-length apart. If a ray of light thus treated passed through a film of sensitive material, it is obvious that where we get no light we shall have no chemical action, and consequently no deposit of silver; whilst in between these places we shall get a deposit; and a film of this character, after development, will only reflect that light which has a wave-length just double the distance between the reflecting particles of silver; consequently we get a reproduction of the colour which caused this deposit. Lippmann used first of all Taupenot's albumen process, which consists practically of using iodide of silver suspended in albumen; later he used bromide of silver suspended in albumen; but he met with one great difficulty, and one which every practical photographer meets with in ordinary practice, and, that is that the silver salts are more sensitive to the blue and violet than to any other colour, or, to put it more popularly, the photographic plate sees the blue and violet as the brightest part of the spectrum; therefore he exposed his spectrum in sections,

using a deep orange-red screen and giving one hour's exposure to get the red, and then five to ten minutes for green with a yellow screen, and a very pale yellow screen and twenty to thirty seconds' exposure for the blue. After exposure the plates were developed with pyrogallol, and fixed, washed and dried. Naturally, when the accounts of Lippmann's experiments were published, and the results confirmed, many attempted to do the same thing. Kroné of Dresden was one of the first, and he used albumen plates, but instead of mercury he used black velvet. M. de St. Florent, in 1892, exposed an ordinary gelatino-bromide plate with an orange screen under a coloured transparency, and then, without developing, fixed and washed it; and it was said this plate whilst damp reproduced the colours. In 1892 MM. Auguste and Louis Lumière showed at a meeting of the Sociéte des Sciences Industrielles of Lyons some spectra produced by Lippmann's method which were superior in brilliancy. These were made on gelatino-bromide plates. In 1892 Valenta published some experiments on the preparation of such an emulsion, and a year later the brothers Lumière published their formula. Valenta's process is as follows:—

A.		B.	
Gelatine	10 gm.	Gelatine	20 gm.
Water	300 c.cm.	Water	300 c.cm.
Silver nitrate ...	6 gm.	Potassium bromide	5 gm.

The solutions should be cooled to 30°-35° C., and then solution A gradually added to solution B, with constant stirring, and a faint opalescent or almost transparent liquid is obtained, which is immediately poured into about 1 litre of 90 per cent. alcohol, and well stirred till the gelatine emulsion clings to the glass rod. It is then cut up into small pieces, washed in running water for a short time, and made up to the original bulk (600 c.cm.) with water, melted and filtered, for which purpose Valenta strongly recommends fine Italian hemp, well washed with caustic potash and water or glass wool. After filtration the emulsion is colour-sensitised with some dye and coated. Valenta states that, after the emulsion has set, the plates should be soaked in dilute alcohol, and rocked till the small air bubbles, which adhere very firmly to the film, are no longer visible. They should then be washed under a tap, and dried. To render these plates

colour-sensitive alcoholic solution of cyanine 1 : 500 is used, and either 1-2 c.cm. of this is added to every 100 c.cm. of emulsion before coating, or the plates can be bathed after coating in a bath of 1-5 c.cm. of above solution in 100 c.cm. of water. Better results are obtained by mixing cyanine and erythrosin as follows: Cyanine solution (1 : 500) 4 c.cm., erythrosin solution (1 : 500) 2 c.cm.; and of this mixture 1-2 c.cm. can be added to every 100 c.cm. of emulsion. Vogel's azaline may be used in the same proportion. The silver salts of eosine have been very successful in reproducing mixed colours. Valenta gives the two following chloro-bromide emulsions as also giving good results, particularly with the less refrangible rays, but cannot state which is the better:—

I.

A.		B.	
Water	200 c.cm.	Water	15 c.cm.
Gelatine ...	10 gm.	Silver nitrate ...	1·5 gm.

C.

Water	15 c.cm.
Potassium bromide	0·35 gm.
Sodium chloride	0·35 ,,

A is divided into two parts, one poured into B, the other into C, well mixed, and then B added to C at 35°-40° C.

II.

A.

Water	300 c.cm.
Gelatine	10 gm.
Silver nitrate	6 ,,

B.

Water	300 c.cm.
Gelatine	20 gm.
Potassium bromide	2·4 ,,
Sodium chloride	1·5 ,,

Mixing temperature, 35° C.

The exposure for sunlight for the bromide plates with a width of 0·3 to 0·5 mm. slit is one minute, but with a wide open slit and

a condensing lens ten to twenty seconds. For developing Valenta used—

A.

Pyrogallol	4 gm.
Water	400 „
Nitric acid	6 drops.

B.

Potassium bromide...	10 gm.
Water	400 „
Ammonium sulphite	12 „
Ammonia (sp. gr. 0·91)	14 c.cm.

For 2-3 parts of B are mixed with 1 part of A and 12-14 parts water. Valenta has also used the following modification of Lumière s developer:—

A.

Water	100 c.cm.
Pyrogallol	1 gm.

B.

Water	200 c.cm.
Potassium bromide	20 gm.
Ammonia (sp. gr. 0·96 at 18° C.)	67 c.cm.

For use mix

Solution A	10 c.cm.
„ B	20 „
Water	70 „

For chloride bromide plates these developers should be diluted to double the volume. For fixing, a 4 or 5 per cent. solution of potassium cyanide is the best. Valenta points out that under-exposed and under-developed photochromes thus prepared can be intensified with mercuric chloride, followed by amidol and sulphite. Lippmann presented to the Académie des Sciences de Paris on October 24th, 1892, some good reproductions of the solar spectrum on bichromated albumen and gelatine; these only show the colours when wet. The albumen must first be coagulated with mercuric chloride solution, then well washed before treating with bichromate of potash. Lippmann's theory of the formation of these colours is that in the chromated film

series of maxima and minima of interference are formed. The maxima alone make the film insoluble, and in treating the plates with water a laminar structure is formed which is partly saturated with water and partly dry. The index of refraction of the laminæ varies periodically, and thus gives rise to the interference phenomena and the colours. St. Florent is stated to have obtained photochromes or colour photographs by treating a plate coated with a thin gelatine film with a solution of—

Water	1,000 c.cm.
Ferric chloride	10 gm.
Citric acid	5 „

and then exposing under a coloured glass transparency. Valenta writes upon the preparation of emulsions for Lippmann's process: "The drawback to plates prepared by the Lumière or Valenta process for colour photographs is that the means taken to secure the grain being sufficiently fine results in the plates being very slow. So slow is this emulsion that a plate exposed in a sensitometer for five minutes to a light of fifty-candle power scarcely shows the first number. Valenta finds, however, that the addition of one gramme of sodium sulphite to 300 c.cm. of emulsion with subsequent heating at 38° C. results in five minutes in an emulsion showing the fourth number on the sensitometer, or the eighteenth number in an hour. Krone has formulated the following conditions or rules, which must be complied with for the successful working of Lippmann's process. (1) It is essential that the sensitive film be homogeneous, and that a reflecting surface be in contact with the film, the rays from which reflecting surface must interfere with the direct rays and thus produce stagnant or stationary waves in the film. (2) If the thickness of the film exceeds a certain thickness, the colours are not obtained, or not the correct colours. Where the regular film encloses a particle of dust this appears particularly noticeable. (3) The faithful reproduction and appearance of the colours in correct position is not absolute, but depends upon the following without exception:—(*a*) an absolutely accurate concurrence in the film of the finest divided silver haloid with the colour sensitiser and the correct amount of the latter; (*b*) on the temperature in drying the film; (*c*) on the duration of exposure; (*d*) on the development. It may thus happen that with less

favourable concurrence of the above-mentioned factors, green may appear in the place of blue, and yellow in the place of red. This is also the reason why many appearances of anomalous colour-dispersion appear, and that many colours are wanting, etc. (4) An increased or diminished dampness of the results alters the colours. (5) The altitude of the sun at the time of the exposure has considerable influence on the results, as shortly before sunset or after sunrise, although all the colours may appear vigorous in the spectroscope, yet the more refrangible rays show much less actinic power, so that finally, with prolonged exposure—for instance, shortly before sunset—the violet, blue, and ultra-violet are not reproduced. The ultra-violet first disappears, then the blue, the place of the latter being taken up by a prolongation of the green, or shows a steely-grey colour. (6) With sufficiently long exposure the, to the eye invisible, infra-red

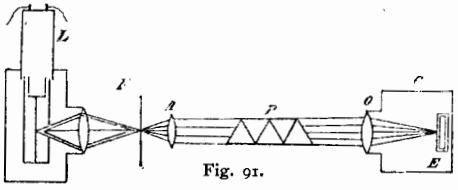


Fig. 91.

(beyond the line A) appears as a dark purple, the ultra-violet (beyond H) sinking into yellowish rose-red lavender. (7) In the ultra-violet (beyond H) there appears, when an electric arc light is used, a very intense light maximum which is separated from the H group by a group of colourless carbon lines, this maximum being visually recognised, and with sufficient exposure, is of a deeper and more intense dark blue than the indigo blue of the solar spectrum. (8) The actinic intensity of the electric arc light, at a distance of 36 cm. from the slit of the spectroscope to the positive pole of the carbons, is to direct sunlight (midday, April, clear sky) as 1 : 38 to 1 : 40. (9) Only by using Lippmann's mercury mirror, when the requirements of rule 3 are complied with, is it possible to obtain the photographic colour results corresponding to the visual spectrum and the colours in their correct places. Reflected light acts always more strongly than direct light, and Krone recommended in the first place the use of

a metallic mirror in order to avoid the formation of two spectrum images which would give rise to the formation of mixed colours in the pictures. Fig. 91 shows Lippmann's arrangement for obtaining a spectrum. L is an electric arc lamp, the rays from which are condensed by a lens upon F which is an opaque screen with a narrow slit in it. A is a convergent lens which renders the rays parallel from whence they strike the prisms P, and are formed into an image by O, the lens of the camera C, on E, the dark slide of particular form. To view these photographs in natural colours it is necessary to cement them to a prism of small angle and back them with black velvet or black varnish. The method of showing them by artificial light being sketched in fig. 92, in which A is the lantern, C the condensers, sending a beam of parallel light on to the picture whence it is reflected and taken up by a projecting lens and thrown on the screen.

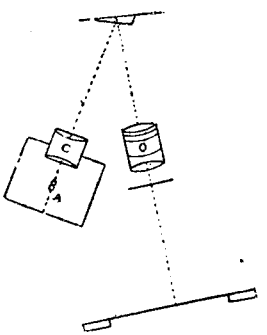


Fig. 92.

The Three Colour-sensation process. This is based upon the theory of colour sensation first promulgated by Young, Helmholtz, and Clerk Maxwell, which assumes that, although we have many spectrum tints, yet our eyes are provided with three sets of nerve fibrils, one conveying the sensation of red, another of blue, and another of green, the other and intermediate colours being excited by a mixture of the red, green, and blue in varying proportions. An early suggestion was made by Collen, in 1865, and practically tried by L. Ducos du Hauron and Cros; also later by Ives, Vogel, Kurtz, and others. The subject may well be divided into two heads, first, the production of lantern slides or transparencies, and, secondly, the production of prints. For the production of lantern slides the process is by no means difficult. We require three negatives, *a* representing the red sensation, *b* the green sensation, and *c* the blue sensation. For the red sensation a red sensitive orthochromatic plate should be used, or an ordinary plate which has been sensitised by a solution of cyanine, one-third of a grain in an ounce of absolute alcohol; the plate should be flowed over

with this, dried in absolute darkness, then immersed in distilled water for two or three minutes, and again dried in the dark. For the coloured screen to cut off the blue rays a piece of orange-red glass should be used. For the green sensation a commercial isochromatic plate should be used, and two thicknesses of chromium green glass. For the blue sensation an ordinary plate with two thicknesses of cobalt blue glass should be used. From these negatives, lantern slides should be made in the ordinary way, and projected by means of a triple lantern. The transparency representing the red sensation should be projected through the glass used to take it, that of the green sensation through one thickness of the green glass, and that of the blue sensation through one thickness of the blue-violet glass. If the images are accurately superimposed, the result will be a reproduction of the objects in their colours. Mr. Ives' photochromoscope, or kromskop, is a device for simultaneously viewing the three positives, each illuminated by its appropriate colour. The group of three positives is called a chromogramme or kromogram. For the production of prints a slightly different procedure is required. Three negatives are obtained in somewhat similar fashion, but in this case we use red, yellow, and blue as the three printing colours. As in all photomechanical printing processes, like collotype, which we will take as an example, it is the shadows which print. If a collotype plate is exposed under a negative, it will be found that, after washing, only the shadows or those portions of the film acted upon by light will take the ink, the high lights where the film was protected refusing to take the greasy ink. The result of this is that we use that negative for making the printing plate, in which the particular colour corresponding to the ink has not acted: for instance, the collotype plate made from the red negative, or the negative taken through the red screen, is inked with blue ink; the plate from the negative taken with the green screen is inked with red ink; and the plate from the negative taken with the blue-violet screen is inked with yellow. The inks used vary slightly according to the recommendations of authorities, but cadmium or chromium yellow, carmine or madder lake, and prussian or ultramarine blue may be taken. The yellow is printed first, then the red, and finally the blue. In the production of prints by the aid of process blocks, one

line screens only are used for each block, the said lines crossing each other at angles of 30°. Whilst from the difficulties of obtaining perfect printing inks corresponding exactly to the spectroscopic absorption curves required, it is at present impossible to obtain an absolutely faithful reproduction of every tint. There is no difficulty in making lantern slides of still more faithful accordance with the original, nor is the work beyond the ordinary scope of an amateur. There are many interesting developments of the three-colour method, among which may be mentioned the following:—Cros, Lumière Brothers, and others have suggested the bleaching out of the pigments or colours of a compound film, each colour light tending especially to bleach out tints complementary to its own, and on this Wiener has based a theory that coloured radiations naturally tend to produce their own colours, and he has applied this doctrine to an explanation of the protective colour adaptation of animals. By successively printing in the three colours on the same sheet by the gum aquatint process (see p. 117), Watzek has obtained very fine results, and this method of producing photographs in colour appears one of the most promising from the artistic point of view. An old method (Ducos du Hauron, 1868) has recently been revived, in which the original negative is taken under a screen covered with transparent lines in three colours, and a monochrome print from the negative is viewed in connection with a similar coloured screen. M. Louis Ducos du Hauron has recently devised a two-colour system of heliochromy, the novelty consisting of leaving out the yellow image and only superimposing the red and blue. The full colour effect does not show in bright white light, a yellowish light being best, although M. Ducos du Hauron contends that the yellowish illumination is not essential. M. Chassagne's method of treating a special monochrome by three coloured liquids in succession is, at the time we write, hardly ripe for criticism.

Photogravure. A general term equivalent to photo-engraving, but most usually applied to the intaglio methods. There are several methods of working, but the most popular, and the easiest for an amateur, is that known as Klic's. The apparatus necessary for this is, first, a dusting box, which should be at least three times the area on all sides of the largest plate to be coated. This

is provided with a narrow door at one side. The box should be mounted on trunnions or side pivots, so as to swing freely. Raw Syrian asphalt, finely powdered, or a mixture of asphalt and resin, is also required. Finely polished copper plates and perchloride of iron; this latter should be solid, and not the acid solution of the chemist. The perchloride is dissolved in water by adding one-third the quantity of distilled water to it and allowing it to dissolve as much as possible, and then diluting it with distilled water till it marks 45° Baume, 40°, 38°, 35°, and 27° Baume. These five solutions are carefully prepared of the above strength, or, in the absence of a hydrometer, the solutions may be made up of the percentage strengths which correspond to the above, 47, 41, 38, 35, and 27. These must be the percentage solutions, and can be made as follows, assuming that we require 10 ozs. of solution:—

1. Perchloride of iron, 2,256 grs. Dist. water to make 10 ozs.
2. ,, 1,968 ,, ,, ,, ,,
3. ,, 1,824 ,, ,, ,, ,,
4 ,, 1,680 ,, ,, ,, ,,
5. ,, 1,296 ,, ,, ,, ,,

We require a transparency of the negative to be reproduced. This transparency should be made on an ordinary dry plate, and should be soft and delicate, more approaching the ordinary negative than lantern-slide characters. From this transparency we must prepare a negative in carbon. Either transparency or standard brown may be used. The negative must be thin, and quite free from any deposit in the deepest shadows. The dusting box must be lined with varnished paper, and the asphalt sifted through fine linen. The copper plates should be obtained already bevelled and polished, and merely require cleaning with weak caustic potash solution and then with ammonia, and washing, whitening, rinsing and drying. The plates are now ready for graining. To do this the box, containing from one-half to a pound of powder, is rather slowly revolved for about three times, and then brought to a stand with the door at the bottom. It is allowed to rest for one minute, and then the copper plate, placed on a larger piece of plate-glass, is placed on a box or piece of wood on the bottom of the box inside, the door closed, and the dust allowed to settle for about five minutes, and then taken out and examined to see

whether enough dust or grain is on it. How much grain to lay is a matter of experience. A dark subject requires not only more grain, but a coarser grain, than a lighter subject. For ordinary subjects the best way is to allow the dust to settle for about one minute, and then to leave the copper plate in for ten minutes. Having grained the plate, the next thing is to fix the grain. This is done by heat, and the best heater is a proper copper plate heater. Failing this, an ordinary gas stove may be used, or merely a sheet of iron placed over a gas stove. The plate is now placed on the hot plate till the grain melts and adheres firmly to the plate. The sign of the grain being fixed is a peculiar bloom or steely colour, which appears, when looking at the plate, at an angle of about 30°. When the grain is fixed the plate should be allowed to spontaneously cool; and in this condition the grain will not rub off, and the plate may be kept some time. The carbon negative is the next thing to be prepared, and this is printed in the usual way, a safe edge being used. As we wish the margins to be white, it is necessary to use some protecting covering; and the simplest method is to cut a sheet of orange paper the full size of the negative. Out of the middle of this cut a piece the exact size of the desired picture, and from the margin cut another eighth of an inch all round; and, after the real exposure has been given, cover the exposed portion with the central cut-out and the margin with the edge. This is best done by pasting the mask and margin on a piece of glass the exact size of the negative. This ensures an insoluble strip of carbon tissue all round the picture. The carbon negative is now developed on the copper plate in the usual way, and when developed and fixed is rinsed with water, then with a mixture of equal parts of methylated spirit and water, and finally with spirit alone till all the water is out of the film. The plate, both margins and back, is covered with black varnish, allowed to dry, and it is ready for etching. The plate is now placed in No. 1 bath of perchloride, and left for one minute; then into No. 2, where it is left for two or three minutes; then into No. 3 for about three minutes; then into No. 4 for three minutes; and, finally, into No. 5 till the highest lights on the copper are just darkened, and half a minute longer. The plate is now dropped into a 5 per cent. solution of caustic potash, the resist or carbon cleared off, and then the varnish, with turpentine and benzole,

the plate well washed and polished with whitening, when it is ready for printing from in the copperplate press. Very full working directions are to be found in Mr. Denison's "Treatise on Photogravure," published by Iliffe and Son.

Photo-Hyalography. See HYALOGRAPHY.

Photo-Lithography. One of the most important of all photo-mechanical methods, in which a print is obtained from a negative and transferred to lithographic stone, and printed from in the ordinary way; there are also direct methods on the stone, when the image is generally obtained by a method corresponding to the first stages of the Fish Glue Process (*q.v.*). Transfer methods depend on the principles explained under COLLOTYPE. The transfer may be made from a collotype surface to the stone; but more usually the equivalent of a collotype surface is made on paper, and then put down on the stone.

Photometer, Photometry. The simplest form of photometer is an upright rod; the two lights to be compared being so adjusted that they throw shadows of equal intensity on a screen; the luminosity of the two being now in inverse relation to the square of the distance.

Photo-Micrography. The art of obtaining photographic enlargements of microscopic objects by the aid of the microscope. The chief advantage of photo-micrography is that the results obtained are free from much of the personal element which is always present with hand-drawn diagrams. And again, although the successful results are often extremely difficult and tedious to obtain, yet when obtained they are far superior to anything that can be done by hand. Any good firm microscope stand may be employed, and the draw-tube should be lined with black velvet or cloth—not the usual black matt varnish, which soon wears off. Several lenses will be required, and these should be of low or narrow-angle, and usually a 2-, 1-, ½-, and ¼-in. will be found sufficient, and a ¼-in. wide-angle also. These should be obtained from those makers who now manufacture lenses specially for photo-micrography. A large bull's-eye condenser and a parabolic reflector are also required. The majority of beginners will most likely confine themselves to small plates, the lantern size $3\frac{1}{4} \times 3\frac{1}{4}$ being the most usual. Special forms of light

cameras are now made for this size for use with the eye-piece, and from practical experience the beginner is recommended to always use the eye-piece till he has become more proficient. The camera, however, must have a sufficient pull of bellows, about 12 or 14 inches. For focussing, the usual ground glass is utterly useless, the only method being to use a piece of patent plate which has lines drawn upon one surface with a diamond; and when these lines and the image are both in focus with a compound focusser, the correct focus is obtained. Or another method consists of moving the head from side to side, and when the image moves with the head the object is not in focus; when, however, it remains stationary the focus is correct. The method

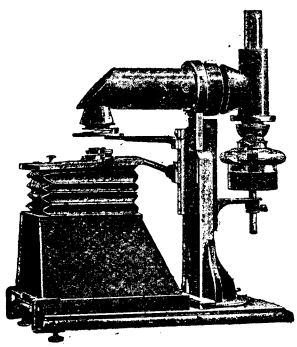


Fig. 93.

of attachment of the microscope to the camera differs much,—some employ loosely fitting black velvet sleeves; others employ a brass connection, into which the microscope tube either screws or merely slides. In some cases, especially those in which yellow predominates, isochromatic plates will be found the best. In others, where orange or orange-red is the prevailing colour, then plates specially sensitised for these rays will be found most effectual. If the illuminant used is gas or lamp light, then the exposure may be considerably shortened by always using isochromatic plates as these plates are much more sensitive to such light than ordinary plates. The rapidity of the plate is not a subject of much consequence, as equally good results have been obtained by eminent workers on both slow and rapid makes. A

convenient photomicrographic device for low powers, and also available for sketching, is that of Edinger, recently described in *The Amateur Photographer*. The sketch (fig. 93) shows the device as used with the camera. The flame of the lamp is, of course, screened by an opaque outer chimney, having an aperture corresponding to the condensing lens in the horizontal tube; a reflector at the other end of the tube throws the light down on the object, which is on an independent stage, and the microscopic objective is mounted in the camera. When an image is to be projected on the base-board for sketching, the lower arm carries the objective.

Photo-Sculpture. See SCULPTURE, PHOTOGRAPHIC.

Phototype. A mechanical printing process in which a gelatine film itself is used to print from. (See COLLOTYPE.)

Pigeon Post. An ingenious application of micro-photography, carried out by M. Dagron, when Paris was besieged by the Germans. Messages to those outside were set up in type and reduced by photography so considerably, that a bundle of films weighing 15 grs., and forming the load for a pigeon, contained over 80,000 words. On the safe arrival of a pigeon at its destination, the messages were transcribed and forwarded.

Pigment Process. See CARBON PROCESS and ARTIGUE'S PROCESS.

Pinhole Photography. Of late years the possibility of taking passable negatives without the use of an ordinary camera and lens has become an established fact. For this purpose any rectangular box which is absolutely light-tight will do. In one end insert a very thin plate of metal in which a minute hole has been made with the point of a needle, and at the other end place the sensitive plate, keeping it in its place by means of a clip or other simple arrangement. A prolonged exposure is required, about twenty or thirty times the ordinary one for any given subject. No focussing is required, as the image is always fairly sharp, no matter what distance the plate is from the hole. The larger the plate the wider the angle, and the greater the distance the larger the image. Mr. Alfred Watkins has calculated out a table as a guide to the best results, and suggests that, as

ordinary sewing needles are made to standard sizes, they should be used to punch the holes in the metal plate or card.

No. of Needle.	Diameter.	Distance to Plate.	Ratio.	Calculate as
1	$\frac{1}{22}$ inch	32 inches	$\frac{1}{700}$	*f*/70
2	$\frac{1}{23}$,,	28 ,,	$\frac{1}{640}$	*f*/64
3	$\frac{1}{26}$,,	23 ,,	$\frac{1}{600}$	*f*/60
4	$\frac{1}{28}$,,	20 ,,	$\frac{1}{560}$	*f*/56
5	$\frac{1}{31}$,,	15 ,,	$\frac{1}{460}$	*f*/46
6	$\frac{1}{34}$,,	13 ,,	$\frac{1}{440}$	*f*/44
7	$\frac{1}{39}$,,	10 ,,	$\frac{1}{390}$	*f*/39
8	$\frac{1}{44}$,,	8 ,,	$\frac{1}{350}$	*f*/35
9	$\frac{1}{49}$,,	6 ,,	$\frac{1}{290}$	*f*/29
10	$\frac{1}{54}$,,	5 ,,	$\frac{1}{270}$	*f*/27 and multiply by 100.

Pinholes. Minute transparent spots making their appearance on the plate in the fixing bath. They are chiefly due to air bubbles, or particles of dust adhering to the film whilst in the developer, and thus preventing the action of the developer on the film at these spots. To obviate these the film should be brushed with a soft camel's-hair brush whilst in the developer, but where pinholes are in existence recourse must be had to retouching or painting them out with some non-actinic colour.

Pizzighelli's Printing-out Platinotype Process. Rives or Saxe paper may be used, either glossy or with matt surface. The following solutions are required:—

No. 1 Solution, Gum Arabic.

Gum arabic (finest white lumps)	770 grs.
Distilled water	27 drms.

No. 2 Solution, Arrowroot.

Arrowroot	30 grs.
Distilled water	27 drms.

Mix the arrowroot into a paste with a little water, add to the remainder of distilled water whilst boiling, and keep the tempera-

ture up for five or ten minutes. No. 1 solution gives the best effects.

No. 3 Solution, Ammonia Ferric Oxalate.

Ferric oxalate	308 grs.
Oxalic acid	8 ,,
Ammonium oxalate	288 or 308 ,,
Distilled water	27 drms.

No. 4 Solution, Sodium Ferric Oxalate.

Ferric oxalate	308 grs.
Oxalic acid	8 ,,
Sodium oxalate	230 to 290 ,,
Distilled water	27 drms.

The exact amount of sodium or ammonium oxalate to use is found by the formation of a brilliant emerald green colour, turning slightly darker as more of the salt is added. The addition of the salt must be stopped at this stage. After shaking slightly, filter the solutions, and preserve from actinic light.

No. 5, Sensitising Liquid.

Solution of chloro-platinite of potash (1 in 6)	408 mins.
,, No. 1	391 ,,
,, ,, 3	374 ,,

Or No. 6.

Solution of chloro-platinite of potash (1 in 6)	24 mins.
,, No. 4	391 ,,
,, ,, 1	374 ,,

Or No. 7.

Chloro-platinite of potash	24 grs.
Sodium oxalate	24 ,,
Ferric oxalate	31 ,,
Oxalic acid	3 ,,
Gum arabic	52 ,,
Distilled water, to make	480 mins.

The mixtures are well stirred, filtered through muslin, and kept from actinic light. No. 5 gives bluish black, No. 6 brownish black tones. The coating, drying, and storing of the paper are

precisely the same as for the original process patented by Willis. Chlorate of potash may be added in the same way, to increase contrast. About 90 minims of sensitising liquid are required for a sheet 10 by 8. The printing may be carried on until the image has appeared in all its parts, and should be no darker when printed than required. When finished, the print is washed in acidified water, as recommended for the old process, and finished in the ordinary way. A second method of printing is to print till the general details are out, but all the half-tones are wanting. The print is then taken from the frame and put on one side, when the action set up by the light continues, and in from a half to two hours the print is finished, and can be treated as above in acidified water, or the incomplete picture may be developed upon a cold dilute solution of carbonate of soda of the following strength :—

Carbonate of soda	...	...	38 grs. or 2 grms.
Distilled water	...	...	27 drms. ,, 150 c.cm.

Immerse the print in this till sufficiently developed. A third method of printing is to expose till only the principal details are visible, and develop, as in the old process, upon a hot solution of potassium oxalate.

Plates, Sizes of. See SIZES, PHOTOGRAPHIC.

Platino-bromide. A somewhat misleading term occasionally applied to developed silver prints.

Platinotype. The basis on which this process is founded is the reduction of ferric oxalate by the action of light into ferrous oxalate, and the reduction of a platinum salt by the ferrous oxalate, when wetted with a suitable agent. The following are concise directions for the process:—Paper of good strong quality, even in texture and white in colour, should be chosen, and may be sized in one of the following baths:—Soak 150 grs. of Nelson's X opaque gelatine in 30 ozs. of water for half an hour, and heat in a water bath at a temperature of 140° F. to dissolve it. Add 45 grs. of powdered alum and 7 ozs. methylated spirit, filter through muslin, and put in large flat dish. Thoroughly immerse the paper bodily in this solution, taking care to break all adherent bubbles; the paper should be

allowed to soak for three minutes, and then hung up by clips to dry. The drying should be as rapid as possible, and a second bath for the same time should be given, and the paper hung up by the opposite corners. A sizing of gelatine tends to a bluish black tone; arrowroot and starch to a brownish tinge. If arrowroot or starch be used, the following bath may be prepared:— Rub 150 grs. of arrowroot or pure starch powder into a cream with a little water, and then pour gradually and with constant stirring into 30 ozs. of boiling water, and boil for ten minutes; then add 7 ozs. methylated spirit, and allow to cool. The following are Pizzighelli and Hübl's formulæ for sensitising the paper:—

Solution of Ferric Oxalate.

Ferric oxalate	120 grs.
Distilled water	1 oz.
Oxalic acid	8 grs.

No actinic light must be allowed to gain access to this solution, or the ferric will be reduced to ferrous salt.

Solution for Increasing Contrast.

Solution of ferric oxalate	1 oz.
Chlorate of potash	2 grs.

The same care must be exercised in the keeping of this as of the former solution.

Solution of Chloro-Platinite of Potassium.

Chloro-platinite of potassium	80 grs.
Distilled water	1 oz.

Sensitising Solutions.

No. 1.

Sol. chloro-plat. of potassium	24 drms.
„ ferric oxalate	22 „
Distilled water	4 „

A normal solution, working well and giving deep blacks.

No. 2.

Sol. chloro-plat. potass.	...	...	...	24 drms.
„ ferric oxalate	...	...	...	18 „
Sol. chlorate potash (contrast sol.)			...	4 „
Distilled water	...	...	...	4 „

This gives brilliant prints.

No. 3.

Sol. chloro-plat. potass.	...	...	...	24 drms.
„ pot. chlor. (contrast sol.)			...	4 „
Distilled water	...	...	...	4 „

This is a solution for weak negatives. Chloro-platinite of potash when obtained commercially should be tested as follows:—(1) 1 drm. of the salt should be soluble in 6 drms. of distilled water. (2) The solution should not be acid. This solution will keep unaltered by light for an almost indefinite period. Very feeble light must be used for coating the paper. To keep the paper flat whilst coating, the edges should be turned underneath a plate of glass placed upon a table; for larger pieces the paper can be easily clipped to glass plate by wooden clips, or it can be pinned at the corners by drawing pins. For coating a sheet of paper 8 by 10 ins., 30 minims of sensitiser are required, which should be poured into the middle of paper and spread over the surface with a uniform circular motion, by means of a pad composed of a tuft of cotton-wool enclosed in a piece of fine washed muslin. The rubbing should be continued gently for at least three or four minutes. As soon as coated, the sheet should be hung up by two corners to dry, and as soon as the surface moisture has disappeared, the paper should be carefully and quickly dried over a gas burner, or before a stove or fire. The whole success of the process lies in this stage—the drying of the paper; the paper must be absolutely dry. This point is known from the change in colour from lemon to an orange colour, and by the crackle of the paper. Care should be taken not to scorch the paper, or fog will be the result. Between the coating and drying about five minutes must be allowed to elapse in summer and eight or nine minutes in winter. The exposure required for the paper is about one-third of that required for a silver print from the same negative. Absolute dryness, both in the keeping before, during, and after exposure is a *sine quâ non;* the slightest trace

of moisture immediately renders the paper useless. It should be stored in tubes in which chloride of calcium (anhydrous) is kept to absorb the moisture. The image on the paper is but faintly visible, and requires a developer to bring it out in all its beauty. This is made as follows:—

Oxalate of potash	130 grs.
Distilled water	1 oz.

This solution may be kept as a stock solution, and when required for use must be heated to a temperature of 170° to 180° F. Development is effected by passing the print face downwards over the surface of the solution, and allowing it to remain for two or three seconds; the developed print should be passed at once into a bath of hydrochloric acid 1 oz., water 60 ozs., and allowed to remain for ten minutes; it should be then passed into another bath for the same period, and lastly into a third; it can be then washed, dried, and mounted in the usual way. The developing solution may be used over and over again. For over-exposed prints solution at 100° F. can be used; for under-exposed over 180° F. may be used with advantage.

Warm Tones with Platinum Prints. The Platinotype Company issue a paper which gives a sepia tinge, which perhaps owes its colour to mercuric and cupric chlorides. The addition of a few drops of solution of these chlorides to the developer materially alters the colour of the image. Warmer tones may be obtained by the following process. The following solutions are required:—

Solution No. 1.

Oxalate of potash	463 grs.
Oxalic acid	15 „
Distilled water	27 drms.

Dissolve and add

Solution No. 2	3 drms.

Shake thoroughly, and leave; if crystals form they are of no consequence.

Solution No. 2.

A.

Chloride of calcium, crystal	147 grs.
Distilled water	2 ozs.

Dissolve.

B.

Sulphate of copper, crystal	249 grs.
Distilled water	10 drms.

Dissolve. Mix A and B, filter, and label "Cupric Chloride Solution, No. 2." Put solution No. 1 into an iron enamelled dish, and heat to 180° F., then develop the prints as usual; wash in acidified water (the tint can be altered by raising or lowering the temperature). Prints that are already developed may be treated in the same way. After washing, the prints are soaked for a short time in a 5 per cent. solution of ferrous sulphate, acidulated with a drop or two of sulphuric acid, then rinsed in acidified water and dried. In 1888 a modification of the above process was suggested by Willis, in which the heating of the developer is entirely done away with, and greater transparency in the shadows and more control over results can be obtained. The paper has to be preserved with the same care from damp, and the image is printed rather deeper than with the old paper. It can be developed upon the solution of the developing salts of the manufacturers, or upon the normal oxalate solution as used for ferrous oxalate developer. The print is floated on this, and as soon as intense enough washed in the acid baths in the usual way. Considerable control over results may be obtained by the use of glycerine in the following manner. Three solutions should be prepared:—

No. 1.

Solution of oxalate of potash	2 parts.
Pure glycerine...	2 ,,

No. 2.

Solution of oxalate of potash	1 part.
Pure glycerine...	4 parts.

No. 3.

Pure glycerine.

The print should be pinned to a board and a small pool of the pure glycerine poured on to the print and evenly distributed all over it by means of a soft pad of linen. If there are any portions of the print which have a tendency to appear too white, or wanting in detail, a broad mop or flat brush charged with solution No. 2 should be applied to those places, and then gradually over the

whole of the print, except in the very deepest shadows, which should be left untouched. As soon as the image begins to develop, the brush should be charged with No. 1 solution, and passed rapidly and evenly over the whole print; the print will gradually gain in intensity, and by careful use of solutions No. 1 and 3 with brushes, it will be possible to hold back one portion and coax another out. As with most other processes, success is not always attained at first, and it may happen that our finished prints are too dark or too light. In the former case there is not much to be done, as platinum is one of those intractable metals not easily amenable to reagents; strong chlorine water will reduce the image slightly. Platinotype prints can be far more easily intensified, and several processes have been suggested for this purpose, by means of which also various modifications of tone are possible. Dollond suggests what is practically a gold toning process which he describes as follows. The solutions required are :—

1. Gold chloride ... ... 15 gr.
   Distilled water ... ... 7½ drachms.

Neutralised with chalk, filtered, and one drop of strong hydrochloric acid added.

2. Glycerine.

3. Sodium sulphite ... ... 1 oz.
   Water to ... ... 10 „
   Metol ... ... 50 gr.
4. Potassium carbonate .. .. 1 oz.
   Water to ... ... 10 „

The following is the method of application :—The platinotype print developed, cleared and dried in the usual way, is soaked for two or three minutes in water, then laid upon a flat surface, preferably a sheet of opal glass, and blotted to remove the excess of water. Next glycerine is gently spread over the whole surface of the print with a soft brush or the finger-tip. When evenly coated, a few minims of the gold solution are dropped on and rapidly mixed with the glycerine with a soft camel-hair brush. Very soon the print will begin to gain in strength and assume the blue-black colour. During the whole time the toning is proceeding, the surface of the print should be brushed lightly and

quickly, in order to insure even action and to constantly bring fresh gold chloride into contact with the platinum image; also there seems to be less tendency for a deposit to be formed on the high lights if the solution is kept in motion. The high lights should be watched, and as long as they remain clear the action may be allowed to continue. When the desired effect is obtained or when any coloration is seen in the high lights, the print should be quickly rinsed to remove the adhering glycerine and gold. After this a mixture of equal parts of metol and potash solutions is sponged over both front and back of the print. Washing for half an hour completes the operation. Prints may be kept after development for some weeks, or even months, before toning, but very old prints will not readily tone. If the weather is cold, the water and dishes used will probably require to be slightly warmed or the action will be very slow. Prints are best toned in good daylight, as it is easier to see that the gold is kept evenly distributed over the print, and daylight also assists the action and renders the process more rapid than when performed by gaslight. The general effect of the toning action is to slightly increase the contrasts in the print, as proportionately more gold is deposited where there is a large quantity of platinum present than where there is a small quantity. The best results are obtained when the actual increase in intensity required is small only. The method of treatment I have described will, I think, be found to have four distinct uses: (1) To strengthen under-exposed prints; (2) To convert a rusty or brownish colour in a print into a pure black; (3) To produce blue-black in the place of black prints when this modification of colour is considered desirable; (4) To enable brighter prints to be obtained from flat negatives than is usually possible by the ordinary method. A method of intensifying platinotype with silver has also been suggested. For this either an acid pyro or acid hydroquinone developer could be used, to which a few drops of a 10 per cent. solution of silver nitrate had been added. The solutions required are,

1. Pyrogallol	2 grs.
Citric acid	20 „
Distilled water	1 oz.

or,

2.	Hydroquinone	2 grs.
	Citric acid	20 ,,
	Distilled water	1 oz.
3.	Silver nitrate	48 grs.
	Distilled water	1 oz.

The prints after clearing must be thoroughly freed from acid and placed in a clean dish. Ten drops of No. 3 should be added to one oz. of either 1 or 2, and the solution, which turns white and cloudy, immediately applied to the print and the dish rocked. As soon as the desired degree of intensification is reached the print should be thoroughly washed and then fixed in hypo, and well washed to free it from any soluble silver salt. The intensified print can afterwards be toned with gold or platinum to obtain different tones. Platinotypes may also be toned with uranium by the following process suggested by Hübl :—

A.

Uranium nitrate	48 grs.
Glacial acetic acid	48 ,,
Water	1 oz.

B.

Potassium ferridcyanide (ferricyanide) ...	48 grs.
Water	1 oz.

C.

Ammonium sulphocyanide...	240 grs.
Water	1 oz.

For use, add to 1,000 parts of water 10 parts of the above solutions one after the other. The well-washed platinum print should be placed in a dish and covered with the solution, and the dish rocked till the desired tone is attained. The toning bath should then be poured away, the prints washed in frequently changed water. The process of toning is complete in about five minutes, and with concentrated baths takes place so quickly that it is impossible to avoid failure. In place of the sulphocyanide, sodium sulphite may be used, but as this acts more energetically the bath must be more dilute. For this should be used 5 parts of A and B and 5 parts of a 10 per cent. solution of sodium sulphite to 100 parts of water. Grape sugar acts very slowly

and thiosinamin very quickly. Platinotypes may be toned in a similar manner to the above, with ferridcyanide of iron, and blue tones be obtained which are suitable for moonlight and night scenes. With this process sodium sulphite is less suitable. The following solutions should be used :

A.

Ammonium iron alum	48 grs.
Hydrochloric acid	48 ,,
Water	10 oz.

B.

Potassium ferridcyanide ... 10 per cent. solution.

C.

Ammonium sulphocyanide 50 per cent. solution.

For the toning bath, to 1,000 parts of water add first 5 parts of A, then 2 parts of B, and 5 parts of C. The solution should be of a red colour, and is used similar to the above-mentioned uranium bath. The above physical uranium and iron toning is very easily carried out, and the desired tones may be obtained. In preparing the pictures, however, it must be remembered that these baths have an intensifying action. The prints before toning should have soft delicate half-tones, pure whites, and not too deep shadows ; in no case should they be too brilliant, otherwise after toning they will be hard. Soft, harmonious, and somewhat thin negatives on soft-printing platinotype paper are the most suitable. If the toning process is a failure, or the desired tone is not obtained, the prints may be restored to their original condition by treatment with dilute ammonia. Any slight yellow stain may then be removed by dilute hydrochloric acid. The ferrocyanide compounds of iron and uranium withstand the action of acids, but are removed by alkalies ; therefore the toning bath must be faintly acid, and the washing of the toned prints must not be done by ordinary water containing lime or alkalies. It is in any case advisable to add a few drops of acetic acid to the washing waters to prevent the removal of the toning. Platinotypes may be generally tinted with solution of aloes, catechu, infusion of coffee or other dark-coloured organic liquids ; and as the true platinum image is remarkably permanent even against hypochlorous acid, these, or platinotypes

which have become yellow by age, may be bleached and restored by the process described under BLEACHING PRINTS OR ENGRAVINGS.

Palladiotype.

This is a process due to Mr. Alleyne Reynolds. No distinct formulæ are given, but the operations are thus described:—

"1st. Coating the paper. This may be done with either uranic chloride, ferric oxalate, or sodic ferric oxalate, or a mixture of any or all of these.

"2nd. Exposure.

"3rd. Development. Half a drachm of a 15-grain solution of sodio-chloride of palladium is diluted with about 1 oz. of water, and the print floated thereon face downwards. It is better to add a trace of hydrochloric acid to the developer.

"4th. Fixing as in platinotype.

The result will be a print like a platinum print, only of a pleasant warm tone, which may be rendered colder by adding a trace of platinum to the developer. For particulars of the printing-out platinum method, see PIZZIGHELLI'S PRINTING-OUT PROCESS.

Platinum (Ger., *Platin;* Fr., *Platine;* Ital., *Platino*). Pt = 196·7. Synonym: Platina. This metal occurs usually in the free state, the chief source of supply being Mexico, Brazil, and Siberia. It is a silvery white metal, having specific gravity 21·5. When in an extremely fine state of division, it is black, and is one of the most permanent and immutable of all metals. It is tolerably hard, very difficult of fusion, not dissolved by hydrochloric, nitric, or sulphuric acid, and only slightly acted upon by some alkaline substances.

Platinum Perchloride. Synonyms: Tetrachloride of Platinum, Platinum Chloride, Platinic Chloride, Muriate of Platina, Chloroplatinic Acid. This salt is prepared by dissolving metallic platinum in aqua regia. It occurs in small brownish-red masses extremely deliquescent, forming a deep orange or brownish-orange solution. Very soluble in alcohol and water. It is used for preparing chloroplatinite of potash, and has been used for toning prints and collodion positives. This salt readily combines with the chlorides of potassium, sodium, and ammonium to form double salts—*e.g.*, $PtCl_4 2KCl$.

Platinum Toning. Either with the desire for greater variation in the tones, or for possible greater permanence of the image, platinum has been applied to the toning of silver images, and whilst rich brown blacks and cool sepias are obtained it does not seem possible to obtain pure blacks as when using platinotype paper. There are several conditions which are essential for successful work. The prints, whether on gelatino-chloride, plain salted, or smooth or rough surface paper, need not be printed any deeper than usual. The platinum salt employed should be the chloro-platinite, the ordinary perchloride being comparatively useless for this purpose. The print must be absolutely freed from soluble silver salts before toning, the toning bath must be acid, and the paper must be free from all acid and soluble platinum salts before fixing, or else the whites become yellowed. To free the print from silver nitrate the best thing to do is to allow it to soak for five minutes in a solution of salt and water 2 ozs. to the pint, and then wash so as to free it from excess of salt, and then place in the toning-bath. Numerous formulæ have been suggested for this, but the most suitable are either that of Stieglitz, which is—

A.	Oxalate of potash	256 grs.
	Acid phosphate of potash	128 ,,
	Distilled water	5 ozs.
B.	Chloroplatinite of potash	60 grs.
	Distilled water	2 ozs.

For use take of

Solution A.	3 parts.
Solution B.	1 ,,
Distilled water	2 ,,

This can be brushed over the well-washed print. A far simpler bath is obtained by using the chloro-platinite with an acid or acid salt, and provided nitric or hydrochloric acid is not used there is not much difference to be detected. If a faintly acid and somewhat weak bath be used, such as is obtained by using a saturated solution of cream of tartar, warm sepia tones are obtained, whereas, by using stronger acids, such as phosphoric or citric and a greater concentration of bath, deeper tones are obtained.

No. 1 for Sepia Tones.

Acid tartrate of potash (cream of tartar) ...	60 grs.
Potassium chloroplatinite	1 „
Distilled water	6 ozs.

No. 2 for Blacker Tones.

Citric acid	60 grs.
Potassium chloroplatinite	2 „
Distilled water	2 ozs.

Not much guide as to the final tone of the print is to be obtained by examining them by transmitted light. After toning the prints should be well washed, and then passed into solution of carbonate of soda, about 1 oz. to the pint, and thence into the fixing bath.

Playertype. A process for direct copying which appears to depend on some unrecognised principle. A sheet of sensitive development paper is laid face downwards on a print—as an engraving in a book—pressed in contact, and the back of the paper is exposed to light, when, if the exposure was correct, a developable image is obtained; but the image seldom or never shows much contrast. (See *The Amateur Photographer*, Nov. 13th, 1896, p. 398.)

Pneumatic Holder. A convenient apparatus for holding plates for the purpose of coating, used chiefly in the old collodion days, the pressure of the atmosphere keeping the plate in its position on the holder.

Poisons. Some of the chemicals used in photographic processes are poisonous when taken internally or when absorbed through the skin. Aqueous hydrofluoric acid when applied to the skin, even in a dilute state, causes painful ulcers, and 1 in 80 can also cause irritation and tenderness. Bichromate of potash and cyanide of potash, when applied to cuts, wounds, and abrasions, are absorbed, and may cause much mischief, and even fatal results. The subjoined table is not given to encourage hasty and often ill-judged treatment, but it may give useful hints when medical aid is not obtainable. A special caution may be needed against giving strong acids or alkalies as antidotes; indeed, unprofessional treatment should seldom go beyond emollients, and such an emetic as mustard and hot water.

POISON.	EFFECTS.	ANTIDOTE.
Acid, Acetic	Corrosion of windpipe, violent inflammation ...	For acids, emollients, as gruel or starch paste, mixed with chalk and magnesia. In case of poisoning by oxalic acid, chalk alone should be used.
,, Carbolic	,, ,, ,, ,, ...	
,, Fluoric	,, ,, ,, ,, ...	
,, Hydrochloric ...	,, ,, ,, ,, ...	
,, Nitric	,, ,, ,, ,, ...	
,, Oxalic	Hot, burning sensation, vomiting, cramp, numbness	
,, Sulphuric	Corrosion, etc.	
Alcohol	Drunkeness, coma	Emetic, stomach-pump.
Ammonia	Swelling of tongue, suffocation	Give diluted acids, vinegar, lemon-juice.
Barium	Irritating, with colic	Give a sulphate, as Epsom salts, or sulphate of soda.
Bromine	Acrid taste, tightness about throat	Use stomach-pump, egg albumen, milk.
Copper Sulphate ...	Caustic and corrosive	White of egg, starch and water.
,, Chloride ...	,, ,, ...	Use stomach-pump.
Gold perchloride ...	,, ,, ...	Emetics.
Iodine	Same as Bromine	See Bromine.
Lead Acetate	Constriction in throat, acute cramp in abdomen ...	Sulphate of soda, or magnesia.
Mercuric Chloride ...	Acrid taste, burning in throat and stomach, nausea	White of egg, milk, flour paste.
Potash, Bichromate ...	Irritant pains in stomach, vomiting	Emetic, and emollients.
,, Cyanide	Insensibility, gasping, spasmodic action of jaws ...	Strong coffee, dash cold water over face, give ammonia, or use smelling salts.
Pyrogallol	Acute burning pain in stomach	Milk, white of egg, emetics.
Silver, all Salts of ...	Powerful irritant, contraction of throat	Give copious draughts of salt and water, followed by emetics of mustard.
Zinc, all Salts of	,, ,, ,, ,, ...	Milk, oil, eggs, emetics.

Polypose. A term applied to combination or trick photographs, in which a person is shown in several positions on the same plate. There are special and complex devices for making polypose photographs, notably that of M. Bracq; but the following method will answer in most cases. Cut a circle of thin black cardboard to fit in the hood of the portrait lens, and double back a portion of the circle so as to leave between one-fourth and one-third of the lens exposed, the doubled edge being vertical. A position can now be found for this stop in the hood where it will shade about one-third of the field, as shown by the focussing screen, and an ideal adjustment for it would be a position in which two exposures—the hood being turned half round for the second—will give an evenly illuminated representation of a scene before the camera. Two such exposures are made to produce a double, the sitter being in each case in that portion of

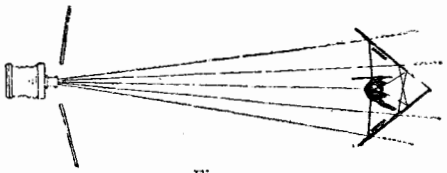


Fig. 94.

the scene which is brightly represented on the focussing screen. When a finer line of demarcation is required, the screen or stop may be inside the camera, at a distance from the plate to be found by experiment, the essential condition being that there shall be a vignetted overlapping of the background in each case, and that the background shall not be in any way shifted between the two exposures. If one of the subjects is to appear as a ghost —a person's own ghost appearing to him—the instructions given under SPIRIT PHOTOGRAPHY will serve as a sufficient guide for the ghostly part. Another kind of Polypose involves the principle of the kaleidoscope, and several, or many, aspects of the same person may be obtained at one pose and on the same plate —a matter of possible value to a sculptor requiring photographic assistance in his work. As regards this matter, an article in the *Photogram* gives the accompanying diagram, and says:—"With two mirrors of large size, the number of effects obtainable is

very great. By placing them face to face and the sitter between, reflection and re-reflection can be so arranged that the sitter in each of the mirrors appears as a series of copies of himself arranged in a row, side by side. Placing the mirrors so that their edges meet at an angle of 75° (see fig. 94), and letting the sitter face the angle, five different views of the same subject are obtained, all giving essentially different views of the face. In some of the American cities this class of picture has been made a specialty by one or two photographers, with the result that considerable business has been done for a while. This method has very distinct advantages as a style of portraiture, and gives great scope for ability in posing and lighting, so that we wonder it has never been taken up by a first-class photographer and developed to the full extent of which it is capable. It will be seen from the diagram that the camera is arranged to point between two plain backgrounds on stretchers, or plain screens, to prevent any part of the room near the camera coming into reflection."

Porcelain Pictures. See ENAMELS and OPALOTYPES.

Portrait Lens. See LENS.

Portraiture. The portrayal of the features of those with whom they are in daily contact may be said to be the summit of ambition of many amateurs, and, as a rule, it is their weakest point, and naturally the stronghold of the professional. So many happy possessors of a camera consider that all they have to do is to stick their sitter down somewhere near a strong light, tell this much-to-be-pitied individual, after he or she has become thoroughly worn out and tired of the whole thing from frequent changes of position and camera, this being wrong, and then something else requiring readjustment, to look pleasant—fancy looking pleasant when you wish the whole thing elsewhere! —and then, after the usual operations, a first-class pleasing memento is expected to be the result. They expect in a few trials to reach the same standard that it has taken the professional years of apprenticeship, hard work, and study to learn; and should their results be any but first-class and pleasing, the blame is thrown on the lens, camera, light, sitter, the bad plates, anywhere but on the right shoulders. Portraiture needs a keen appreciation of the value of light and shade, a good

knowledge of what the lens will do, and considerable artistic skill and ability. It is impossible to give complete directions for the successful working of this branch of photography, but some hints may possibly be gained from the following notes. One of the most important of all accessories for home portraiture is the background. Nothing is so painful as to see a fine head spoilt by some not always artistic wall paper, which is generally so sharply focussed that one may count every petal on some impossible flower, or see joins and irregularities in the said paper. If we want to turn out artistic work, wall papers must be avoided as a rule ; rarely do the patterns lend themselves for use as backgrounds, and even when they do they should be thrown out of focus so as to become mere suggestions rather than concrete shapes. There are of course portable backgrounds to be obtained commercially, of perfect quality, and at such a price as to bring them within the reach of all. But many of us have a great hankering after home-made contrivances, and the few hints we may give may be of service to those handy with carpenter's tools. The first background we ever used was the so-called felt paper or wide brown paper, as used under carpets ; this may be obtained from almost any house furnishers, about six feet wide and any length. Having obtained the paper, the next question is how to mount it. For this purpose procure an ordinary blind roller of the requisite length, and fold down six inches of the paper at one end, and, having some thin glue ready, coat the turned down portion of the paper with the glue, place the roller under the fold, and dab quickly into contact with a cloth. It is obvious that we mean the underneath side of the turned down strip is to be glued, the turning down being merely a device to obtain the paper straight on the roller, otherwise we may get some nasty bulges in the background. When the glue is dry, a sufficient length of the paper may be cut off, and a lath glued into it in the same way as the roller. About eight feet will be found a convenient length, and we have thus a background six feet by eight feet of one uniform tint. This will serve its purpose well, and may be rolled up and stowed away in some convenient corner when done with. A more durable background may be made of the materials used for blinds, and with this we can obtain two or three backgrounds without much expense. Thus we may choose a pale buff, which will give us

a pale tint suitable for dark people; and by choosing also a deep green or deep red, we can obtain a dark background for fair hair, white or light dresses, and children. There are one or two points in connection with the background which it will be as well to mention before proceeding any farther. The first is, when mounting cloth backgrounds, it is advisable to nail them to the roller, exactly like a blind, and an important point in this, as in the paper backgrounds, is to get them to hang straight; this can best be done by commencing to nail in the centre, working out to the edges, and giving the cloth at each nail a gentle stretch; we then get no bulges or wrinkles. The second point refers to the choice of colour. It is well known that the illumination in most rooms is poor, and it is also a well-recognised fact "that coloured substances undergo changes of tint when they are seen under a very bright or very feeble illumination": hence it is advisable to choose rather a lighter tint of any colour than we actually desire, as in the poorly lit room the tint will actually appear darker than it really is. The next question to consider is how to support the background, and this requires practically a frame or stand, which can easily be made from deal by a carpenter, or even by the amateur himself. The frame should take the form of an inverted V, thus Λ, and one of these at each end will be quite sufficient to support any background it may be desirable to use. Personally we use two iron rods, which were originally used as curtain suspenders, we fancy; these are bound together near one end, so as to leave two little cross-pieces about six inches in length, which, crossing over, form a fork, in which the ends of the roller rest; these at each end serve to support the background. The lower ends of the iron rods are inserted in holes bored in pieces of deal six inches square and two inches thick; this prevents the rods slipping, and enables one to shift the background. (See also article under BACKGROUND.) In portraiture in rooms not specially built for that purpose the great difficulty to contend with is want of light, and power to control what light there is. The light streaming in from a narrow window which has not always an uninterrupted view of the sky gives a somewhat bright illumination to one side of a sitter's face, and the other is in somewhat dark shadow, and as the shadow side of the face is illuminated by light reflected from surrounding objects, such as dark-coloured furniture, or frequently somewhat yellowish

paper, etc., the sensitive salt of silver in our dry plate has a tendency to exaggerate this shadow, and without an inordinately long exposure we get "soot and whitewash" results, or, in other words, one side of the face bare glass without any detail, and the other side very dense; so that to obtain the detail in the latter in the print we over-expose the former, and the print is too harsh. To modify this state of things must be our great endeavour, and we shall see how to do this in lighting, or rather placing of sitter, and also by the use of reflectors. Now reflectors may be of two kinds, which we may call the small and intense, such as a mirror, and the large and diffused, like a sheet. The latter will be found of far greater service that the former, and to be of service must be of large size and properly placed—of sufficiently large size to be placed not only on some support, but also to be spread out on the floor. A convenient support for this reflector is the domestic clothes-horse. We may as well digress here a moment and give one hint to all would-be home portraitists, and that is make friends with the ruling spirit of the house, whether wife, mother, or sister, as to turn out decent work means some upsetting of the room and utilisation of household property; so first of all get on the right side of the powers that be, and secondly always clear up after you—put things back, as far as lies in your power, in the position you found them. Ladies will always look with disfavour on any one who turns the place upside down, and even when "you men" put curtains, chairs, etc., to rights, the gentle hand must give the final arranging artistic touch. Curtains are sure to drape the window, so these must be pulled right back, and pinned or held back by a chair, etc.; blinds, venetian or otherwise, must be pulled right up; and finally windows must be clean—a dirty window will stop out 50 per cent. of the light sometimes. If the windows are of the French fashion—that is, opening out or in like a door—open them wide, if not too cold. Finally, when necessary, use a reflector outside the window; we all know how snow on the ground lights up the room, so use a reflector, and use a big one. We daren't suggest putting a sheet out, because this might get us into serious trouble with the ladies, but "we are free to confess" that we do it, though under protest from somebody. When it comes to full length, we get another question to consider, that of suitable accessories, and when considering the subject of posing, we shall note a point or two which

may be useful, as very fine results may be obtained from taking a portrait of anybody engaged at work, or seated by the fire, or reading, writing, etc., and in such cases the picture would be incomplete without the actual and necessary furniture in the room, and in this case, too, we may admit the otherwise inadmissible wall paper. Without going to any outlay, a capital background, especially for children, is the screen to be found in so many houses, and the same may also serve for the support of a ready-made background which may be found in every house—namely, a blanket; or the screen may be used to support the reflector. We may use either a portrait lens or, as these when of good quality are costly, we may get what is perhaps the next best lens for portraiture, and that is the single lens of fairly long focus, working at rather a larger aperture than usual—viz., *f*/8. There is sufficient spherical aberration present with such an aperture, as a rule, as to have no baneful influence and yet give us roundness and softness. Personally, we have rigged up a compromise, and that is as follows. We managed to get hold of some unmounted single or meniscus landscape lenses, and we use these in a mount specially made for us, and we are thus able by a little calculation to obtain any focal length and any ratio aperture we want. The lenses are of 22, 18, 16, 13, 10, and 8 in. focus respectively. We had a tube of brass made with a cell to fit in each end; into these cells we can slip any one of the above lenses, and a ring of brass keeps the lens in its place. The tube is 2½ ins. long, and the cells screw in till there is only two inches between the inner surfaces of the lenses. The diaphragm slot is just midway. Now, according to the well-known rule, multiply the foci of the two combinations together, and divide by the sum obtained by adding them together and subtracting the distance of separation, it is quite possible to reckon out any focus we like. Let us take, for instance, the 22 and 18-in. lenses—$22 \times 18 \div [(22 + 18) - 2] = 396 \div 38 = 10\frac{1}{2}$ focal length. Now, the full aperture of our lens is 1⅛; therefore we get a focal length of 10½ ins. and a ratio aperture of *f*/6·5, at which there is sufficient outstanding spherical aberration to give us softness. Or we may use the 18 and 16-in. lenses, and then we get $18 \times 16 \div [(18 + 16) - 2] = 288 \div 32 = 9$, and the aperture will then be *f*/4·8, and we must, or may, stop down with advantage; or, if we take the two extremes, we get $22 \times 8 \div [(22 + 8) - 2] = 176 \div 28 = 6{\cdot}3$, and

we get an aperture *f*/3·9, which requires a good deal of stopping down. This arrangement is not optically and scientifically perfect, but, at any rate, it will just do what we want it to, and we have a very convenient and efficient combination lens with which we can obtain any focal length, and consequently any sized image, so that we can actually work our lens at any aperture we like without having to get too near the sitter, and thus decrease the ratio aperture. The next point to consider is the camera and tripod. This may be the ordinary one we are always in the habit of using; but if we want to avoid any outcry we had better shoe the tripod points with bits of cork to prevent damage to carpets, etc. A swing-back is extremely convenient here. No other point in the camera or its appurtenances requires notice.

The next important consideration is the plate. This is always a burning question, and our advice is to use as sensitive a plate as you can get hold of—isochromatic, orthochromatic, or colour-sensitive, in preference, because there is less work for retouching. Freckles and sallow skins and yellowish lighting have, therefore, less influence. We prefer personally a bromo-iodide plate, and always give as long an exposure as we possibly can without allowing the sitter to obviously move, and for this reason keep our eye on the sitter, and have the lens cap ready to clap on the instant we note a tremor. The developer we use is eikonogen with hydroquinone, but at present we have only considered the necessary appliances, and consequently the development takes a later place. Every amateur who wants to start portraiture will generally place his sitter as close as possible to the window, and is astonished to find on developing his plate that he has obtained a wonderful and fearful hybrid, with one side of the face black and the other white. To such a novice we propound the startling theory that the farther he puts his sitter away from the window the softer and more harmonious the lighting and the better the results obtained. If he does not believe this, let him set to work to prove it optically and practically on himself, for which purpose all that is necessary is a decent-sized hand-glass or mirror, a chair, and the would-be operator. Now let him seat himself in the chair close to the window and hold the glass so that he can see his face plainly, and yet so that the glass shall not cast the reflection of the light on to the face, and he will find that one

side of his face is brightly illuminated, but the other has a heavy black nose shadow, and the one ear is hardly to be seen. Now let the chair be moved back from the window about five or six feet, and the same operation be gone through, when it will be seen that there is less contrast between the light and shade, and we know we can further reduce this contrast by the use of reflectors. More is to be learnt by thus figuring about and admiring yourself and features in various attitudes and positions as regards the window, than any amount of reading how to do it; but still, for the instruction of those who like everything illustrated, the following diagram (fig. 95) will be of assistance. A and B are two windows; B should be blocked out entirely by blinds, or curtains, etc. The softest and most harmonious lighting may be got by placing the sitter about S, and the camera

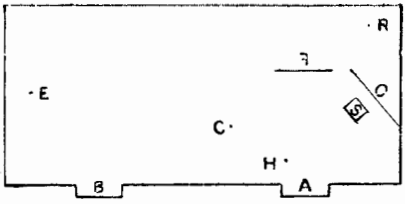


Fig. 95.

placed about C or H, according to whether profile or full face be required. For full lengths the camera will have to be placed about E. Now for a few general hints on lighting, etc. Never put your sitter at F in the above diagram, or directly opposite the window and the camera in the window recess. Full-front lighting makes any face look like a plain, flat piece; there is no relief, no roundness, no shadow. Another important point is the character of the face, and the way this can be altered by varying the position of the camera and lens. Let us take, for instance, a long, thin, cadaverous face, with abnormally long upper lip, and sharply-defined septum of the nose, with rather receding nostrils. Now let us place the lens level with the nose, and what do we see? Why, the lip and nostril natural, it is true, but too long and too prominent. Placing the lens so as to slightly look down on the nose and lip reduces

these to pleasing proportions, whilst if we place the lens level with the breast, so as to look up to the nose and lip, the abnormal length is intensified. We might go on multiplying instances in this fashion, but must leave the operator to find these things out for himself. Some people, especially those who do much head work or who have experienced great troubles or worry, have very marked furrows or furrow at the root of the nose between the eyebrows, and on either side a protuberance more or less marked, which give great character to the face, and which the possessors are sometimes very proud of. The face should be so lighted that these, or at least one, is distinctly visible, and a very good position is the profile just showing a little of the further eye. Another important point to be considered is the presence of scars, moles, and other marks; when these are present, it is of course absolutely necessary to take the other side of the face, unless, in the case of a fair sitter, when sometimes a small mole or beauty spot is very effective, giving piquancy to the face. All professional photographers and all authorities upon portraiture state that one side of the human face is better or more perfect than the other. Thus H. P. Robinson, the best known authority, in his excellent little book, "The Studio, and What to Do in It," p. 50, says, "The first thing to decide when you see your sitter should be, 'Which side of his face will make the best picture?' This consideration seldom gives an experienced operator any trouble. To one who is in the habit of observing, the sides of every face differ so much and in such a definite manner, that a glance is all that is necessary to settle the question; but the young photographer will want to know how to select and have some rule for the selection. If you will look critically at a full face (or the photograph of a full face would be better, as it would enable you to measure), you will find that the eyes are not level—one is higher than the other. This is almost invariable, and is one of the peculiar instances in which nature insists on variety, even where uniformity would seem to be proper. . . . I keep an illustrated catalogue of all the portraits I take, and on looking through several volumes . . . I found that about four out of five of the portraits were taken looking to the right, showing that I had in these instances chosen the left side as the best." An important point, and one often neglected by the amateur operator, is the direction of the

eyes. It is no uncommon thing to see a rather fine large head, with good gradation and modelling, facing a point slightly to one side of the camera, probably about six inches from the lens, whereas the eyes are directed to a point at least three times that distance from the camera. In other cases the eyes are elevated too much. A very good plan is to place a decent-sized mirror in front of the sitters, and allow them to look at themselves in that, when, as a rule with sitters of mature age and sound judgment, it is by no means a difficult operation for them to so command the facial muscles as to put on a pleasing look when they can see themselves. The old formula of "Wet your lips and look pleasant, please" has almost disappeared, simultaneously with the habit of the operator turning his back on the sitter. There is a tale, the veracity of which, however, we will not vouch for, that a tintype worker used to draw on the once white-washed wall of his studio, and tell his visitors to "look at that and look pleasant," possibly a difficult matter. We have personally, however, worked in a studio where it was customary to tell sitters to look at a little gaudily-painted box, and at the same moment as the lens shutter was raised, a little Jack-in-the-box sprung up and "put his thumb unto his nose and stretched his fingers out." The effect of this on the sitters was marvellous; in some a genuine home-made Cheshire grin appeared, in others the jaw dropped in surprise, in juveniles the eyes extended; so finally poor Jack was relegated to the shelf, as these results were by no means artistic. It is far better to use merely a looking-glass; some writers use a picture, others have recommended a clock, etc. Whatever is used, however, let it be a fair size, and tell your sitter not to be afraid, but to blink his or her eyes as usual, and not to fix them in a steady glare, as though trying to freeze somebody. Above all things, let your sitters be natural. If a lady, give her a piece of needlework, and tell her to work at it, then drop it in her lap, and look up as though going to speak. For young ladies a doll, animate or inanimate, may be of use; in the former case, however, it is preferable to have one that will sleep—some won't, or at least we have come to that conclusion. For a gentleman, give him a stick, cigarette, cigar, or pipe, or let him stand by a table on which lie hat, gloves, and stick, and tell him to begin to pick them up. For smaller boys, a top or game may be utilised. Who does not know Rejlander's picture, "The

Game of Chess"? Here there is an excellent chance for a group; two persons playing chess, one leaning back looking rather pleased, the other leaning over the board "with bent brow and eye intent," whilst behind a third may stand smiling at the triumphant player. Call this "A Poser" or "In a Fix," what you please, only whatever you do carry the thing out properly. Place the chess men in a difficult position—not as we saw them a week or two back in a picture, a chess board without a single piece lost; not that we mean to infer difficult situations do not occur then, but they are more likely to at the end of a game. Then again, for a group of four, what is better than a scientific rubber of whist? Here, too, put your accessories in; the markers, the second pack, the played cards in the middle of the table, the tricks won, etc. We may possibly make the title tell the tale; for instance, "The call for trumps." Or again, let one party be scoring, the other counting the tricks—"Two by tricks and honours easy;" or a more difficult subject still, "Trumped my ace, by gad, sir!" Surely this recalls the choleric, stout old gentleman, rising in hot haste, his hand flung down, the chair upset behind him, whilst the luckless wight who has been unfortunate enough to "trump my ace," stares in shivering astonishment at his wrathful partner and triumphant opponents, one of whom leans back enjoying the joke with a rude guffaw, the other calmly smiling at the wretched culprit. We might go on giving our readers hints without end, but must content ourselves by impressing on them the importance of having everything in harmony. Give your sitters something to do or hold that they are in the habit of using, and they'll immediately fall into natural attitudes; but give a man a violin or something he knows nothing about, and he will immediately look as though it was some strange thing, and nothing you can do will prevent it. We have considered briefly the single figure, and noted a possible chance of a group indoors. We have now to consider some general principles to be observed in outdoor portraiture. There is one background which is very common and is by no means artistic, that is a trellis work, sometimes partially covered with ivy, jessamine, or Virginia creeper, which is too often sufficiently thrown out of focus to make the interstices of the trellis round, patchy spots, which attract the eye before the figure or face. Ivy, Virginia creeper, or any other plant or a shrub may form a

very pretty artistic background, but it should never be as sharply focussed as the sitter, nor sufficiently fuzzy to lose its outline and character. Never take your subject standing against a wall, the top of which just comes across the back of his neck; this gives one an idea of the guillotine or block, which is not pleasant. Always look carefully, too, to see that there is no obtrusive branch or flower which apparently grows out of his neck or the top of his head. We have a most curious example of amateur portraiture in which the sitter, a lady, wears a hat trimmed with some flowers, and from the position she is placed in it looks for all the world as though she was supporting a whole rose tree on her head. A sitter should never be placed in the sun, nor under a tree through the branches or leaves of which the sun shines on him in patches, or the resulting prints will give one the idea of a piebald sitter. Very good results can frequently be obtained by placing the sitter in the angle of a wall facing the north or north-west; but it is far preferable to use a lawn studio, such as sold by various firms. We have used one made on the same principle for some time with the best results. With such a studio one can command the lighting, and obtain results otherwise impossible, and the cost is but small. Outdoor work gives us very good chances for happy groupings, and we shall note one or two possibilities, leaving our readers to carry out more fully the ideas we sketch. Tennis parties are capital opportunities, not only for flirting, but also for group work. Thus we may have two gentlemen, one in the act of tossing, the other watching him; and two young ladies standing together having a confidential chat, and "Tossing for Partners" will tell the story. In the background we can place a group of onlookers, and perhaps a couple quietly walking down a path or across the grass for a quiet *tête-à-tête*. Afternoon tea out of doors, again, affords us another capital subject—the tea-table, the presiding divinity and her attendant satellite, then two or three pairs scattered about, but near. Here one must apply to a great extent the well-known rules of composition, which are easily mastered. Whatever you do, carry out the idea well. Do not crowd everybody together; give some tea-cups, others plates, etc., and fill cups and plates; and don't let all your sitters look straight at the camera; let them chat to one another. Again, in outdoor work there are plenty of chances

of making a pretty picture with children, either singly or in groups at play, or at the swing, etc., and far greater success can be usually obtained, as the light is more even and stronger, and therefore a somewhat slow shutter may be used. The fortunate possessor of a flight of stone steps leading from the house to a drive has a capital chance of artistic composition, especially if riding hacks can also be had to order. Thus we may plant a gentleman half-way up the steps, looking into the hall of the house through the open door, or impatiently at his watch, and make a groom lead a pair of hacks up and down; and a title such as "Impatient" or "How much Longer am I to Wait?" tells the tale. A very pretty little study can be made from a cavalier arranging the riding habit of some fair dame, whilst a groom holds the horse. Then, again, we have the forlorn maiden watching her lover riding way, or anxiously looking for him. There are hundreds of such subjects to be found, with a little care in posing so as to conceal the art, and probably one or two failures may be met with ere success and a picture crowns the efforts. To the fortunate visitor to farmland there are subjects innumerable ready to hand; they only want seeing, that is all; such subjects as feeding calves, poultry, etc. Then again many a homely yokel with his work-a-day smock will make an excellent subject, but too often the operators seem blinded by familiarity or false pride, never thinking that in such homely and true-to-nature pictures there is "the one touch of nature" that "makes the whole world kin."

Artificial light for portrait work may be classed into several divisions, such as electric light, magnesium ribbon, magnesium flash, oil lamps, and gas. Electric light is the most convenient if the necessary installation is ready to hand. Magnesium ribbon requires more attention, though this has to a great extent been replaced by the flash-light. (See FLASH LIGHT.) We need not again enter into the question of posing, but merely give a few hints as to lighting. Our plan is to pose and focus the sitter, and place on one side of the sitter, which should be the shadow side, a lamp about one yard off and slightly to the front, just so as not to show on the focussing screen. We then use a pair of household steps, mount these, and have some helper to remove the cap of the lens at the moment we light twelve inches of magnesium ribbon, which is waved about. The steps are placed slightly to

one side of the camera; the burning ribbon is moved about so as to equalise the illumination, and the two final inches are brought so as to illuminate the shadow side of face. The disadvantage of burning magnesium in the room is that the oxide or magnesia formed flies about and settles on everything, and if two or three exposures have to be made one after the other, the negatives obtained subsequent to the first are foggy and hazy. A large white reflector should be used with magnesium, the same as with ordinary daylight. There is one point which it is advisable to note, and that is that magnesium ribbon, and not wire, should be used, and, secondly, that magnesium ribbon which has been kept for some time is frequently oxidised on the surface. This should always be removed by drawing the ribbon once or twice through emery paper, or else between the nails. If much oxidised, the ribbon will splutter, and we have known it to be quite extinguished. Few of our readers will believe in the use of an oil lamp, but there is one method which has given us fairly good results for profile and three-quarter-face portraits, and which may also be used for full face with a little ingenuity and contrivance. Still, this is only to be done by the possessors of an optical (or magic) lantern. The lamp is lighted and the circle of light directed on to the sitter, and so adjusted that no heavy black shadow appears on one side of the face, and also so that no black shadow appears on the background. An ordinary lamp should be used to light up the shadow side of the face, and in all artificial-light work the room should be as well lit up as possible, so as to avoid great staring pupils to the eyes; and when this is not feasible without giving false lighting, the sitter should be made to look at a lighted lamp. The exposure required with such an arrangement is about twenty to thirty seconds, but if the limelight is to be had, ten seconds will be plenty. An important point when working with artificial light is to use as rapid a plate as possible, and *it should be colour-sensitive*, isochromatic or orthochromatic. To the more ambitious person home portraiture opens up an enormously wide field for practical experiments, which, if successful, lead to fine pictorial results. We shall, therefore, give a few hints which may suggest some subjects to the more advanced worker who is not afraid of combination printing, and the little trouble it entails. We shall take, first of all, a comparatively easy subject. This is a sitter seated by a

window writing or reading; through the window is seen a fine landscape. Now, if we give sufficiently long exposure for the figure to obtain detail in the deeper shadows, we shall enormously over-expose for the landscape, so much so as to make it extremely difficult to develop the plate so as to obtain detail in the landscape. The best plan to obtain such an effect is to make two exposures; thus we may suggest fifteen to twenty seconds exposure for the figure, the lighting of which will be the so-called Rembrandt style, whereas probably one to two seconds would be sufficient for the landscape. We should give the longer exposure to the figure first, and then, without changing the position of camera, or allowing the sitter to move, we should insert another dark-slide, and give a short exposure for the landscape. On development we shall obtain two negatives, one well exposed for the portrait and over-exposed for the landscape, the other correctly exposed for the landscape and a mere ghost of a figure. By double or combination printing we can obtain a very good picture. Another subject which would give the best results by flash-light would be a group round a fire, which may be treated in the same way, and if a good negative of the fire itself is required, it is advisable to throw nitre or powdered sulphur on to it to make a rather more actinic blaze. Another class of subject which is by no means difficult, though one which perhaps ought not to be included in picture-making, is the production of ghost pictures, which are by no means difficult to make. The usual method of making the ghost wear white cerecloths is entirely unnecessary. Thus a subject for a picture might very well be made by those possessed of the requisite accessories—an old hall, some antique clothes, etc. We will call our picture "The Ancestral Ghost"; the scene, a long passage or corridor dimly lighted, preferably by a grated window high up; a friend, either lady or gentleman, dressed in habiliments of the last century. Now, if we have such a corridor, we can easily make the picture. A magic lantern placed outside the window, which may be real or temporary, may be used to project a beam of light on to the floor, in the path of which the lady or gentleman should stand for about one or two seconds; the cap should be placed on the lens, and then the subject allowed to walk away, and a fairly long exposure given to the corridor. If this plate be successfully exposed and developed we shall have a somewhat thin negative of the corridor

or room, with a ghostlike figure in the beam of light, and by printing deeply on ordinary albumenised paper, tinted blue or green, we shall have a very fair picture of a moonlight visitor in the shape of "the ancestral ghost." (See also POLYPOSE and SPIRIT PHOTOGRAPHY.) The main point for which all our notes have been contending, and which we must not lose sight of in development, is reduction of contrast and the production of soft, harmonious negatives. The developer, therefore, should be chosen with this end in view, and either a pyro developer with a small proportion of pyro used, or else amidol or metol, directions for the use of which will be found under the various headings.

We have now reached the last stage of our hints on photography at home, and include a few hints on the faking of negatives and choice of printing processes. A rough proof should be taken from the negative as soon as perfectly dry, and the proof toned and fixed; we are now in a position to find faults and defects. If the shadow side of the face is too dark, it will be found advisable to coat the back of the negative with pale yellow matt varnish, or even to work on the film side with a little retouching medium and powdered graphite, manipulating with a stump. Pinholes may be easily stopped out and, if necessary, a little black speck on the film, which gives a white spot on the print, can be easily eradicated by carefully manipulating a needle inserted in a penholder. Of actual retouching, we do not intend to speak, further than to strongly recommend any one desirous of entering this by no means difficult branch of practical work to study No. 5 of the *Amateur Photographer* handbooks, and then practise what is there taught. It has been said that a successful retoucher must be an artist and an anatomist. Possibly this is true, but any one with a little practice can learn sufficient retouching to be able to soften down glaring freckles and other defects, natural or appertaining to the process. Negatives should be varnished before proceeding to actual printing, and although this is too frequently a bugbear to the amateur, it is, like everything else, merely a question of practice. The choice of printing process is always a difficult one. Many sitters who are ignorant of photography prefer the ordinary albumen print, merely because they have never seen any other process. For small work, such as *cartes-de-visite*,

gelatino-chloride paper, white will give good results, but for larger work, such as cabinets, whole-plates, etc., a matt-surface paper is far superior. To this category belong matt-surface chloride papers, rough bromide paper, printing-out platinotype, the ordinary platinotype, and mezzotype. In choosing a process we must look at the character of the negative. Thus for a flat, thin negative a gelatino-chloride paper should be used, as this tends to increase of contrast; for a plucky negative with decided contrasts this paper should be avoided, and a rapid bromide paper or platinotype, used. Vignetting is by no means difficult, and, in some cases, is of advantage for cutting off unnecessary details in the backgrounds, etc.; but it should be well done to be effective. Then, again, the character of the vignette should be chosen in accordance with the style and character of the picture. Thus, a sitter in a white dress against a dark background should be vignetted, not with the margins white, which would detract from the high lights of the picture, but the edges should shade off darker, which is obviously done by shading the centre from the action of light and allowing the edges to blacken and bronze in the sun. A sitter in a dark dress against a light background may be vignetted in the usual way. Instruction for making "doubles"—that is, two representations of the same person on one plate—will be found under the heading POLYPOSE; and under the same heading are some hints as to multiple portraits based on the principle of the kaleidoscope.

Positive. A reproduction of any object in which the lights and shades are represented as seen in nature, whether on glass or paper. A positive for viewing by transmitted light is sometimes called a diapositive, and one for viewing by reflected light —like an ordinary print on paper—is sometimes distinguished by the term kata-positive. It is the opposite to negative.

Potassium Bichromate (Ger., *Kaliumdichromat;* Fr., *Bichromate de potasse, Chromate rouge de potassium;* Ital., *Bichromata di potassa*). $K_2Cr_2O_7 = 295$. Synonyms: Potassium Dichromate, Red Chromate of Potash, Acid Chromate of Potash. Is prepared on a large scale from chrome iron ore. It is met with commercially as fine orange-red crystals, which give a very deep-coloured solution. Solubility, 7·4 per cent. in cold, 9·4 per cent. in hot water; insoluble in alcohol. It is of great importance

commercially, the fact of its being decomposed by light when in contact with organic matter being taken advantage of. It is used for dyeing, and also for tanning hides, the action in this case being analogous to that in the carbon process. It is used, photographically, for nearly every photo-mechanical printing process. It is also used in solution as a colour screen for orthochromatic work.

Potassium Bromide (Ger., *Bromkalium, Kaliumbromid ;* Fr., *Bromure de potassium ;* Ital., *Bromuro di potasio*). KBr = 119, Prepared in white cubical crystals by acting on bromide of iron with carbonate of potash, or by the action of the metalloid itself on caustic potash, and subsequent purification and crystallisation. Solubility: 58 per cent. in cold, 102 per cent. in hot water; 0·13 per cent. in cold, 7 per cent. in boiling alcohol; 0·2 per cent. in ether, 0·05 alcohol and ether; 25 per cent. in glycerine.

Potassium Carbonate (Ger., *Kaliumcarbonat, Kohlensäures Kali, Potasche;* Fr., *Carbonate de potasse ;* Ital., *Carbonato di potassa*). $K_2CO_3,3H_2O = 192$. Synonyms: Pearlash, Subcarbonate of Potash, Salt of Tartar, Salt of Wormwood, Potash. It contains nearly always about 16 per cent. of water of crystallisation, and is prepared by lixiviation, and subsequent purification, of the ashes of wood and vegetable matters. Solubility: 100 in 75 of water; insoluble in alcohol and ether. It is extremely deliquescent—that is, absorbing moisture from the air—and becomes a pasty mass. It is used for developing, and for the preparation of the other salts of potash. It should not be confounded with the bicarbonate or acid carbonate of potash ($KHCO_3$), which is a much less active salt.

Potassium Chloroplatinite (Ger., *Kaliumplatinchlorür, Platinkaliumchlorür;* Fr., *Chloroplatinite de potassium;* Ital., *Cloroplatinito di potassio*). $K_2PtCl_4 = 318·6$. This is prepared by heating 50 parts of bichloride of platinum dissolved in 100 parts of water to 100° C., and passing through it a stream of washed sulphurous anhydride, SO_2, till the solution turns deep red, and gives no precipitate with ammonium chloride. The solution is then allowed to cool, and 25 parts of potassium chloride in 50 parts of water added, and the solution allowed to crystallise, and the crystals washed. It occurs in ruby red deliquescent crystals, very soluble in water, insoluble in alcohol.

It is used in platinotype printing and for toning prints. A convenient method of preparing this salt for the platinotype process is that given by Hoffman :—Take of platinum in scraps 5 parts, dissolve in aqua regia, and evaporate carefully till the solution is syrupy; add 5 parts of potassium chloride dissolved in a little distilled water; then evaporate down till it forms a mass. Dissolve the mass in sufficient water to make 100 parts. To the 100 parts of this solution add 10 parts of dry ferrous oxalate, and heat in a capsule for about two minutes at 158° F., and allow to cool and filter. Double decomposition takes place, and a mixture of ferric oxalate and chloroplatinite is formed.

Potassium Cyanide (Ger., *Cyankalium, Kaliumcyanid;* Fr., *Cyanure de potassium;* Ital., *Cianuro di potassio.* KCN or KCy = 65. Synonyms: Cyanide of Potash, "Cyanide." Obtained by fusing ferrocyanide of potassium with carbonate of potash. The resulting fluid mass is poured out on slabs, and then broken up into the irregular masses met with in commerce. Solubility, 1 in 1 of cold, 122 per cent. in hot water; 1·2 per cent. in absolute alcohol; more soluble in dilute alcohol. It is used for reducing the density of negatives, and for fixing in the wet process. It is extremely poisonous when taken internally, and also when absorbed through the skin, or by any cut or abrasion. The addition of an acid immediately causes the evolution of hydrocyanic or prussic acid, which is extremely poisonous, and when inhaled, even in small quantities, produces vertigo and headache.

Potassium Ferricyanide (Ger., *Rothes Blutlaugensalz, Kaliumeisencyanid;* Fr., *Ferricyanure de potassium, Cyanoferride de potassium, Prussiate rouge de potassium;* Ital., *Cianuro rosso di potassio e di ferro, Prussiato rosso di potassio.* $K_3Fe(CN)_6$ = 567. Synonyms: Ferridcyanide of Potash, Red Prussiate of Potash. Made by the action of chlorine gas on ferrocyanide of potash. Solubility: 36 per cent. in cold, 77·6 per cent. in hot water; insoluble in absolute alcohol; more soluble in dilute alcohol. It is met with as deep red crystals, that become covered with a yellowish powder, which should be removed by rinsing with water before use. It is used for reducing, and in some printing processes, also for toning bromide prints.

Potassium Ferrocyanide (Ger., *Gelbes Blutlaugensalz, Kaliumeisencyanür;* Fr., *Ferrocyanure de potassium, Prussiate jaune, Cyanoferrure de potassium;* Ital., *Cianuro giallo di potassio e di ferro, Prussiato giallo di potassio).* $K_4Fe(CN)_6, 3H_2O = 426$. Synonym: Yellow Prussiate of Potash. Is prepared by heating nitrogenous matter, such as hoofs, horns, hide clippings, etc., with pearlash and iron filings in an iron pot. The resulting mass is dissolved in water and evaporated, and the large yellow plates or crystals of the salt obtained. Solubility: 26 per cent. in cold, 50 per cent. in hot water; insoluble in alcohol. The salt is non-poisonous of itself; but as a deadly poison can be easily formed from it, care should be exercised in its use. It has been recommended as an addition to developers, and is said to give pluck and brilliancy to the negatives.

Potassium Iodide (Ger., *Iodkalium, Kaliumiodid;* Fr., *Iodure de potassium;* Ital., *Ioduro di potassio*). KI = 166. Prepared by dissolving iodine in hot solution of caustic potash, evaporating and fusing the crystalline mass with charcoal, and subsequent lixiviation. Solubility: 138 per cent. in cold, 220 per cent. in hot water; 1·5 per cent. in alcohol, 0·12 per cent. in ether; 0·8 per cent. in alcohol and ether; 40 per cent. in glycerine. It is used for iodising collodion, in emulsion making and as an ingredient of some intensifiers.

Potassium Metabisulphite (Ger., *Kaliummetabisulfit;* Fr., *Métabisulfite de potassium, Bisulfite* or *Sulfite acide de potasse;* Ital., *Metabisolfito di potassa*). $K_2S_2O_5 = 222$. Prepared by saturating solution of potassium carbonate with sulphurous acid gas and precipitating the metabisulphite with alcohol. Solubility: 1 : 3 of water, insoluble in alcohol. It is used as a preservative of pyrogallol, but on keeping becomes very acid and necessitates therefore the use of larger quantities of alkali. It may also be used as an addition to the fixing bath to make the same acid and prevent it staining.

Potassium Nitrate (Ger., *Salpetersaures Kali, Kaliumnitrat, Salpeter, Kalisalpeter;* Fr., *Azotate de potasse, Nitrate de potasse, Salpetre sel de nitre;* Ital., *Azotato di potassa*). $KNO_3 = 101$. Synonyms: Nitre, Saltpetre. Occurs naturally in many parts of India, contaminated with nitrate of calcium. It is also made artificially by the process of nitrification. It can also be made by

adding chloride of potash to nitrate of sodium in solution. Solubility: 30 per cent. in cold, 335 per cent. in hot water; insoluble in cold alcohol, 2 per cent. in boiling alcohol. It is used for making nitric acid, pyroxyline and for magnesium flashlight powders.

Potassium Nitrite (Ger., *Salpetrigsaures Kali, Kaliumnitrit;* Fr., *Azotite de potassium;* Ital., *Azotito di potassio).* KNO_2=85. Can be made by heating nitrate of potassium, when oxygen is given off and the nitrite left. It is an extremely deliquescent salt, and of but little use photographically, it being recommended for preparing the paper for Actinometers (*q.v.),* and for preventing commercial sensitised paper from yellowing.

Potassium Oxalate (Ger., *Oxalsäures Kali, Kaliumoxalat;* Fr., *Oxalate neutre de potassium;* Ital., *Ossalato neutro di potassa).* $K_2C_2O_4$ = 164. Synonym: Neutral Oxalate of Potash. Prepared by neutralising oxalic acid with carbonate of potash or caustic potash. Solubility: 1 in 3 of water; insoluble in alcohol or ether. It is used for the production of ferrous oxalate, and as a developer in the platinotype process. A convenient method of making it is as follows:—Dissolve 13 ozs. of carbonate of potash in 30 ozs. of water, and add gradually about 9 ozs. of oxalic acid, till, after boiling, the solution is neutral to test paper. Filter and make the resulting solution measure 64 ozs., when a solution of oxalate of potash will be obtained 1 in 4. This salt should not be confounded with the binoxalate or acid oxalate of potash known commercially as salt of sorrel, from which it may be prepared by heating 200 parts of acid oxalate in 1000 parts of water, and adding carbonate or bicarbonate of potassium, till a faint alkaline reaction is given, and then adding a few grains of oxalic acid or the acid salt.

Potassium Permanganate (Ger., *Ubermangansäures Kali, Kaliumhypermanganat;* Fr., *Permanganate de potasse;* Ital., *Permanganato di potassa).* $KMnO_4$. Prepared by fusing together hydrate and chlorate of potash and black oxide of manganese, boiling the product thus obtained with water, and purifying and crystallising the product. Solubility: 6·3 per cent. in cold, very soluble in hot water; decomposed by alcohol. It is used for intensifying negatives, as a test for hypo, and as an intensifier for carbon prints.

Potassium Sulphide (Ger., *Schwefelkalium, Kaliumsulfid Schwefelleber;* Fr., *Foie de soufre, Trisulfure de potassium;* Ital., *Pentasulfuro di potassio*). Synonyms: Liver of Sulphur, Sulphurated Potash, Potassium Trisulphide. Made by heating together sulphur and carbonate of potash, the resulting mass being poured out on slabs and broken up. It is of variable composition. Solubility: partially soluble in water, and three-quarters of it by weight soluble in alcohol. It is used for the reduction of residues.

Powder Process. A process much used on the Continent for the production of prints on paper, and in England for transparencies on glass. The process is not by any means difficult, and as the results are extremely pleasing and can be obtained in any colour, the process is well worth the attention of amateurs. An organic tacky body, sensitised with bichromate of potash or ammonia, is allowed to dry as much as possible, and exposed to light, when it is found that the tackiness of the organic body disappears in exact proportion to the action of light, and any fine powder dusted on will adhere to the tacky portions unacted upon by light. It is obvious, therefore, that by this means an image can be obtained in any colour, and almost any material, a reversed positive being used to produce a positive. It has been lately recommended in *The Amateur Photographer* for the production of lantern slides, and from experiments made by the author seems very suitable for the purpose. The following formulæ are recommended for the preparation of the organic tacky body:—

OBERNETTER'S FORMULA.

Dextrine	60 grs.
White sugar	75 „
Ammonium bichromate	30 „
Glycerine	2 to 8 mins.
Distilled water	3 ozs.

WOODBURY'S FORMULA.

Gum arabic	60 grs.
Glucose	45 „
Glycerine	10 mins.
Potassium bichromate	30 grs.
Distilled water	2 ozs.

Mix by gently heating, filter, and preserve in a stoppered bottle.

A plate is coated with either of the above solutions, and dried at a gentle heat, and then exposed under a positive, reversed as regards left and right, for three or five minutes to sunlight, or ten or fifteen minutes to diffused light; on removal from the printing-frame a faint image is seen. The plate is then exposed to the air for a few minutes to allow it to absorb moisture, and fine plumbago, as used by electrotypers, is applied with a flat brush, when it adheres to those portions protected from light, and the lights and shades are represented more or less by a coating of graphite. When the image is fully developed, and there is no further adherence of the graphite, the superfluous powder is dusted off, the film is coated with collodion, and then well washed to remove the unacted-upon gum and bichromate; the film may be detached from the plate, and used for enamels, ivory, opal, or any textile fabric. (For the application of this method to etching on glass, see HYALOGRAPHY.)

Pretsch Process. See GALVANOGRAPHY.

Primuline (Ger., *Primulin;* Fr., *Primulin;* Ital., *Primulina*). A complex organic dye obtained by the action of sulphur and fuming sulphuric acid on paratoluidin. It has the property of dyeing cotton without any mordant, and is used in the Diazotype process.

Primuline Process. See DIAZOTYPE PRINTING.

Principal Axis is the straight line which joins the centres of curvature of the spherical surfaces of a lens, or if one surface is plane, the principal axis passes through the centre of curvature of the spherical surface, and perpendicular to the plane surface. A straight line passing through the optical centre, and making an angle with the principal axis, is termed a secondary axis. The centres of curvature are the points from which the arcs of the circles forming the spherical surfaces of the lenses are calculated—that is, the centres of curvature are the centres of circles, of which circles the spherical surfaces of the lens are segments.

Printing. This term is applied to any method by means of which a positive is obtained from a negative, so that a picture is obtained in which to some extent at least the gradations of light and shade are represented as seen in nature. More

usually, however, this term includes the production of pictures upon any flexible support, such as paper; and as the other branches of printing, such as bromide paper, opals, and lantern slides by means of which prints are obtained by development, are treated of elsewhere, it is the author's intention to confine this article entirely to what is termed sensitised or albumenised paper printing. If the operator desires to sensitise his own paper, instructions will be found elsewhere, and it is supposed that he has his paper ready for cutting to the desired size. The author would impress upon his readers the necessity for cutting the paper, not to the exact size of the finished print, but rather larger. He recommends the use of an old negative glass for cutting it to shape, as this allows of some margin, and does not require such nice adjustment as when the paper is cut to the exact size. Having the paper ready cut, the next operation is to place it in the printing-frame. This should be done in weak daylight, and the film side of the negative should be placed next to the paper, and one or two thicknesses of blotting paper placed on the back of the paper, the hinged back being put into position, and the springs fastened down. The next question which naturally arises is that of light: what light is the best to print in? On this point there can be no doubt; except during the months of November, December, January, and February, and in the case of very dense negatives, sunshine should never be used. Some authorities recommend printing in the sun with a screen of tissue paper over the negative, but even in this case the author thinks better effects are obtained by printing in the shade. Select, if possible, a window-sill or other open space, which has a free, uninterrupted view of the sky, and place the printing-frame out and leave for a short time; then withdraw into a subdued light, and, unfastening one of the springs, turn back the half of the back and examine the paper. Some may think the caution of examining the print in subdued light unnecessary; but it is not. By examining the paper in a strong light the purity of the whites is degraded, and a decided tinge given to them. For printing from weak thin negatives a screen of tissue paper is an advantage, or the back of the negative may be coated with matt varnish or ordinary negative varnish, tinted with gamboge, aurantia, or some other yellow dye. For very dense negatives, as stated above, printing in the sun is allowable. When a negative is very dense at one end and

not at the other, the printing-frame may be placed in a deep lidless box resting up against one side, with the denser end uppermost; by this means the printing may to some extent be equalised. The next question is how dark or to what depth the printing should be carried. On this point considerable difference of opinion exists, it being to some extent dependent upon what toning bath is used, as some baths bleach more than others; but as a rule, for general guidance, printing should be carried on till the whites of the pictures are well coloured and the shadows beginning to block up. Prints should not be kept too long before being toned, as some further chemical change takes place, and discoloration of the paper ensues, and it is then almost impossible to tone satisfactorily, if at all, by any of the ordinary baths. There is one process in photographic printing in which at least considerable artistic skill is required—viz., combination printing, by means of which at least we may to some extent utilise the material already found, and, employing some of the licence of artists of the brush and palette, produce effects which are not strictly true, but are yet more artistic. Thus, in the case of a low-lying horizon, the uniform tint of the sky is extremely unnatural and really untruthful, as we never hardly find in nature a sky so barren of clouds or colours as to present one uniform unbroken tint, as given by the agency of the camera and dry plate. In such a case the sky may be graduated in tint from pure white at the horizon to a deeper tint in the zenith, or we may have recourse to a second negative, and print in some fine masses of clouds. The author has in his possession a print of a bit of an Essex marsh, as flat and as uninteresting in itself as it is possible for anything to be, but the whole has been converted by means of a cloud negative into one of the finest pictures it is possible to produce, the clouds giving one the impression of a dull, windy day in autumn, in which the cattle huddle together and turn their backs to the gale, and man instinctively buttons up his coat and bends his head to the wind. It is, I think, as clever and suggestive in its way as any of the grand compositions of J. W. M. Turner, perhaps the only true artist who could depict wind and clouds. Again, by use of a second negative a figure may be introduced into an otherwise uninteresting stretch of country, giving life and beauty to the whole, and raising the composition at once above the mediocre photograph. To effect such

composition requires true artistic skill and considerable clever manipulation in a photographic sense. The usual method of making such an effect is to print the subject, such as a stretch of land, first, and to utilise this print as a mask. For this purpose the outlines must be carefully cut out with a pair of scissors, and after a second print has been taken, to place the first and cut-out mask over the second print, and place on top of it the cloud or second negative, and again expose to light till the second negative has printed in sufficiently deep. Another method is to paint over the first print with gamboge or some other non-actinic paint, and print again under the second negative when dry. This method, however, is not so satisfactory. For tinting the skies a piece of sheet tin or stout cardboard should be used, and one end bent up to about an angle of 45 degs. This can be placed over the print, and the whole exposed to daylight, the metal or cardboard being moved up or down, so as to graduate the tinting. It is only by practice that success in this branch of printing can be obtained, the chief difficulty being to so blend the print from the two negatives as to show not the slightest trace of the use of two negatives. (For special information as to printing process, the reader must refer to such articles as BROMIDE PAPER, ARTIGUE'S PROCESS, CARBON PROCESS, CYANOTYPE, PIZZIGHELLI PROCESS, PLATINOTYPE, COLLOTYPE, PHOTOGRAVURE, AUTOMATIC PRINTING, AUX DEUX CRAYONS, etc., etc.)

Process Blocks. See CHEMIGRAPHY, FISH GLUE PROCESS, and GALVANOGRAPHY.

"Psychic" Photography. See "SPIRIT" PHOTOGRAPHY.

Psychography. See RETINAL IMPRESSION.

Pyrogallic Acid (Ger., *Pyrogallussäure;* Fr., *Acide Pyrogallique*). $C_6H_6O_3$ = 126. Is not actually an acid, its proper chemical name being pyrogallol; it is prepared by sublimation from gallic acid. In the presence of alkalies in solution it absorbs oxygen from the air, turning black, a carbonate and acetate of the alkali used being formed. It is a powerful deoxidiser and reducing agent, and is more extensively used than any other agent for developing. As pyro is very easily oxidised it is extremely difficult to preserve in solution, many substances being recommended for that purpose; the following are some of them, which are enumerated in the order of their value for that purpose:—

A mixture of glycerine and alcohol, metabisulphite of potash, sulphite of soda, citric acid. Solubility: 1 in 2 of water, the resulting solution measuring $2\frac{1}{2}$; 9 in 10 of alcohol; it is also soluble in glycerine and ether.

Pyroxyline (Ger., *Pyroxylin, Collodiumwolle, Scheissbaumwolle;* Fr., *Pyroxyle;* Ital., *Cotone Fulminante, Pirossilina*). A substance of variable composition obtained by acting upon cellulose $C_6H_{10}O_5$, with a mixture of nitric and sulphuric acids, and in this process one or more atoms of hydrogen are replaced by NO_2. The following directions for preparing it are taken from Hardwich's "Photographic Chemistry," but the author would advise anybody who requires small quantities to buy it ready made, rather than prepare it for his own use, as the operation is not very easy, and the acids are dangerous to handle:—

Sulphuric acid (sp. gr., 1·854 at 60° F.) ...	18 fluid ozs.
Nitric acid (sp. gr., 1·457 at 60° F.) ...	6 ,, ,,
Distilled water	$4\frac{3}{4}$,, ,,

Pour the water into a dish, add the nitric acid, and lastly the sulphuric acid. The mixture must be well stirred, and the temperature, which is raised by the addition of the sulphuric acid, should be allowed to sink to 150° F., at which heat the mixture must be kept by means of a water bath. The wool must be first put in a strong solution of carbonate of soda or potash to free it from its natural oil, and then washed in plain water till the washings show not the slightest trace of alkalinity or the salt used, and dried. The prepared wool should be then weighed out into balls of about thirty grains each, and immersed one by one into the mixture of acids, and well stirred up, care being taken that each little ball is thoroughly saturated with acid; they should be left for ten minutes, and then taken out and washed in running water for twenty-four hours, or till they show no acid reaction with litmus; they can be then dried in the sun, or on a water bath. The resulting production should be entirely soluble in a mixture of equal parts of alcohol and ether, and also inflammable. The nitric acid alone acts upon the cotton, the sulphuric causing this action to be much more rapid. This action of the sulphuric acid is said to be catalytic. A special kind of pyroxyline, called celloidin, has been introduced

by Dr. Schering, of much greater purity than the other, and which yields a much finer collodion. This is said to be prepared by immersing ordinary pyroxyline in pure nitric acid for ten minutes, washing and drying. Pyroxyline is insoluble in water, almost insoluble in alcohol, and ether, but readily soluble in a mixture of the two, and in glacial acetic acid. It is used for preparing collodion. (See CELLULOSE and CELLULOID.)

Radiography. When the intermittent discharge from an ordinary induction coil—which discharge it must be remembered has a prevailing direction, the impulse on breaking contact being much more powerful than that on making contact—is passed through a highly exhausted vacuum tube, radiations are given off from the cathode (negative pole), and appear to be reflected from the anode (positive pole); these when they escape from the tube are found to be not only capable of affecting the gelatino-bromide film, but they also are able to penetrate many substances opaque to ordinary light. Such radiations, as long as they are within the vacuum tube, are generally called Cathode rays; and Hertz, who investigated this subject shortly before his death, which took place on January 1st, 1894, came to the conclusion that cathode rays are fundamentally different in their nature from light rays, but that cathode rays differ among themselves much as the various degrees or wave lengths of light differ among themselves. About the beginning of 1896 Professor Röntgen realised that such radiations as actually escape from the vacuum tube, and which he prefers to rather call X rays than cathode rays, may be used in obtaining outline photographs of many objects invisible to the eye; and the "new photography," thus inaugurated, has been the most popular of all scientific recreations during 1896. Metals and mineral substances are generally very opaque to the X radiations, while vegetable substances, water and the softer animal tissues, are fairly transparent even when coloured black with carbon. Hence it is that if a sensitive plate be wrapped up in ordinary black paper (film upwards), and the hand is laid over the package, an image of the bones of the hand can be obtained on the plate by exposure to the radiations from the vacuum tube. Similarly the shadow of an impacted needle can be cast on the plate. To detect the presence of a substance opaque to

the X rays (or maybe a certain rank or degree of the cathode rays) it is not essential to use a photographic plate, as many substances fluoresce or phosphoresce (see note on fluorescence and phosphorescence under heading LUMINOUS PAINT); and if the shadow of a substance opaque to the rays is received on such a surface, it can be recognised as a dark area on a generally illuminated ground. An abstract of all that has been written regarding Radiography would fill many pages of this DICTIONARY, but we may give the following particulars as to the nature of the outfit required for ordinary work. An induction coil, giving a spark of about 4 in., and five pint cells of Grove's battery to work it, will cost, if of the best quality, from £18 to £20, and a suitable vacuum tube will cost from £1 to £1 10*s*. A fluorescent screen, consisting of paper covered with tungstate of calcium, or platino-cyanide of barium (or potassium), may cost from £1 to £2; and sensitive sheets of negative paper can be obtained, each in a separate black envelope; a very convenient arrangement when it is wished to radiograph for surgical purposes. Several sheets may be exposed at one time, the sensitive material being remarkably transparent to the exciting radiations. Under the heading BIBLIOGRAPHY will be found reference to two treatises on Radiography.

Rapid Rectilinear. See LENS.

Rapidity of Lenses. The rapidity of a lens depends upon the relation the working aperture bears to the focus. It is an almost universally misunderstood question. Because a lens-maker calls any one lens rapid, it is generally supposed that such a lens is the quickest and most suitable for instantaneous or general work, whereas what is termed a wide-angle may be equally as rapid with the same size diaphragm, which gives the same working aperture. The following rule is a standard on this point: "Depth of focus and definition are opposed to rapidity. Whatever increases the rapidity of a lens reduces the power of definition, and conversely any gain in definition and depth, granting the lens to be well made in other respects, must be made at the expense of rapidity." Definition and depth are thus opposed to rapidity. As rapidity is increased with larger aperture, definition and depth are lost, till a point is reached at which the extent of such loss prevents the further

increase of rapidity. Supposing a lens is being used which works at *f*/8, and it is desired to substitute a lens working at *f*/22, and the exposure for a given subject is known with the former, the increase of exposure is found by squaring and comparing these numbers: *f*/8 × 8 = 64, *f*/22 × 22 = 484. Therefore the exposure will be as 64 to 484, or 1 to 7·5. In this way the necessary increase in exposure for any size aperture may be found.

f	*f*	*f*	*f*	*f*	*f*	*f*	*f*	*f*
4^2	6^2	8^2	$11{\cdot}3^2$	16^2	22^2	32^2	45^2	64^2
16	36	64	127	256	484	1,024	2,025	4,096

Or reducing these, and reckoning the exposure necessary with *f*/4 as unity, the exposures will be—1, 2·25, 4, 7·9, 16, 30·25, 64, 126·5, 256.

Rayometer. A kind of actinometer (generally a screen of aluminium of graduated thickness) used in testing sensitiveness to X rays. (See RADIOGRAPHY.)

Reaumur. See THERMOMETER.

Red Fog. See FOG.

Redevelopment. A process usually confined to the wet collodion. It is actually intensification of the image. It has been suggested, however, for dry plates and bromide papers, and is useful in the former case to intensify under-developed negatives, and in the latter to obtain warmer tones. The negative to be intensified is washed thoroughly free from hypo, and bleached in a solution of cupric or mercuric chloride, well washed, and then redeveloped with hydroquinone or ferrous oxalate. To make a solution of cupric chloride:—

Solution I.

Chloride of calcium (crystalline)	147 grs.
Distilled water	2 ozs.

Solution II.

Sulphate of copper	249 grs.
Distilled water	10 drms.

Dissolve each separately, mix, and filter. For obtaining warm tones with bromide paper, the finished print is bleached as above, and then redeveloped with hydroquinone or dilute ferrous citrate developer. To obtain a regular tone it has been recommended to bleach Alpha paper with mercuric chloride, and redevelop with ferrous oxalate.

Reduction (in Size). An exceedingly useful operation in the preparation of lantern slides or prints from larger sized negatives. One or two methods may be adopted, both of which are satisfactory—one for daylight, the other for artificial light; and the arrangements suggested for enlarging with some modifications will do. The negative to be reduced in size should be placed in the same position (see ENLARGEMENT), but in this case the lens is turned towards the negative, and focussed on the ground-glass screen in the usual way. The distance between the negative and the lens may be found by referring to the table given under ENLARGEMENT, or the same rules there given may be used for finding the distances, only they must be reversed—that is, whereas in enlargements the greater distance is between lens and sensitive surface, in the case of reduction the greater distance must be between the lens and negative, and the lesser between lens and sensitive plate.

Reduction of Density. When a negative or print has been over-developed or over-printed, the following processes may be adopted for reducing them:—

Reduction of Negatives. Howard Farmer's Reducer. This was suggested by Howard Farmer in 1883. Make a 10 per cent. solution of ferridcyanide of potassium, immerse the negative which should preferably have been dried in a 1:8 solution of hypo, and then add a few drops of the ferridcyanide reducer, and carefully watch the action, taking the negative from the solution before quite reduced to the desired degree. The more ferridcyanide added, the stronger and quicker the action; when only a little ferridcyanide is used, the action proceeds slowly and the gradation does not suffer, with larger quantities the shadows can be eaten away and the contrasts increased.

Belitski's Reducer. This is the most convenient as it is one solution, will keep in the dark indefinitely, can be used over and over again, and when inactive and exhausted the colour changes.

Potassium ferric oxalate	22 grs.
Sodium sulphite	18 ,,
Water	1 oz.

When dissolved add—

Oxalic acid	3 grs.

and shake till the blood-red solution turns green; decant from any undissolved acid, then add—

Sodium hyposulphite	120 grs.

Dissolved in

Water	½ oz.

This can be applied immediately after fixing or to a previously dried negative, and causes no stain.

Eau de Javelle. The method of using this is as follows :—

Solution I.

Chrome alum	20 grs.
Distilled water	1 oz.

Solution II.

Eau de Javelle or Labarraque's Solution.

The Reducer.

Solution I.	½ oz.
,, II.	½ ,,
Water	5 ,,

This mixture is first of a thick green colour, and then turns to a clear yellow. If the negative has been dried, soak in water till wet, then cover with the reducer, and, when sufficiently reduced, wash and refix in hypo. It is well adapted for local reduction as a little of Solution II. may be applied on the tip of the finger.

Cupric Chloride. Spiller suggested the use of—

A.

Alum	120 parts.
Copper sulphate	120 ,,
Common salt	240 ,,
Water	1200 ,,

B.

Saturated solution of common salt.

Before use mix in equal parts and immerse in the solution till sufficiently reduced, then wash well.

Cyanide Reducers. Several formulæ have been suggested for these, but their action is not to be depended upon.

Lainer's Iodide Reducer. Lainer has suggested the following:—

Potassium iodide	10 grains.
Sodium hyposulphite	250 ,,
Water	2½ ozs.

in which the negative is laid. Reduction takes place gradually and evenly.

To Reduce Prints. Bromide prints may be reduced in exactly the same way as negatives. Albumenised Paper Prints may be reduced by dipping into cupric chloride, or by using the chloride of lime or platinum toning baths. To Reduce Ferro-Prussiate Prints, dip into a weak bath of liq. ammonia, and then into weak hydrochloric acid.

Reflected Light is the light obtained by reflection from any mirror or white surface. It is extremely useful in portraiture for lighting up the shadowed side of a sitter's face; but care should be taken, however, that too much reflected light is not used, or the result will be a hard and lifeless picture. Mirrors should rarely be used, and a rough, not too white surface is the best.

Reflection of Light. When a ray of light falls upon a mirror, the ray is bent from its original direction into another;

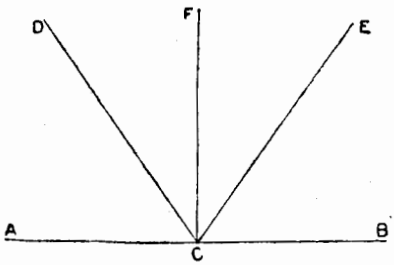


Fig. 96.

this is said to be reflection. Reflection of light obeys certain well-known laws, the first of which is that the reflected ray must

lie in the same plane as the incident ray; the second law is that the angle formed by the reflected ray with the normal must be equal to the angle formed by the incident ray. The reflected ray, CE, is in the same plane as the incident ray, DC, and the angle ECF is equal to the angle DCF (fig. 96).

Refraction of Light. When a ray of light passes obliquely from one transparent medium to another it suffers refraction, or is bent out of its course on emerging from that medium. Refraction obeys well-known laws somewhat similar to reflection. The first law is that the incident, the normal and the refracted rays are in the same plane, and the second that the sine of angle formed by the incident ray with the normal bears a constant ratio to the sine of angle formed by the refracted ray with the normal. The sine of the angle of refraction, in relation to the sine of the incident angle = 1, is the refractive index of the substance. It is necessary for practical opticians to find the refractive index of their glass, and this they do often by making it into a lens of known surfaces, and finding by trial the focus of the lens. It can also be done by decomposing a ray of white light by means of a prism constructed of the glass, and measuring the refraction of a certain line of the spectrum by suitable instruments. The different coloured rays of the spectrum have different refractive indices, that for violet being the greatest, and that for red the least; and this fact is taken into consideration in the achromatising of lenses. (For further information on Reflection and Refraction the reader is referred to any elementary work upon light or optics.)

TABLE OF INDICES OF REFRACTION (FOR D).

Phosphorus	1·075
Carbon disulphide	1·634
Oil of cassia	1·580
Aniline	1·570
Nitrobenzine	1·540
Phenol	1·550
Cubebine...	1·510
Pseudocumene	1·490
Benzine	1·490
Glycerine	1·470
Turpentine	1·460

TABLE OF INDICES OF REFRACTION (FOR D)—*continued.*

Chloroform	1·440
Amylic alcohol	1·400
Ethylic alcohol	1·390
Ether	1·350
Acetone	1·350
Methylic alcohol	1·33
Water	1·33
Diamond	2·47
Crown Glass	1·55

Registration. Any photograph may be registered at Stationers' Hall on payment of a very small fee, and if the registration is effected by the actual producer of the photograph, before any copy has been sold, the copyright is secured. A photographer cannot secure copyright in a photograph which he makes as a matter of business for a customer, and copyright only extends to the photograph, never to the original. Let us suppose a photographer to have access to a unique document, picture, or even photograph. For illustration, let us assume it to be the first daguerreotype ever produced. He could secure copyright in his reproduction, but any other photographer gaining access to the original could also secure copyright in his own reproduction.

Rembrandt Portrait. When the shaded side of a sitter is portrayed with the light more or less behind the head, the picture is given the above name, from a fancied resemblance to the works of that great master. (See PORTRAITURE.)

Removal of Film. See FILM; also NEGATIVES, STRIPPING OF.

Residues. The saving of the unused silver and gold salts in use in photography may be said to be almost beyond the amateur, unless he is in the habit of doing a very large amount of work, but the following directions will prove useful:—To reduce the silver from the fixing baths, the old solutions should be placed in a tub with some crude sulphide of potassium (liver of sulphur), and the silver will be precipitated as a black deposit of sulphide, Ag_2S. This should be allowed to collect at the bottom of the vessel till some considerable amount is ready, when it may be reduced to metallic silver, as described

below, or sent to the refiner. All clippings and trimmings from untoned prints should be reserved, and when a fair quantity is obtained should be burnt, commencing at the top of the pile, or the paper may be beaten to pulp, with dilute sulphuric acid, and strips of metallic zinc or copper placed in the mixture; metallic silver will be precipitated, and the zinc or copper dissolved. The washings of untoned prints should be placed in a jar, and common salt added till no further precipitate is caused, and the precipitate may be collected and treated as above, or all the residues may be mixed with well-dried carbonate of sodium, and fused in a crucible. To reduce old toning baths, whether of platinum or gold, add solution of ferrous sulphate; a black precipitate, of carbonate and oxide of iron mixed with metallic gold, results. This may be digested in aqua regia, and the gold in the resulting solution reprecipitated by ferrous sulphate in a pure state, when it can be redissolved in aqua regia to form the auric chloride. Ordinary albumenised paper absorbs about 30 grs. of nitrate of silver, equal to 19 grs. of pure silver for every sheet. Each sheet weighs about 340 grs.; therefore a quire will weigh about 8,160 grs., and contain about 456 grs. of pure silver. Of the silver used in sensitising paper will be found—

In the finished print about	3 per cent.
„ cuttings about	7 „
„ washing, before toning, about	50 to 55 „
„ fixing bath...	25 „ 30 „
„ washing after fixing	5 „

Restrainer. Any substance used to prevent the too energetic reducing or developing action of any chemical upon the exposed film. Restrainers may be of two kinds—mechanical and chemical. To the first class belongs water or any tanning agent, as chrome alum, which renders the gelatine less permeable to the developer. To the second class belong any soluble bromide or chloride, and the citrates of potash, soda, and ammonium. A soluble bromide is added to the developer to check the reduction of the unaltered silver bromide, the soluble bromide seemingly forming a double bromide with it, which is less acted upon by the developer. The restraining power of the bromides of ammonium, potassium, and sodium bear the following proportion to

one another:—Bromide of ammonium—98 parts are equal to 119 parts of bromide of potassium, and equal to 103 parts of bromide of sodium. Bromide of ammonium is, therefore, the strongest, potassium bromide the weakest, and the sodium salt the medium. The citrates of potassium, sodium, and ammonium seem to act in entirely a different manner; whereas the bromides prevent the excessive deposit on the high-lights to some extent and allow detail to appear, the citrates prevent detail and allow density to be obtained. To make these restrainers, the bromides can be simply dissolved in water, as follows:—

Ammonium bromide	98 grs.
Distilled water, to make	980 mins.

of solution, each drachm of which will contain 6 grs. of bromide.

Potassium bromide	119 grs.
Distilled water, to make	980 mins.

of solution, each drachm of which will contain $7\frac{3}{7}$ grs. of bromide of potassium, equal in restraining power to 6 grs. of bromide of ammonium.

Sodium bromide	103 grs.
Distilled water, to make	980 mins.

of solution, each drachm of which will contain $6\frac{1}{8}$ grs. of sodium bromide, equal in restraining power to 6 grs. of ammonium bromide, or to $7\frac{3}{7}$ grs. of potassium bromide.

Citrate of Potash Restrainer.

	Citric acid	720 grs.
	Bicarbonate of potash	944 „
or	Carbonate of „	884 „
	Distilled water, to make	$2\frac{1}{2}$ ozs.

of solution.

Citrate of Ammonium Restrainer.

Citric acid	720 grs.
Liq. ammonia, ·880	630 mins.
Distilled water, to make	$2\frac{1}{2}$ ozs.

of solution.

Citrate of Soda Restrainer.

	Citric acid	720 grs.
	Bicarbonate of soda	884 ,,
or	Carbonate of soda (crystallised)... ...	1,440 ,,
	Distilled water, to make	2½ ozs.

of solution. These solutions will keep indefinitely, and may be diluted as wanted by adding one part of the above to 5 parts of water. The advantage of these last three restrainers is that when a negative shows plenty of detail, but refuses to gain density, the addition of a little of one of the dilute solutions may be made, and the plate left for hours if necessary, till the required density is obtained, without the slightest sign of fog.

Retinal Impression. Psychography, and the physical rendering of thought. Mr. Ingles Rogers states that after gazing at an object for a certain period, and then, in the dark room, directing his gaze towards a sensitive plate, and thinking of the object, a more or less distinct image of the object was impressed upon the plate, and development became possible. Further, he believes that an object seen long since and thought of while his gaze was directed towards the plate, became impressed thereon. Mr. A. B. Chatwood has made experiments in the same direction, and has arrived at conclusions partially similar. (See *The Amateur Photographer* Feb. 21st, and March 20th, 1896.)

Retouching is the operation of treating a negative by aid of a pencil or by use of a brush and colour, so as to hide the defects of manipulation or soften down the otherwise too obtrusive freckle or wrinkle in a sitter's face. The subject is too comprehensive to enter upon at any length, as the necessary qualifications for a good retoucher for the face and hands, which are generally those parts which it is desired to retouch, are, first, a general idea of the anatomical position of the muscles and bones of the hands; and, secondly, considerable artistic skill in wielding the pencil or brush. But for the operator who may desire to retouch a landscape negative, so as to be able to block out any pinhole in the sky or other light portion, the following may be of some assistance:—Some sort of retouching desk is needed, and this can be improvised from material within the reach of every one, all that is necessary being a printing-frame of the correct size, a deal board, a piece of black cardboard, and a

small mirror or white card. Unscrew the springs of the printing-frame and temporarily remove them altogether, make a small hole in one end of the face of the frame, have a deal board about 12 ins. long and 6 ins. broad, and arrange as shown in diagram:—D D, deal board; S S, two nails driven well into board to prevent frame slipping; P, the support for frame; and B, the black card to prevent top light. A mirror or white card is laid

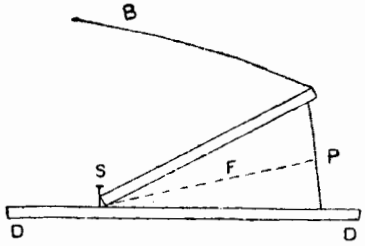


Fig. 97.

upon D D underneath the frame F, so as to reflect the light up through the negative lying in the rebate of the frame. If the reflection from the mirror be too great, a piece of ground-glass or a focussing screen may be intervened midway between frame and mirror, in the position of the dotted line. The negative to be retouched should be varnished well with any good negative varnish, and allowed to dry thoroughly; then on those places where retouching is required should be dusted a little very finely

Fig. 98.

powdered cuttle-fish, and, using the finger as a pad, rub the powder up and down or in a circular manner, till on examining the film through a magnifying glass it is seen to be quite rough; now dust the superfluous powder off, and it is ready for work. The amateur retoucher had better begin by using lead pencil, a Faber's or Hardtmuth's HHHH or HHHHHH being perhaps the most suitable, and the point should be sharpened in the following manner:—The pencil point should always be kept very sharp by rubbing on fine emery paper. Now touch the

abraded surface over the pinhole in a circular manner till the hole is no longer visible. It is as well after several pinholes have been retouched to take a print from the same to see whether they show or not. Instead of the cuttle-fish advised above, any of the following matt varnishes may be used:—

Amber resin	10 grs.
Benzole	1 oz.

Dissolve, and allow to subside for twenty-four hours before use.

Gum dammar	10 grs.
Canada balsam	5 „
Turpentine	1 oz.

Or

Sandarac	6 grs.
Shellac	36 „
Mastic	36 „
Ether	12 drms.

Dissolve, and add

Benzole	2 drms.

To retouch for broad effects Professor Fritz Luckhardt adopts the plan of covering the back of the glass with collodion slightly tinted with a colouring material. When dry the film is scraped away where not wanted; that is to say, where one wishes the negative to print with full vigour. A layer of matt varnish slightly tinted may now be applied, and a second scraping away to suit the subject can be performed. Shading with blacklead powder applied with a stump, and partial masking with fine tissue paper, may come in at this stage, while the paper may form a fresh basis upon which blacklead work may be done. A few drops of aurantia solution in alcohol may be added to plain collodion or matt varnish as purchased or prepared, so as to give the required depth of tint; but in the case of all considerable operations at the back of the negative, trial prints should frequently be made.

Reversal is when those parts of the image which should appear dark in the negative come up light, and *vice versâ*. It is due to the extreme action of light, and is also known as solarisation. There is no remedy when reversal has taken place.

Reversed Negatives. This means that the position of the picture is reversed as regards right and left. Reversed negatives are required for certain photo-mechanical work. They may be made :—First, in the camera direct; secondly, by reversing the negative film itself; thirdly, by reproduction from other negatives. First method: Taken in the camera direct. This again may be divided into three heads—viz., (*a*) those taken by means of a silvered reflector; (*b*) those taken by means of a prism; and (*c*) those taken through the glass plate on the back of the film. By the first of these methods a piece of glass silvered on the external surface must be used, and mounted in the following manner:—C, camera; L, lens; F A B D is the section of a hood which can be screwed on to a camera; A D, the reversing mirror, placed at an angle of 45° with the axis of the lens, and so adjusted that

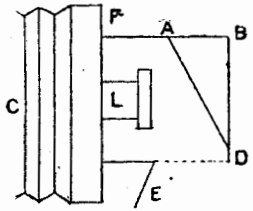


Fig. 99.

the axis of the lens is continued to the centre of the mirror; E is a small door, which can be opened or closed at will (in fig. 99, A D is not shown at the specified angle). The camera is placed sideways towards the object, which is reflected from the exterior surface of A D to the lens. By the second method a right-angled prism is used, as shown in fig. 100. The principle involved being precisely the same as with the mirror, the camera is again turned sideways to object. A B is a hood to fit on lens to take the place of the cap. C C is a right-angled prism, whose breadth is greater than the diameter of the front glass of lens. All the surfaces except C C are enclosed in brass-mounting, but the surface H, opposite to the right angle, must not touch the glass. E is a shutter for exposing; F, F, the screws for clamping same. The third method is by taking negatives through the glass. The most convenient way of doing this is to

have a piece of glass of the same thickness as used for the plate ground on one side, and the ground surface placed outside, just the opposite way to the usual focussing screen. The back of the plate must be carefully cleaned, and should be inserted in the dark slide, with the glass towards the shutter of slide. Care must be taken that the spring used to keep the plate in position does not injure the film.

Second method of procedure: By reversing the negative film itself. This is comparatively easy, and can be done as follows:— The negative is taken and developed in the ordinary way, washed and dried, and is coated with a solution of india-rubber

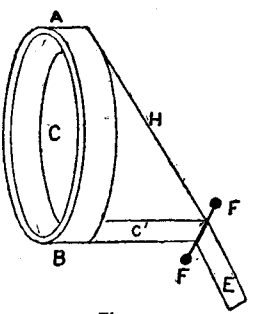


Fig. 100.

in benzole, and when dry coated with transfer collodion made as follows:—

Pyroxyline	24 grs.
Castor oil	24 mins.
Methylated spirit, ·805	2 ozs.
,, ether, ·730	1 oz.

And allowed to dry, and placed in a bath of

Hydrofluoric acid	1 drm.
Distilled water	10 ozs.

The film will soon begin to get loose, and should be gently raised up and floated off into a bath of clean water and washed thoroughly, and then floated in a reverse position—that is, with

the collodionised side downwards—on to a plate coated with a warm solution of gelatine (about 5 grs. to the ounce). It should be then squeegeed into contact and left to dry. (See also NEGATIVES, STRIPPING OF).

The third method: By reproduction from the negative:—A dry plate is soaked for five minutes in a 4 per cent. solution of bichromate of potash, rinsed once or twice in water, and then dipped into a bath of equal parts of methylated spirit and water, the superfluous moisture blotted off, and dried. All these operations must be conducted in the dark-room. It is then exposed under the negative to be reversed to sunlight for three or four minutes, when a faint delicate image will be seen impressed; it is then washed and developed with ferrous oxalate or alkaline pyro, and fixed and washed as usual. The result is a reversed and negative image.

Rising Front. A movable piece of wood fitted to the front of camera, which can be moved up and down so as to exclude or include more or less of the foreground of a picture without shifting camera. It should be sparingly used, however, as of course the shifting of the lens either up or down causes the optical axis of the lens to be altered with regard to the centre of the plate; and as the brightest illumination is obtained with the central rays it is obvious that unequal illumination may ensue.

Rives Paper. A particular make of paper specially prepared at Rives in France, for photographic purposes.

Roller Slide. The use of films and paper supports for the sensitive compounds suggested, of course, the natural idea of using the same in a continuous band for the purpose of exposing on many subjects without changing, and for this purpose the roller slide was devised quite in the early days of photography.

Rolling Prints. Consists of passing prints between two rollers, or between a roller and a bed of steel. It improves the appearance, and causes the print to lie flat.

Röntgen Rays and Method. See RADIOGRAPHY.

Ruby Light. See DARK-ROOM.

Salicylic Acid (Ger., *Salicylsäure;* Fr., *Acide Salicylique*), $HC_7H_5O_3$. Occurs naturally, but is prepared commercially by heating carbolic acid with caustic soda and passing carbonic acid into the mixture. Solubility: 1 in 700 of cold water, 1 in 9 of boiling water, 1 in 4 of alcohol; 20 grs. with 20 grs. of borax or acetate of potash will dissolve in 1 oz. of water. It is but rarely used in photography; as a preservative it is added to some mountants, and as salicylate of soda is recommended to give increased sensitiveness to dry plates.

Screen, Coloured. See ISOCHROMATIC PHOTOGRAPHY AND PHOTOGRAPHY IN NATURAL COLOURS.

Screen, Lantern. See AERIAL SCREEN; also MAGIC-LANTERN.

Screen, Ruled. See FISH GLUE PROCESS.

Sculpture, Photographic. A method was formerly in use by which a number of silhouettes taken simultaneously served as a mechanical guide in the first modelling of the clay. (See a suggestion in article POLYPOSE.) Bas-reliefs may be made by the following process, given in *The Amateur Photographer:* "Grind a lantern-sized plate, and having set it tolerably level on the rim of a wine-glass, flood it with the following mixture:—

Gelatine	60 gr.
Water	1 oz.

Soak until the gelatine is soft, then melt by setting the vessel in hot water, and when completely melted, stir in—

Liquid ammonia	4 drops.
Powdered bichromate of potassium ...	10 gr.

Skim off the surface skin and all air-bubbles, using strips of thin card as skimmers, and now flood the plate, which is supported, ground side upwards, on the wine-glass. As soon as the gelatinous mixture is on the plate a more accurate levelling can

be obtained by noticing where the liquid tends to flow off, and wedging up the foot of the glass by means of match-stems cut taper. Finally, pour on as much as the plate will hold, or about one-sixteenth of an inch in height. All this must be done quickly, and before the mixture sets; but by previously warming the plate the setting of the mixture will be hindered, and more time becomes available. The plate should now remain at rest until the mixture sets, when the plate can be set up on edge to dry, in a photographically dark room of course. Next expose in a printing-frame under a negative for about one and a-half times as long as would be necessary for printing-out paper, or until all details are visible, in a darkened tint, at the back of the plate. Now soak for five or ten minutes in cold water, when the gelatine will swell and give a most delicately modelled bas-relief. A cast must be made from this in plaster while the gelatine is wet, and the plaster cast is a basis for any further reproduction. To cast in plaster, a small quantity of oil is dabbed on the gelatine relief with a hog-hair brush, and four strips of wood are placed round the plate, so as to leave a recess about an inch deep. Into this recess is poured the plaster of Paris, mixed with water to the consistency of thickish cream, and, with a view of removing any air bubbles, a camel's hair brush is worked through the liquid plaster so as to once sweep the surface of the gelatine relief. When the plaster is quite set, the thin edge of a knife should be inserted under one edge of the cast, and the cast is separated by a slight and very slowly increasing strain applied by forcing the blade to an angle with the face of the plate. When the plaster cast is obtained, a reproduction can be made from it in metal, earthenware, ebonite, or almost any material."

Sensitiveness, Sensitometry. See under heading EXPOSURE. As supplementary to this the following relative speed details by Mr. Alfred Watkins may be given:—Mr. Watkins says that Cadett's H. and D. number is to be multiplied by $1\frac{1}{4}$ to give his plate speed number, Imperials multiplied by 1, and Marion's by $1\frac{1}{2}$. Thus Cadet H. and D. 100 = Watkins 125; Imperial H. and D. 100 = Watkins 100; Marion's H. and D. 100 = Watkins 150. Mr. Watkins gives some words of caution thus: "The speed of different batches of plates of the same maker's plates

often varies. It must by no means be presumed that the quickest plates on this list are the best for hand-camera work. The figures are no guide to quality of film, and quick-plates do not keep well. In many cases higher numbers than those given must be used to avoid so-called over-exposure." Tables of the relative sensitiveness of various silver compounds are given under SILVER.

Shutters, Instantaneous. When the images of rapidly moving objects are desired, it is found that the hand is not quick enough to uncover and recap the lens, therefore some mechanical device is used for this purpose, and is called an instantaneous shutter. The names, styles, and prices of these are legion, but they may be conveniently divided into two main classes: (I.) Exposing Shutters; (II.) Rapid Shutters. As some practical guide, the following notes on each form are given:—

(I.) *Exposing Shutters.* These are more or less simple arrangements devised to replace the cap, and are usually fitted

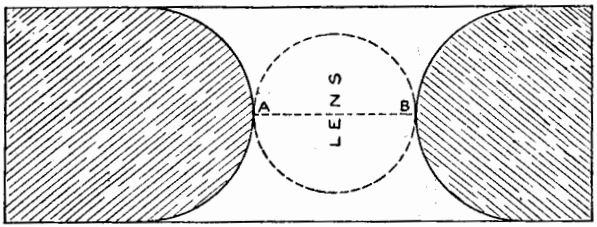


Fig. 101.

to the lens hood and actuated by a pneumatic ball and tube, which releases that portion of the shutter covering the lens, and again covers the objective when the necessary exposure has been given. Usually pressure on a ball, or the tension on a string or cord, raises a flap from in front of the lens, which remains raised till such pressure or tension is removed when the necessary exposure has been given. Many of the shutters classed in Section II. are arranged to give time exposure also.

(II.) *Rapid Shutters.* This class may be again conveniently divided into (*a*) shutters working in front of the lens, (*b*) those

working behind the lens, (*c*) those working in the diaphragm slot, (*d*) those working in front of the sensitive plate.

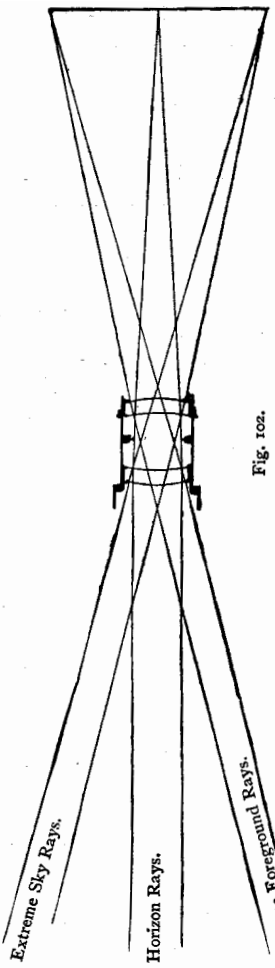


Fig. 102.

(*a*) *Shutters Working in Front of the Lens.* I have to confess that the treatment of this subject is like an eternal division sum, but my idea is to provide a practical guide to the choice of a shutter. We may again divide into classes—

(Class II., *a* 1) *The Simple Drop.* This consists of a sliding piece of wood or ebonite, with an aperture which, passing in front of the lens, makes the exposure. The longer the aperture in the dropping piece the more even the illumination of the plate. From theoretical considerations the aperture should take the form shown in the accompanying diagram (fig. 101), the distance along the dotted line A B being made equal to, or twice, or thrice, the diameter of the lens: the narrower this aperture the quicker the exposure, but the less light admitted during exposure. The longer the slide drops before uncovering the lens, the more even the illumination of the plate and the shorter the exposure. In this, as in all shutters fitting on the hood of the lens, the aperture of the shutter should never be smaller than the lens aperture, or it acts as a stop. Some of the drop-shutters are so arranged that the aperture may be elongated or shortened by an additional sliding piece.

(Cl. II., *a* 2) *The Flap and Drop.* This is a combination of the flap with a drop, and the flap is raised, and then at a given point the drop falls. This class of shutter gives more exposure to the foreground than the sky. A modification of this form has been introduced, in which the flap rises, and then turns on a bar and falls like a drop.

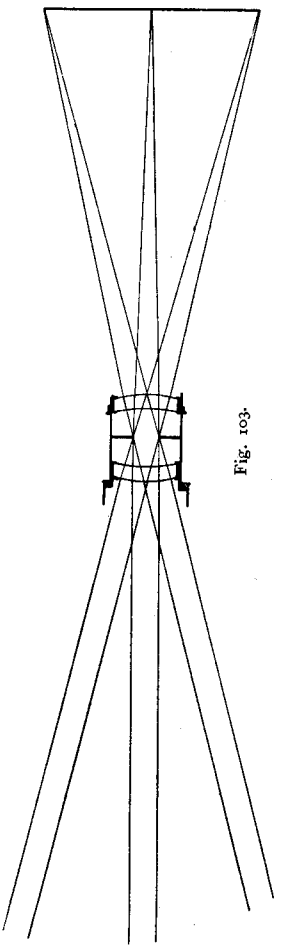


Fig. 103.

(Cl. II., *a* 3) *The Double Drop.* In this form a sliding piece is raised by pulling a string, and then when the lens is completely uncovered another sliding piece falls, closing the aperture; thus more exposure is given to the foreground than sky.

(Cl. II., *a* 4) *The Rotating Screen.* In this style of shutter a rotating screen uncovers and covers the lens aperture. In several shutters of this class a special shape is given to the rotating screen to give more exposure to the foreground.

(Cl. II., *a* 5) *The Flap and Double Flap.* The principle of this class consists of a flap which is raised and lowered, or one which is raised, opening the lens, and another closing the lens.

(Cl. II., *a* 6) *The Go and Return.* The disadvantage of this class of shutter is that, if the moving part is heavy and not counterbalanced, the reversal of the motion at the critical moment of exposure, that is, when the lens is fully open, is apt to cause vibration and blurring of the outline. Many shutters of this class are constructed to fit in front of, behind, or between, the lenses.

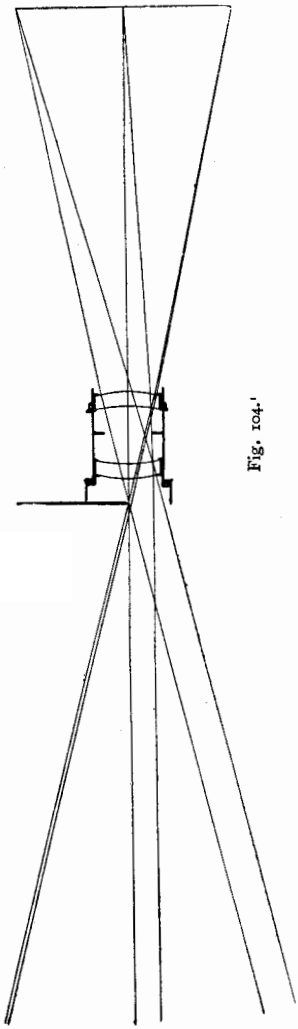


Fig. 104.

(Cl. II., *a* 7) *The Blind Pattern.* This is again a very favourite form, and one which, acting on the principle of the simple drop-shutter, gives a fair range of speed. It consists of a blind of opaque cloth fastened at each end to rollers, the lower one being provided with a coiled spring, the upper with a small milled head for winding up the material, which, on the release of a catch, passes in front of the lens, exposing the plate and again covering the lens.

(Cl. II., *a* 8) *Shutters opening from Centre.* The form of opening takes various shapes, from the long straight narrow strip—the eyelid, and the diamond. The first form of opening is given by two roller blinds opening from the centre and closing again to the centre. In the second form, the aperture takes first the shape of an eyelid, and opening from, and closing to, the centre. In the third form the aperture takes the form of a diamond, opening from, and closing to, the centre.

(Cl. II., *a* 9) *The Ever-Set Shutter.* This shutter is of French origin, but is now made by many English firms.

(Cl. II., *b*) *Shutters Working behind the Lens.* There are few shutters on the market specially constructed to work in this position, though many of those working in front of the lens can be thus used, especially the blind pattern.

(Cl. II., *c*) *Shutters Working Between the Lenses.* This variety is again divided into (1) The go and return; (2) the blind or drop; (3) opening from and closing to centre with eyelid aperture; (4) opening from and closing to centre with diamond aperture; (5) opening from and closing to centre with longitudinal strip opening; (6) Iris diaphragm action: (7) rotating screen.

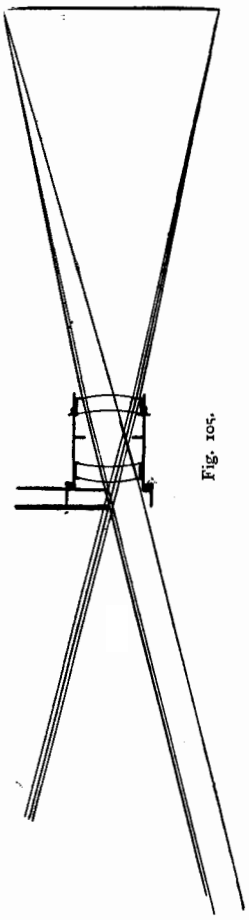


Fig. 105.

(Cl. II., *c* 1) *The Go and Return.* This form has for some time held the front rank in between-lens shutters, but is open to the theoretical objection that the reversal of the motion at the critical moment of exposure, when the lens is fully open, is liable to cause vibration.

(Cl. II., *c* 2) *The Blind or Drop.* In the case of the drop it is obvious that the lens mount has to be cut to allow the dropping-piece to pass through. This has, probably for this reason, found but little favour. The blind form is practically the same as that made for the front of the lens but with a narrow slit.

(Cl. II., *c* 3) *Opening from and Closing to the Centre with Eyelid Aperture.* This form of aperture is a favourite one.

(Cl. II., *c* 4) *Opening from and Closing to the Centre with Diamond Aperture.*

(Cl. II., *c* 5) *Opening from and Closing to the Centre with Longitudinal Strip Opening.* So far as I am aware there is only one commercial shutter which gives this form of opening, and it consists of double blinds which work in opposite directions.

(Cl. II., *c* 6) *Opening from and Closing to the Centre with*

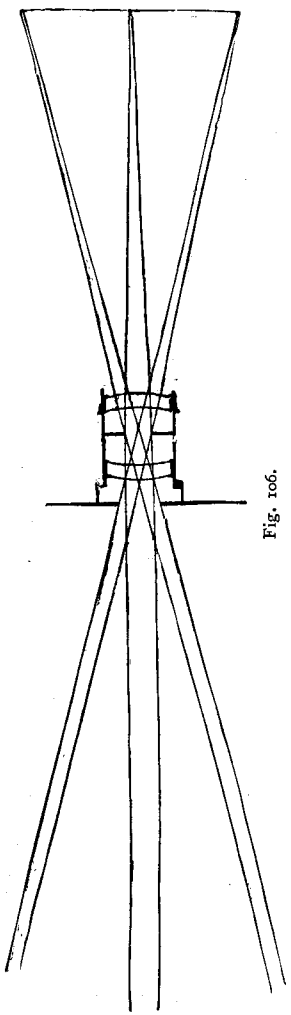


Fig. 106.

Iris Diaphragm Action. Several new shutters have lately been introduced of this pattern.

(Cl. II., *c* 7) *Rotating Screen.* In this form a screen pierced with a circular aperture rotates across between the lenses.

(Cl. II., *d*) *Shutters Working in front of the Sensitive Surface.* —In this form of shutter, which is by no means new, a roller blind with a narrow slit in it, passes immediately in front of the sensitive surface, thus exposing the same in successive portions, and allowing the lens to act with full aperture for the whole period of exposure—no matter how short that exposure be. This shutter also possesses the advantage of allowing any focus lens, or a lens of any diameter, being used without any difficulty.

As to make a choice of shutters it is necessary to understand something of the manner in which they act, we will first of all show the lens working at full aperture fig. 102. From this it will be seen that far more light is transmitted axially, that is, with the horizon rays, than with the sky and foreground, but if the lens is stopped down to *f*/16 as shown in fig. 103 the illumination is practically equal. For this particular portion of my notes shutters are only divided into four main classes:—A, those acting in front

of the lens; B, in between the lenses; C, behind the lens; and D, in front of the plate. To learn the action of any shutter on the light and image transmitted by a lens, the reader is advised to take a piece of card, and pass it across the diagram in the direction of the moving parts of the actual shutter; he will thus be able to see the action of shutter he is thinking of buying. As an example, we will take the *Go and Return* shutter acting in front of the lens, and show it when the moving piece is halfway up fig. 104. From this it will be seen that there is considerable difference in the amount of light received by the plate. It is not a matter of indifference whether the shutter be close to the lens or not, as will be seen from fig. 105 there being a considerable gain when it is close to the lens. With shutters opening from, and closing to, the centre in front of the lens, the centre of the picture, which is generally the horizon of the picture receives far more light than the margins, which include the sky and foreground, the action of such a shutter being shown in fig. 106. When this class of shutter acts between

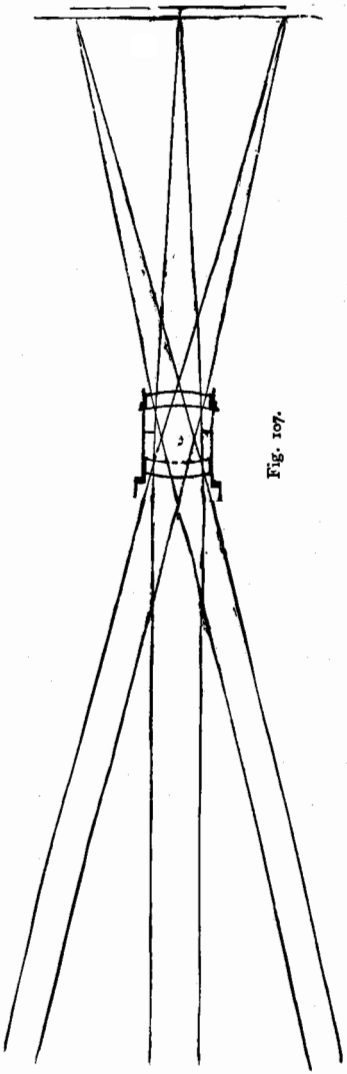


Fig. 107.

the lenses it is in the very best position, and acts for part of the time as a small stop, and therefore should give better definition with a large aperture than any other kind. The last type of shutter is the focal plane, and this is a flexible blind working close to the surface of the plate. This is the best position as to light, for no matter how brief the exposure, the full intensity of the light transmitted by the lens reaches the plate. The action of such a shutter is shown in fig. 107. Such a shutter may depict a moving object with microscopic sharpness, owing to the narrowness of the slit, yet deform the image taken as a whole. As a practical help also we add a table giving the speeds of various commercial forms of shutter arranged in classes as above.

Table of commercial shutters, showing the speed of each. Where the speed is distinguished by an asterisk, it has been experimentally determined by some observer; in all other cases the speed is that stated by the makers; where no speed is given, this depends upon particular circumstances, such as, with the drop shutter, the use of indiarubber bands, etc.

Class and Name.	Speed.		Remarks.
	Lowest.	Highest.	
I.—Exposing Shutters.			
Cadett's Drop	Time	$\frac{1}{33}$ sec.*	...
„ Pneumatic	„	...	...
Lancaster's Pneumatic ...	Time*	$\frac{1}{25}$ sec.*	$\frac{1}{25}$ sec. sky, $\frac{1}{20}$ sec. foreground.
Marion's Dolce	Time	...	...
Newman's Studio.....	„	...	...
Taylor's Exposing Flap ...	„	...	...
Thornton-Pickard Studio	„	...	...
Tylar's Self-Portrait	„	...	...
II.—Rapid Shutters.			
a 1. *Drop.*			
Simple Drop	$\frac{1}{7}$ sec.*	$\frac{1}{15}$ sec.*	...
„ „ with india-rubber bands	...	$\frac{1}{40}$ sec.*	...

Class and Name.	Speed.		Remarks.
	Lowest.	Highest.	
a 2. *Flap and Drop.*			
Reynolds and Branson's "Leeds"	$\frac{1}{50}$*	$\frac{1}{100}$ sec.*	$\frac{1}{60}$ sec. sky, $\frac{1}{50}$ sec. foreground; and $\frac{1}{75}$ sec. foreground, $\frac{1}{100}$ sec. sky.
Reynolds and Branson's "Phœnix"			
Robinson's "Regent"	...	$\frac{1}{15}$ sec.*	Less for sky, $\frac{1}{22}$ sec.*
a 3. *Double Drop.*			
Place's	Time	$\frac{1}{33}$ sec.*	$\frac{1}{28}$ sec. sky, $\frac{1}{32}$ sec. foreground.
Tylar's Foreground	,,	$\frac{1}{33}$ sec.*	$\frac{1}{28}$ sec. sky, $\frac{1}{33}$ sec. foreground.
Vevers' Window Blind ...	,,	$\frac{1}{33}$ sec.*	$\frac{1}{28}$ sec. sky, $\frac{1}{33}$ sec. foreground.
a 4. *Rotating Screens.*			
Cadett's Lightning	$\frac{1}{25}$ sec.*	$\frac{1}{33}$ sec.*	...
Lancaster's Instantograph	...	$\frac{1}{15}$ sec.*	Screen shaped to give less sky exposure.
Leisk's Sky	$\frac{1}{10}$ sec.*	$\frac{1}{12}$ sec.*	Less for sky.
Underwood's XL.	$\frac{1}{21}$ sec.*	$\frac{1}{30}$ sec.*	And time.
a 5. *Flap and Double Flap.*			
Furnell's	...	$\frac{1}{18}$ sec.*	...
Guerry	...	$\frac{1}{38}$ sec.*	...
Tylar's Norden Flap	$\frac{1}{6}$ sec.*	$\frac{1}{11}$ sec.*	Sky $\frac{1}{10}$ sec., foreground $\frac{1}{6}$ sec.; sky $\frac{1}{20}$ sec., foreground $\frac{1}{11}$ sec.
a 6. *Go and Return.*			
Lancaster's Chronolux.....	4 sec.*	$\frac{1}{32}$ sec.*	...
Mitchell's Pneumatic Return	...	$\frac{1}{18}$ sec.*	Less for sky.
Perken's Plunge	$\frac{1}{6}$ sec.*	$\frac{1}{11}$ sec.*	...
a 7. *Blind.*			
Kershaw	...	$\frac{1}{100}$ sec.*	...
Thornton-Pickard's Time	Time*	$\frac{1}{75}$ sec.*	See table below.
,, ,, Instantaneous	$\frac{1}{28}$ sec.*	$\frac{1}{75}$ sec.*	,, ,,
Underwood's Instantolux	$\frac{1}{23}$ sec.*	$\frac{1}{75}$ sec.*	...

Class and Name.	Speed.		Remarks.
	Lowest.	Highest.	
a 8. *Opening from Centre.*			
Gotz Wing	...	$\frac{1}{60}$ sec.*	With two extra bands, $\frac{1}{85}$ sec.
Lancaster's '90 Chronolux	3 sec.*	$\frac{1}{80}$ sec.*	...
Thornton-Pickard's Double Blind	...	$\frac{1}{400}$ sec.*	...
Sands and Hunter's Ribbon	...	...	...
The "Stanley".....	17 sec.*	$\frac{1}{40}$ sec.*	...
Stereoscopic Company's ...	...	...	...
Watson's Double Snap ...	...	$\frac{1}{20}$ sec.*	..
a 9. *Ever-Set.*			
L'Automatique	...	$\frac{1}{60}$ sec.*	...
Lancaster's See Saw	...	$\frac{1}{60}$ sec.*	...
" " " Oval	...	$\frac{1}{60}$ sec.*	...
Shew's Repeat	...	$\frac{1}{40}$ sec.*	...
II. *b.*—Behind Lens.			
Thornton-Pickard	...	...	See table below.
II. *c.*—Between Lenses.			
1. *Go and Return.*			
Grimston (Wratten)	...	$\frac{1}{23}$ sec.*	...
Newman's	1 sec.*	$\frac{1}{75}$ sec.*	Varies considerably.*
Stanley's Serjeant's	Time	$\frac{1}{10}$ sec.*	...
2. *Blind or Drop.*			
Thornton-Pickard's Blind	...	$\frac{1}{60}$ sec.*	See table below.
3. *Centre Opening.*			
4. *Eyelid.*			
Bain's Crown	...	...	...
Beck-Newman	1 sec.	$\frac{1}{1000}$ sec.	...
Caldwell's (Wray)	$\frac{1}{6}$ sec.*	$\frac{1}{200}$ sec.	...

Class and Name.	Speed.		Remarks.
	Lowest.	Highest.	
5. *Diamond.*			
Sands and Hunter's Patent	...	$\frac{1}{3\,8}$ sec.*	...
Wollaston's Diaphragmatic	...	$\frac{1}{6\,0}$ sec.*	...
6. *Strip.*			
Thornton-Pickard	...	...	See table below.
7. *Iris.*			
Dallmeyer	...	$\frac{1}{1\,0\,0}$ sec.	...
Shew's Matthioli	...	$\frac{1}{5\,0}$ sec.*	...
Voigtlander's (Marion) ...	...	$\frac{1}{6\,0}$ sec.*	...
8. *Rotating Screen.*			
Celeritas (Adams and Co.)	...	$\frac{1}{5\,0\,0}$ sec.	Stated also to work up to $\frac{1}{1\,0\,0\,0}$ sec.
II. *d.*—In Front of Plate.			
Loman's Light Economic...	$\frac{1}{4}$ sec.*	$\frac{1}{3\,0\,0}$ sec.*	With 1-in. aperture on $\frac{1}{4}$-plate.

Messrs. Thornton-Pickard give the following table for their shutters:—

Size of Shutter.	No. of Turns of the Speed Knob.	Speed in Fractions of a Second.	Size of Shutter.	No. of Turns of the Speed Knob.	Speed in Fractions of a Second.
1½ in. ...	0	$\frac{1}{1\,5}$	3 in. ...	0	$\frac{1}{1\,0}$
	5	$\frac{1}{2\,5}$		5	$\frac{1}{3\,0}$
	15	$\frac{1}{6\,0}$		15	$\frac{1}{6\,0}$
2 in. ...	0	$\frac{1}{1\,5}$	3½ in. ...	0	$\frac{1}{1\,0}$
	5	$\frac{1}{4\,0}$		5	$\frac{1}{2\,5}$
	15	$\frac{1}{8\,0}$		15	$\frac{1}{6\,0}$
2¼ in. and 2½ in.	0	$\frac{1}{1\,2}$	4 in. ...	0	$\frac{1}{1}$
	5	$\frac{1}{3\,5}$		5	$\frac{1}{2\,0}$
	15	$\frac{1}{7\,0}$		15	$\frac{1}{4\,0}$

These approximate speeds have been arrived at after a series of very careful tests with apparatus constructed specially for the purpose. The method used gives undeniably accurate results. The speed used in this table apply to the "time and instantaneous" shutter, "instantaneous" shutter, "foreground" shutter. The "extra-time" shutter (double-blind) pattern works at one and a-half times these speeds. The "special" instantaneous (double-blind) pattern works at twice these speeds.

HOLETSCHEK'S TABLE OF DROP-SHUTTER SPEEDS.

Distance of the opening of the drop shutter above the aperture of lens.	2 cm.	4 cm.	6 cm.	8 cm.	10 cm.	15 cm.	20 cm.	25 cm.	30 cm.	
Diameter of lens. 4 cm.	$\frac{1}{16}$	$\frac{1}{22}$	$\frac{1}{27}$	$\frac{1}{32}$	$\frac{1}{36}$	$\frac{1}{43}$	$\frac{1}{50}$	$\frac{1}{56}$	$\frac{1}{61}$	Exposure in seconds.
5 cm.	$\frac{1}{13}$	$\frac{1}{18}$	$\frac{1}{22}$	$\frac{1}{26}$	$\frac{1}{28}$	$\frac{1}{34}$	$\frac{1}{40}$	$\frac{1}{44}$	$\frac{1}{49}$	
6 cm.	$\frac{1}{10}$	$\frac{1}{15}$	$\frac{1}{18}$	$\frac{1}{21}$	$\frac{1}{23}$	$\frac{1}{29}$	$\frac{1}{33}$	$\frac{1}{37}$	$\frac{1}{40}$	
7 cm.	$\frac{1}{8}$	$\frac{1}{13}$	$\frac{1}{16}$	$\frac{1}{18}$	$\frac{1}{20}$	$\frac{1}{25}$	$\frac{1}{28}$	$\frac{1}{32}$	$\frac{1}{35}$	
8 cm.	$\frac{1}{8}$	$\frac{1}{11}$	$\frac{1}{14}$	$\frac{1}{16}$	$\frac{1}{18}$	$\frac{1}{21}$	$\frac{1}{26}$	$\frac{1}{28}$	$\frac{1}{30}$	

To use this Table find the distance of the opening of the dropping piece of the shutter above the lens, measuring from centre to centre of each. *Example:*—Assume this to be 8 cm., the lens has a diameter of 20 cm., the time of exposure is $\frac{1}{25}$ sec.

Silhouettes, Photographic. The sitter is placed against a thin screen strongly illuminated from behind; an excellent plan being to stretch the screen over the doorway of a passage in which the camera is placed.

Silver (Ger., *Silber;* Fr., *Argent;* Ital., *Argento*). Ag = 108. This metal occurs either alone or in combination with various metals and elements. There are three principle methods of extraction of the metal from its ores: (*a*) alloying with lead, and subsequent cupellation, (*b*) amalgamation with mercury, and recovery of mercury by distillation, (*c*) hydrometallurgic process, in which the silver is converted into a soluble salt, and precipitated with copper. Silver may be obtained, chemically pure, by decomposing the chloride AgCl with hydrochloric acid and zinc; the metal separates in a spongy form, and may be fused under carbonate of soda to prevent access of air, and obtain a button of silver; or by adding hydrochloric acid to silver nitrate solution, collecting the chloride and reducing this to the metallic state. When pure, silver will absorb twenty-two times its volume of oxygen if exposed to the air in a melted state, but on cooling the oxygen is given off. It is the best conductor of heat and electricity of all the metals, and it is extremely

malleable and ductile. When examined by transmitted light, as the thinnest leaf, it is of a distinct emerald green colour. It can be drawn into wire, 400 ft. of which only weigh 1 gr., and its tenacity is so great that a silver wire $\frac{1}{4}$ of an inch in diameter will support a weight of 187 lbs. It melts at about 1,832° F. Molten caustic alkalies, or alkaline nitrates, have no effect upon it; it is unaffected by the air, but oxidised by ozone; sulphurous vapours, however, immediately act upon it, forming sulphides. Many silver salts are acted upon by light, with partial reduction to the metallic state. Silver is soluble in nitric acid and boiling sulphuric acid, and only partially so in hydrochloric acid. The standard British coinage contains 92·5 parts of pure silver and 7·5 parts of copper. In the United States and France 10 per cent. of copper is used, and in Germany 25 per cent. To prepare pure silver from any coin, the following process will be found efficient:—Place the coin either entire, or preferably cut up small, in a test tube, with one part of pure nitric acid, and two parts of water; apply a gentle heat, and an action commences at once, orange-red fumes of nitric oxide being evolved; if after the lapse of some time the whole of the coin is not dissolved, add more nitric acid, and again apply heat. When the coin is dissolved, the solution will be seen to be of a bright blue colour, due to the copper; pure silver can be obtained from this solution by evaporating to dryness, and fusing strongly the resulting mass. A little taken out and dissolved in water should give no blue coloration with solution of ammonia; or sheet copper may be placed in the acid solution, when a precipitate of pure silver will take place, which may be collected and again dissolved in nitric acid to form solution of nitrate of silver; or the precipitate may be collected and fused as above to obtain a button of silver. The relative sensitiveness of various silver salts, as given in the following tables, should prove of very great value to the experimenter; but it must not be forgotten that special circumstances may considerably influence the question—a matter obvious enough when we mention that chloride of silver by itself (that is to say, in an absolutely dry state) appears to be quite insensitive to light, and doubtless the same holds good for the other haloid salts of silver. Speaking generally, the tables are as accurate as possible, in relation to usual methods of working.

TABLE OF THE LIGHT SENSITIVENESS OF VARIOUS SILVER COMPOUNDS (Marktanner—Turneretscher).

v. i. = very intense; i. = intense; t. i. = tolerably intense; m. i. = moderately intense; s. i. = slightly intense. n. i. = not intense.

Name.	I. With Excess of Silver.				II. With Excess of Salt.				Remarks.
	A. Without Ammonia fuming.		B. With Ammonia fuming.		A. Without Ammonia fuming.		B. With Ammonia fuming.		
Chemical Formula (Solubility).	Sensitiveness of AgCl = 100.	Colour and Intensity.	Sensitiveness of AgCl = 100.	Colour and Intensity.	Sensitiveness of AgCl = 100.	Colour and Intensity.	Sensitiveness of AgCl = 100.	Colour and Intensity.	
1. Silver Chloride: AgCl (insol.	100	blue black, v. i.	100	blue black, more intense than without fuming	80	violet, v. i.	100	violet, v. i.	With excess of salt, although very intense, still less so than with excess of silver.
2. Silver Bromide: AgBr (insol.)	700	bluish grey, n. i.	900	bluish grey, n. i.	250	bluish grey, n. i.	300	bluish grey, n. i.	Scarcely more intense with fuming than without.
3. Silver Iodide: AgI (insol.)	300	greenish grey, n. i.	450	reddish grey, n. i.	40	yellowish grey, n. i.	75	yellowish grey, n. i.	Fuming scarcely increases the intensity.
4. Silver Chloride: AgCl; excess of silver nitrate removed by washing.	95	violet, with red tinge, v. i.	100	violet, with a red tinge, v. i.	—	—	—	—	Less intense than No. 1, the normal paper: scarcely more intense with fuming.
5. Silver Chloride: AgCl treated as in 4, and then floated on KNO_2 solution.	80	Intense, very nearly equal to the normal, No. 1.	130	Intense, equal to normal No. 1.	—	—	—	—	Paper prepared according to Abney's process.
6. Silver Chloride: AgCl, prepared as No. 5, but Sodium Sulphite used.	100	violet, v. i.	100	violet, v. i.	—	—	—	—	The papers attain nearly the very

									same intensity as the normal paper, but more intense than the merely washed paper.
7. Silver Nitrate: $AgNO_3$.	6	reddish, n. i.	8	reddish, n. i.	—	—	—	—	Silver nitrate alone does not become coloured only in the presence of organic substances.
8. Silver Albuminate without Silver Chloride.	13	red, s. i.	30	bluish, s. i.	—	—	—	—	The paper was prepared by floating on beaten albumen and then silvering.
9. Sensitised Paper, freshly prepared.	50	purple brown, v. i.	60	purple brown, uncom. i.	—	—	—	—	So-called "Rosa brilliant papier" was used.
10. Sensitised Paper, commercial.	70	purple brown, v. i.	80	purple brown, v. i.	—	—	—	—	
11. Gelatino-bromide Plate.	—	—	—	—	600	greenish grey, v. i.	—	—	
12. Formiate: $AgCHO_2$.	—	—	—	—	—	—	—	—	The sensitised papers turn brown even in an absolutely dark room.
13. Acetate: $AgC_2H_3O_2$ (1 : 97).	6	yellowish grey, s. i.	20	reddish grey, t. i.	4	yellowish grey, n. i.	15	reddish grey, s. i.	
14. Propionate: $AgC_3H_5O_2$ (1 : 119).	6	red brown, s. i.	10	yellow brown, s. i.	7	red brown, s. i.	15	yellow brown, s. i.	
15. Normal Butyrate: $AgCH_3(CH_2)_2CO_2$ (1 : 200).	8	reddish yellow, m. i.	22	red brown, m. i.	10	reddish grey, m. i.	20	grey brown, m. i.	Colour somewhat more intense than with isobutyrate.
16. Isobutyrate: $(CH_3)_2—CHCO_2Ag$ (1 : 108).	7	yellowish red, n. i.	18	brownish, s. i.	6	reddish brown, s. i.	18	red brown, s. i.	Colour somewhat less intense than with the salt of the normal acid.
17. Valerianate: $Ag(CH_3)_2CHCH_2CO_2$ (1 : 540).	8	violet brown, m. i.	14	reddish grey, t. i.	14	reddish grey, m. i.	30	grey brown, t. i.	

TABLE OF THE LIGHT SENSITIVENESS OF VARIOUS SILVER COMPOUNDS (*Continued*).

Name.	I. With Excess of Silver.				II. With Excess of Salt.				Remarks.
	A. Without Ammonia fuming.		B. With Ammonia fuming.		A. Without Ammonia fuming.		B. With Ammonia fuming.		
Chemical Formula (Solubility).	Sensitiveness of AgCl=100.	Colour and Intensity.	Sensitiveness of AgCl=100.	Colour and Intensity.	Sensitiveness of AgCl=100.	Colour and Intensity.	Sensitiveness of AgCl=100.	Colour and Intensity.	
18. Caproate: $AgC_6H_{11}O_2$ (sol. with great difficulty).	9	grey, m. i.	15	grey, m. i.	14	reddish brown, t. i.	24	grey, t. i.	
19. Œnanthyeate: $AgC_7H_{13}O_2$ (sol. with difficulty).	10	brown violet, t. i.	14	grey violet, t. i.	14	brown violet, t. i.	16	grey brown, i.	
20. Caprylate: $AgC_8H_{15}O_2$ (scarcely soluble).	12	grey, s. i.	5	grey, n. i.	17	reddish brown, t. i.	6	grey brown, s. i.	
21. Œnanthate: $AgC_9H_{17}O_2$ (insol. in cold water).	25	first of all red, then grey, t. i.	30	grey, t. i.	20	first red, then grey, t. i.	25	brown, s. i.	
22. Rutate: $AgC_{10}H_{19}O_2$ (insol.).	5	brown violet, s. i.	6	reddish grey, n. i.	14	reddish brown, t. i.	18	reddish grey, t. i.	The papers remained white for several weeks when kept in the dark.
23. Palmitate: $AgC_{16}H_{31}O_2$ (insol.).	5	yellowish, n. i.	6	yellowish grey, n. i.	3	yellowish, n. i.	8	yellowish grey, n. i.	The solution of salt was 1/10 normal.

24. Stearate: $AgC_{18}H_{35}O_2$ (insol.).	14	grey, n. i.	22	grey, n. i.	—	—	—	—	Solution of the salt 1/4 normal.
25. Certotate: $AgCH_3(CH_2)_{25}CO_2$ (insol.).	1	yellowish grey, s. i.	5	yellowish, n. i.	2	yellowish, n. i.	5	yellowish, n. i.	The solution of salt was 1/10 normal.
26. Oleate: $AgC_{18}H_{33}COO$.	10	reddish grey, s. i.	11	greenish grey, s. i.	9	reddish grey, s. i.	6	grey, s. i.	The solution of salt was 1/4 normal.
27. Glycolate: $AgCH_2OH_2COO$ (sol. with difficulty).	6	reddish yellow, s. i.	11	brownish, s. i.	4	yellowish grey, n. i.	7	brownish, n. i.	
28. Lactate: $AgCH_3CHOHOCO$ (1 : 20).	8	yellow red, t. i.	16	yellow red, t. i.	17	rusty yellow, t. i.	18	grey, t. i.	Alcohol was used on account of the difficulty of dissolving the salt.
29. Paralactate: $AgCH_3CHOHCOO$.	7	yellowish red, t. i.	17	yellow red, t. i.	17	rusty yellow to brown, t. i.	17	grey brown, t. i.	The paper prepared with excess of salt was rather more intense than with excess of silver.
30. Oxalate: $Ag_2C_2O_4$ (insol.).	2	reddish, n. i.	80	red brown, s. i.	20	dark brown, i.	70	dark brown, v. i.	
31. Malonate: $AG_2CH_2(COO)_2$ (sol. with difficulty).	4	reddish grey, s. i.	8	grey, t. i.	5	reddish yellow, s. i.	13	reddish brown, t. i.	
32. Malate: $Ag_2C_2H_3OH(COO)_2$ (sol. in hot water).	2	red brown, i.	18	grey brown, i.	7	red brown, i.	13	red brown, s. i.	
33. Tartrate: $Ag_2C_4H_4O_6$.	7	red brown, i.	17	red brown, i.	9	reddish brown, t. i.	24	red brown, s. i.	
34. Citrate: $Ag_3C_3H_5O_7$ (sol. in boiling water).	15	grey brown, m. i.	18	red brown, i.	6	brown, m. i.	12	grey brown, i.	
35. Hippurate: $CH_2^{NHC_7H_5O}COOAg$.	12	rusty brown, t. i.	24	grey brown, t. i.	16	rusty brown, t. i.	50	grey brown, t. i.	

Silver Acetate (Ger., *Silberacetat, Essigsäures Silberoxyd*). $AgC_2H_3O_2 = 167$. Is obtained in white crystals by mixing silver nitrate with a soluble acetate. The crystals are soluble, 1 in 100 parts of water.

Silver Albuminate (Ger., *Silber Albuminat;* Fr., *Albuminate d'Argent;* Ital., *Albuminato d'Argento*). The white precipitate obtained by adding nitrate of silver in solution to albumen in the dark is thus termed. It is a complex compound of oxide of silver and albumen, and is reduced to a red sub-compound by the action of light. It is this reaction which occurs when printing on sensitised albumenised paper.

Silver, Ammonio-Nitrate of (Ger., *Salpetersäures Silberoxyd-ammoniak;* Fr., *Nitrate ammoniacal d'argent*). $2NH_3AgNO_3$. The pure salt can be obtained by exposing powdered nitrate of silver to ammonia gas, combination taking place very rapidly, and with evolution of sufficient heat to fuse the resulting compound, which contains 22·5 per cent. of ammonia, NH_3, and 77·5 per cent. of silver nitrate, $AgNO_3$. Ammonio-nitrate of silver is used for sensitising plain salted paper. It cannot be used for the same purpose for albumenised paper, as the albumen would be dissolved; it is also used in making emulsions. It may also be prepared by dissolving silver oxide in solution of ammonium-nitrate, or adding ammonia drop by drop to solution of silver nitrate till the precipitate first formed is redissolved. A solution containing less ammonia may be obtained by dividing the solution of silver nitrate into two equal parts, to the one adding sufficient ammonia to obtain a clear solution, and then adding the other half of the silver nitrate solution.

Silver Bromide (Ger., *Bromsilber;* Fr., *Bromure d'argent;* Ital., *Bromuro d'argento*). AgBr = 188. Can be prepared by direct union between the elements, as in the Daguerreotype process, or by double decomposition between nitrate of silver and any soluble bromide, as in dry-plate processes:—

$$\begin{array}{ccccccc} AgNO_3 & + & KBr & = & AgBr & + & KNO_3 \\ \text{Silver nitrate} & + & \text{Potassium bromide} & = & \text{Silver bromide} & + & \text{Potassium nitrate.} \end{array}$$

Or it may be prepared by treating carbonate or oxide of silver with hydrobromic acid. Bromide of silver is darkened to a

tawny grey by the prolonged action of light, with evolution of bromine; but by short exposures, as in the camera, it is said to be reduced to a sub-bromide, or, as Carey Lea calls it, a photo-bromide of silver. Sub-bromide of silver in this stage is precisely the same in physical appearance as the bromide; but it is more easily reducible by certain salts, which constitutes the process of Development (*q.v.*). Bromide of silver is practically insoluble in water, alcohol, and ether, but soluble in solution of alkaline hyposulphites, cyanides, sulpho-cyanides, ammonia (about 1 : 1000), and saturated solutions of most chlorides, bromides, and iodides. Silver bromide is the usual sensitive salt in emulsions, either alone or combined with iodide and chloride.

Silver Carbonate (Ger., *Silbercarbonat, Kohlensäures Silber;* Fr., *Carbonate d'argent;* Ital., *Carbanato d'argento*) Ag_2CO_3 = 276. This can be obtained as a yellowish precipitate by mixing silver nitrate and sodium carbonate solutions. It blackens in light, and is partly decomposed by boiling with water into oxide. It is insoluble in water, alcohol, and ether, but is soluble in all the solvents of the haloid salts of silver. It has been used in emulsion making, either for forming bromide, by treatment with hydrobromic acid, or in the form of ammonio-carbonate of silver, by dissolving the carbonate in ammonia. It has also been suggested by Burton and others for gelatino-chloride printing-out papers.

Silver Chloride (Ger., *Chlorsilber, Silberchlorid;* Fr., *Chlorure d'argent;* Ital., *Cloruro d'argento*). AgCl = 143·5. Can be obtained by direct union between the elements, or by double decomposition with nitrate of silver with a soluble chloride,

$$AgNO_3 + NaCl = AgCl + NaNO_3;$$

or by adding hydrochloric acid to silver nitrate,

$$AgNO_3 + HCl = AgCl + HNO_3.$$

It also occurs as a native ore, called horn silver, from its general appearance. On exposure to light when absolutely pure or dry no change takes place; but with the smallest trace of organic matter or water it passes from white through varying shades of purple to black, chlorine being disengaged, and a complex body, now definitely stated to be a mixture of chloride (AgCl), oxy-chloride (AgClO), and metallic silver (Ag) resulting. It melts at about 260° F. and is not decomposed when heated with

carbon, but is immediately reduced by heating in a current of nascent hydrogen. Zinc, iron, and copper reduce the chloride, when moistened with an acid, to a metallic state; whilst when heated with the carbonates or hydrates of sodium and potassium or calcium, the chlorine unites with the alkali, pure silver being set free. It is soluble in solutions of the same salts as the bromide, and also in ammonia—a double salt, ammonio-chloride of silver, being formed. It is used for making lantern-plate emulsions, gelatino-chloride printing-out papers, and is the sensitive salt in albumen paper.

Silver Chromate (Ger., *Chromsäures Silberoxyd;* Fr., *Chromati d'argent;* Ital., *Cromato d'argento*). Ag_2CrO_4. An orange-red precipitate, formed by mixing chromate or bichromate of potassium with silver nitrate. It was suggested by Biny for emulsion making, and by Burton as an admixture with bromide emulsion to stop halation.

Silver Citrate (Ger., *Silbercitrat, Citronensäures Silberoxyd;* Fr., *Citrate d'argent;* Ital., *Citrate d'argento*). $AgC_6H_5O_7 = 297$. This can be obtained in small quantities by adding citric acid to silver nitrate, but more easily by double decomposition of a soluble citrate and silver nitrate. It forms white crystals, which are soluble in water. It was suggested by Monckhoven for gelatino-bromide emulsion, but its chief use is in the gelatino-chloride printing-out papers.

Silver Fluoride (Ger., *Fluorsilber;* Fr., *Fluorure d'argent;* Ital., *Fluoruro d'argento*). $AgF = 127$. This salt is formed by solution of silver oxide or carbonate in hydrofluoric acid, not by double decomposition of silver nitrate and a soluble fluoride. It is fairly stable in light, and soluble in water. It has been suggested for use in emulsions for development and printing-out, but has not come into general practice.

Silver Iodide (Ger., *Iodsilber, Silberiodid;* Fr., *Iodure d'argent;* Ital., *Ioduro d'argento*). $AgI = 235$. This salt can be formed in an analogous manner to the chloride, either by direct union or double decomposition, using iodine and iodide instead of chlorine and chloride. When prepared by precipitation from a solution of an alkaline iodide with nitrate of sliver, the alkaline iodide being in excess, a white precipitate is caused, which is not

so sensitive to light as when excess of nitrate of silver is used, when the precipitated iodide is lemon-coloured. Iodide of silver is insoluble in water and dilute nitric acid, almost insoluble in ammonia, but soluble in all the other salts which dissolve bromide. When iodide of silver is dissolved in excess of solution of an alkaline bromide, iodide, or chloride, a double salt is formed, and on addition of water the resulting solution immediately precipitates the iodide. It is used for making emulsions, giving extremely sensitive emulsions and great latitude of exposure, with great density of image, and is also used in the wet collodion process.

Silver Nitrate (Ger., *Silbernitrat, Salpetersäures Silberoxyd;* Fr., *Azotate d'argent;* Ital., *Azotato d'argento*). $AgNO_3 = 170$. Is prepared from pure silver by solution in nitric acid, and subsequent purification and crystallisation. Ordinary commercial nitrate is usually very acid, due to its not being absolutely freed from nitric acid; but that prepared for photographic purposes should be almost neutral, or at least show only a faint trace of acid. To the dry-plate operator nitrate of silver is hardly of so much interest as it was to the operator of the wet-plate process; but to those who desire to make their own plates, a pure salt is a *sine quâ non;* and as the testing of this salt is almost beyond the ordinary capabilities of the dry-plate workers, the only recommendation which the author can give is to buy the salt from a reputable firm. Solubility: 100 grains are soluble in 50 minims of distilled water, and will measure 80 minims: 1 in 15 of rectified spirit. When dissolved in common water, a thick curdy-white precipitate of carbonate and chloride of silver is formed. Boiling alcohol dissolves about one-fourth of its weight of nitrate of silver, but deposits it on cooling. It is soluble in ammonia, with the formation of a double salt. It is used for sensitising paper, and preparing all, or nearly all, the other salts of silver used in photography. When heated it melts, and forms, when poured into moulds, the lunar caustic of commerce; and when heated higher still gives off some oxygen, and a mixture of nitrite ($AgNO_2$) and nitrate of silver ($AgNO_3$) is left. When exposed to the light, either in solution or in a pure dry state, no action takes place; but on contact with organic matter it darkens through purple to black.

Silver Oxide (Ger., *Silberoxyd;* Fr., *Oxyde d'argent;* Ital., *ossido d'argent*). $Ag_2O = 232$. May be obtained by adding pure solution of any caustic alkali, except ammonia, to a solution of nitrate of silver, when the oxide is precipitated as a brownish black precipitate. It is but little used now, except to purify silver solutions from copper, but was used in the old wet-plate process to purify the silver bath. It cannot be made by heating silver in a current of oxygen or air, because, although union takes place, the whole of the oxygen is given up on cooling.

Silvering Glass. See MIRROR.

Silver Sulphide (Ger., *Schwefelsilber;* Fr., *Sulfure d'argent;* Ital., *Solfuro d argento*). $Ag_2S = 242$. This salt is met with in residue recovery, and is the resultant salt of the decomposition of hyposulphite of silver in prints. It is insoluble in water.

Sizes, Photographic. The following tabular matter explains itself:—

USUAL SIZES OF FRENCH AND ITALIAN DRY PLATES.

FRENCH.						Inches.		
6½	by	9	Centimetres	...	...	2·5	by	3·7
9	„	12	„	...	...	3·7	„	4·7
12	„	15	„	...	...	4·7	„	5·9
13	„	18	„	...	...	5·1	„	7·0
12	„	20	„	...	...	4·7	„	7·8
15	„	21	„	...	...	5·9	„	8·2
15	„	22	„	...	...	5·9	„	8·6
18	„	24	„	...	...	7·0	„	9·4
21	„	27	„	...	...	8·2	„	10·6
24	„	30	„	...	...	9·4	„	11·8
27	„	33	„	...	...	10·6	„	12·9
27	„	35	„	...	...	10·6	„	13·7
30	„	40	„	...	...	11·8	„	15·7
40	„	50	„	...	...	15·7	„	19·6
50	„	60	„	...	...	19·6	„	23·6

Italian.					Inches.
9	by 12	Centimetres	...	...	3·7 by 4·7
12	,, 16	,,	...	...	4·7 ,, 6·3
12	,, 18	,,	...	...	4·7 ,, 5·9
13	,, 18	,,	...	...	5·1 ,, 7·0
12	,, 20	,,	...	...	4·7 ,, 7·8
18	,, 24	,,	...	...	7·0 ,, 9·4
21	,, 27	,,	...	...	8·2 ,, 10·6
24	,, 30	,,	...	...	9·4 ,, 11·8
27	,, 33	,,	...	...	10·6 ,, 12·9
30	,, 36	,,	...	...	11·8 ,, 14·1
40	,, 50	,,	...	...	15·7 ,, 19·6
50	,, 60	,,	...	...	19·6 ,, 23·6

Sizes of Glass, Mounts, Paper, Etc.

Petite cards	$1\frac{5}{8}$ by $3\frac{1}{8}$
One-ninth plate	2 ,, $2\frac{1}{2}$
One-sixth plate	$3\frac{3}{4}$,, $3\frac{1}{4}$
One-fourth plate (quarter plate) ...	$3\frac{1}{4}$,, $4\frac{1}{4}$
Double quarter plate	$4\frac{1}{4}$,, $6\frac{1}{2}$
Half plate (usual)	$4\frac{3}{4}$,, $6\frac{1}{2}$
Whole plate (4-4)	$6\frac{1}{2}$,, $8\frac{1}{2}$
Extra 4-4	8 ,, 10

Other sizes are expressed by inches.

Sizes of Mounts.

Stereoscopic	$3\frac{1}{2}$ by 7, 4 by 7, $4\frac{1}{4}$ by 7, $4\frac{1}{2}$ by 7, 5 by 8
Victoria	$3\frac{1}{4}$ by 5
Imperial	$7\frac{7}{8}$,, $9\frac{7}{8}$
Boudoir	$5\frac{1}{4}$,, $8\frac{1}{2}$
Panel	4 ,, $8\frac{1}{4}$
Minette	$1\frac{1}{2}$,, $2\frac{3}{8}$
Card	$2\frac{1}{2}$,, $4\frac{1}{8}$
Cabinet	$4\frac{1}{4}$,, $6\frac{1}{2}$
Promenade	$4\frac{1}{8}$,, $7\frac{1}{8}$

Sizes of Albumen Paper.

18 by $22\frac{3}{4}$, $20\frac{1}{2}$ by $24\frac{1}{2}$, 22 by 36, 26 by 40, 27 by 42

Sizes of blotting paper ... ... 19 by 24

Skiagraphy. See RADIOGRAPHY.

Sodium Acetate (Ger., *Essigsäures Natron, Natriumacetat;* Fr., *Acétate de soude;* Ital., *Acetato di soda*). $NaC_2H_3O_2$, $3H_2O$ = 136. Can be prepared by neutralising acetic acid with carbonate or hydrate of sodium. Solubility: 1 in 3 of cold water, 1 in 1 of hot water; soluble also in alcohol. It is a slightly alkaline salt, and is used principally in toning.

Sodium Bicarbonate (Ger., *Natriumbicarbonat, Doppeltkohlensäures Natron*; Fr., *Bicarbonate de soude;* Ital., *Bicarbonato di soda*). $NaHCO_3 = 84$. Synonyms: Acid Carbonate of Soda, Hydrosodic Carbonate. Is prepared by passing carbonic acid gas into carbonate of soda moistened with water. Solubility: 1 in 10 of water; insoluble in alcohol. It is used for toning. It is invariably met with in commerce as a fine impalpable powder, and should not be confounded with the carbonate which is usually met with in crystals. It is far less soluble than the carbonate.

Sodium Carbonate (Ger., *Kohlensäures Natron, Natriumcarbonat, Soda;* Fr., *Carbonate de soude;* Ital., *Carbonato di soda*). $Na_2CO_3, 10H_2O$ = 286. Synonyms: Washing Soda, Sal Soda, Soda Crystals, Carbonate of Soda. This is prepared by several methods, which depend upon the decomposition of salt primarily. Solubility: 60 per cent. in cold, 445 per cent. in hot water, insoluble in alcohol, and 98 per cent. in glycerine. Heat has no effect upon it, except to drive off the water of crystallisation. The commercial varieties of this salt are very numerous, but there are practically only two which need trouble the photographer; the one is the ordinary washing soda of commerce, which is of indefinite strength, and usually contains much sulphate, and the other the pure salt, the sodium carbonate, which is the officinal salt of the pharmacopœia, and can be obtained from any pharmaceutical chemist. This is the only salt which should be used for photography. Tables of the equivalent values of the various carbonates will be found under the heading EQUIVALENCE, CHEMICAL.

Sodium Chloride (Ger., *Chlornatrium, Natriumchlorid, Kochsalz, Edelsalz;* Fr., *Chlorure de soude, Chlorure sodique, Sel de*

cuisine; Ital., *Cloruro di sodio, Sale comune*). $NaCl = 58{\cdot}5$. Synonyms: Common Salt, Sea Salt. This, the most abundant source of sodium, occurs native in very large deposits in Cheshire, Galicia, and Eastern Russia, also in sea water, which contains about 3 per cent. Solubility: 35 per cent. in cold, 39·6 per cent. in hot water, insoluble in absolute, but sparingly soluble in dilute, alcohol, insoluble in ether. Ordinary salt is usually contaminated with traces of sulphate of soda and chloride of magnesium, which make it hygroscopic. Salt is used for precipitating silver from print washings, for making gelatino-chloride emulsions, and salting positive papers.

Sodium Citrate (Ger., *Natriumcitrat, Citronensäures Natron;* Fr., *Citrate de sodium;* Ital., *Citrato di soda*). $Na_3C_6H_5O_7H_2O = 276$. Made by neutralising citric acid with carbonate, bicarbonate, or hydrate of sodium, evaporating, and crystallising the resulting solution. Solubility: 1 in 1 of water; sparingly soluble in alcohol. It is used sometimes as a Restrainer (*q.v.*), and also in preparing some printing-out emulsions.

Sodium Hyposulphite (Ger., *Natriumthiosulfat, Fixirnatron, Unterschwefligsäures Natron, Fixirsalz;* Fr., *Hyposulfite de soude, Thiosulfate de soude;* Ital., *Iposolfite di soda*). $Na_2S_2O_35H_2O = 248$. Synonym: Thiosulphate of Soda. This important salt may be formed by passing sulphurous acid gas through sulphide of sodium until no further precipitation of sulphur occurs, or it may be made by heating—not boiling—sulphite of sodium with excess of sulphur, and commercially by treating tank waste or calcium-sulphide. It is met with in commerce as large watery crystals, which should be entirely free from acid or any yellow tinge. It is soluble 1 in 2 of cold water, 1 in 1 of boiling water, and insoluble in alcohol. Its importance in a photographic sense, as a solvent for the unacted-upon silver salts, was discovered by Sir William Herschel. When a salt of silver is added to hypo-sulphite, two salts are formed, as shown in the following equations:—

$AgCl$	+	$Na_2S_2O_3$	=	$AgNaS_2O_3$	+	$NaCl$.
Silver chloride	+	Sodium hyposulphite	=	Double hypo-sulphite of silver and sodium	+	Sodium chloride.

And

$$2AgCl + 3Na_2S_2O_3 = Ag_2Na_43(S_2O_3) + 2NaCl.$$

Silver chloride + Sodium hyposulphite = Hyposulphite of sodium and silver + Sodium chloride.

The first salt, $AgNaS_2O_3$, is almost insoluble in water, and soluble in hyposulphite of soda; therefore excess of hypo should always be used for fixing: the incomplete elimination of this insoluble salt is one of the chief causes of fading in prints. To test whether the whole of the hyposulphites are eliminated either by washing or by the use of an eliminator, the following may be used:—

Potassium permanganate	2 grs.
Potassium carbonate	20 ,,
Distilled water	40 ozs.

A few drops of this pinkish purple liquid should be added to the last washing water, when, if hypo be present, the pink colour will be discharged; or a few drops of the last washing water may be added to a solution of mercuric chloride, when a cloudiness will make its appearance if hypo be present. Another test is by making a little starch paste by boiling a pinch of starch in distilled water, and adding a drop or two of solution of iodine in alcohol to it, when a deep blue coloration, due to iodide of starch, will make its appearance. A drop or two of this deep blue liquor may be added to the last washing water, when, if hypo be present, the blue colour will be destroyed. The addition of any acid to a solution of hyposulphite will cause evolution of sulphurous acid and deposition of sulphur; hence will be seen the necessity of making the fixing bath for prints distinctly alkaline, to prevent sulphuration.

Sodium Nitrate (Ger., *Natriumnitrat, Salpetersäures Natron;* Fr., *Azotate de soude;* Ital., *Azotato di soda*). $NaNO_3 = 85$. Synonym: Chili Saltpetre. This occurs native in Chili, and has been recommended as an addition to developers to give a good chocolate colour to negatives. Solubility: 1 in 1·2 of water; soluble 1 in 37 parts of alcohol.

Sodium Phosphate (Ger., *Phosphorsäures Natron, Natriumphosphat, Perlsalz;* Fr., *Phosphate de soude;* Ital., *Fosfato di*

soda). $Na_2HPO_4 12H_2O = 358$. Prepared by neutralising phosphoric acid with soda. Solubility: 1 in 4 of cold, 1 in 2 of boiling water; insoluble in alcohol. On exposure to the air the crystals effloresce—that is, give up some molecules of water—and it is questionable whether a complex phosphate is not formed. It is used for toning.

Sodium Sulphite (Ger., *Schwefligsäures Natron, Natriumsulfit;* Fr., *Sulfite de soude;* Ital., *Solfito di soda*). $Na_2SO_3 7H_2O = 252$. Is prepared by passing sulphurous acid gas through carbonate of soda in concentrated solution. Solubility: 1 in 4 of cold water, 1 in 1 of hot water; insoluble in alcohol. It is used as a preservative of pyrogallol, as it absorbs oxygen, and is converted into sulphate. This salt is difficult to keep as pure sulphite, but keeps better in concentrated solutions than weak ones. It has also been recommended as a fixing agent; but as its powers are considerably less, and its price greater than hyposulphite, it is hardly likely to come into general use in spite of its advantages. (See FIXING.)

Sodium Tungstate (Ger., *Wolframsäures Natron;* Fr., *Tungstate de soude;* Ital., *Tungstato di soda*). $Na_2WO_4, 2H_2O = 317$. A combination of tungstic acid and soda, crystallising in rhombic plates. Solubility 55 per cent. in cold water, 124 per cent. in hot water; insoluble in alcohol. It is used in Toning (*q.v.*).

Solarisation. See REVERSAL.

Solutions and Solubility. In preparing solutions, especially saturated solutions, it is often a very great saving of time to support the salt to be dissolved near the surface of the liquid, so that the heavy solution formed may always tend downwards, and fresh liquid rise up to exert its solvent power. Such salts as hyposulphite of soda, carbonate of soda, or oxalate of potassium can be tied up in canvas or muslin "blue-bag" fashion, and the bag can be suspended from a stick placed across the vessel. For small quantities or corrosive salts, the strainer of a French coffee-pot (earthenware) may be used. The following tabular matter relating to solutions and solubilities requires no explanation:—

Table of Solubilities of various Chemicals.

alcohol-ether = equal parts of alcohol and ether.
dec. = decomposed.
m. miscible in all proportions.
s. = soluble.
s. s. = slightly soluble.
v. s. = very soluble.
insol. = insoluble.

	100 parts of cold water at 15° C., or 59° F., dissolve.	100 parts of boiling water dissolve.	100 parts of alcohol dissolve.	100 parts of ether dissolve.	Remarks.
Acetone	m.	m.	m.	m.	
Acid, Acetic	m.	m.	m.	...	
,, Boracic	4	29	25 boiling	...	
,, Carbolic	...	...	...	...	
,, Citric	140	200	...	...	
,, Formic	s.	s.	m.	...	
,, Gallic	1	33	12·5	...	
,, Hydrobromic ...	...	...	...	...	
,, Hydrochloric ...	m.	m.	dec.	dec.	
,, Hydrofluoric ...	m.	m.	...	...	
,, Lactic	m.	m.	m.	m.	
,, Nitric	m.	m.	dec.	dec.	
,, Picric	s. s.	5	s.	s.	
,, Pyrogallic	50	100	90	v. s.	
,, Salicylic	0·23	8	28·57	...	
,, Sulphuric	m.	dec.	m.	dec.	
,, Sulphurous ...	s.	dec.	s.	...	
,, Tannic...	·8	·5	120	...	
,, Tartaric	25	100	20	...	
Alum (ammonia) ...	...	...	...	...	
,, (potash)	13	358	insol.	insol.	
,, (chrome)	9·5	50	insol.	insol.	
Amidol	42	...	...	...	
Ammonium Bichromate	9	422	s. s.	...	
,, Bromide ...	73	v. s.	3	0·11	0·8 % in alcohol-ether.
,, Carbonate ...	25	dec.	s. s.	...	
,, Chloride ...	36	100	2	...	
,, Citrate	200	400	s.	...	
,, Iodide	165	v. s.	25	0·5	5 % in alcohol-ether.
Nitrate... ...	200	v. s.	43 cold, 80 boiling	...	
,, Oxalate ...	33	50	s.	...	
,, Sulphocanide	160	v. s.	v. s.	...	
,, Sulphite ...	100	dec.	s. s.	s. s.	
Amyl Acetate	insol.	insol.	m.	m.	
Aniline	3	...	v. s.	v. s.	
Barium Bromide... ...	100	168	s.	...	v. s. in benzine.

TABLE OF SOLUBILITIES OF VARIOUS CHEMICALS (*Continued*).

	100 parts of cold water at 15° C., or 59° F., dissolve.	100 parts of boiling water dissolve.	100 parts of alcohol dissolve.	100 parts of ether dissolve.	Remarks.
Barium Chloride... ...	36	59	0·1 cold, 0.5 boiling	...	10 % in glycerine.
,, Iodide	200	300	5	...	
,, Nitrate	8	35	insol.	...	
,, Hydroxide (baryta) ...	4·7	48	·9 boiling	...	
Benzine	insol.	insol.	m.	m.	
Borax	6	200	s.	insol.	
Bromine...	3	dec.	...	...	
Cadmium Bromide ...	1·06	v. s.	30	c·4	6·2 % in alcohol-ether.
,, & Amm. Brom.	130	v. s.	18	0·4	4 % in alcohol-ether.
,, Chloride... ...	400	650	13 cold, 70 boiling	...	
,, Iodide	88	135	102	27	50 % in alcohol-ether.
Calcium Bromide ...	100	166	s.	...	
,, Chloride ...	400	650	13 cold, 70 boiling	...	
,, Carbonate ...	insol.	insol.	insol.	insol.	
,, Hydrate ...			insol.	insol.	
,, Iodide	98	135	v. s.	...	
Cobalt Bromide	...	...	...	...	
,, Chloride	100	133	sol.	...	
,, Iodide	...	...	...	...	
,, Nitrate	...	...	...	...	
,, Sulphate	...	...	...	...	
Copper Bromide... ...	1	·75	s. s.	...	
,, Chloride	100	200	s.	...	
,, Nitrate	33	100	s.	...	
,, Sulphate... ...	40	100	insol.	...	
Cyanin	s. s.	...	sol.	insol.	
Dextrine...	s.	s.	...	...	insol. in absolute, s. s. in dilute alcohol.
Eosin	38	0·26	...	insol.	
Erythrosin	s. s.	s. s.	s.	...	
Eikonogen	4·2	12	insol.	...	
Ether Acetic	9	dec.	m.	m.	
,, Sulphuric	8	dec.	m.	...	
Glycerine	m.	m.	m.	s. s.	
Glycin	...	...	...	...	
Gold Chloride	100	133	s.	...	
Hydroquinone	5·8	10 at 30° C.	s.	...	
Hydroxylamine Hydrochloride	v. s.	v. s.	s.	s. s.	
Iodine	s. s.	s. s.	s.	s.	
Iridium Chloride ...	...	...	...	...	
Iron Chloride (ferric)	160	s.	s.	s.	s. in glycerine.

TABLE OF SOLUBILITIES OF VARIOUS CHEMICALS (*Continued*).

	100 parts of cold water at 15° C., or 59° F., dissolve.	100 parts of boiling water dissolve.	100 parts of alcohol dissolve.	100 parts of ether dissolve.	Remarks.
Iron Chloride (ferrous)	140	v. s.	s.	s. s.	
,, ,, Iodide ...	v. s.	dec.	s.	s.	
,, ,, Oxalate (ic)	v. s.	v. s.	...	...	
,, ,, ,, (ous)	0·05	0·03	insol.	insol.	s. in an alkaline oxalate.
,, Sulphate	60	333	insol.	...	
,, Nitrate	50	...	s. in dilute	...	
,, Ammonio-citrate	25	s.	s.	...	
,, ,, -oxalate	90	126	...	...	
,, Sodio ,,	...	...	...	...	
,, Ammonio Sulphate	17	v. s.	insol.	...	
,, Bromide	...	...	...	...	
Lead Acetate	66	200	12	insol.	
,, Chromate	insol.	insol.	insol.	insol.	
,, Nitrate	50	140	insol.	...	
Lithium Bromide ...	143	290	v. s.	...	
,, Carbonate ...	0·77	0·78	insol.	...	
,, Chloride ...	82	146	s.	s.	
,, Iodide	100	133	s.	...	
Magnesium Bromide	100	133	s.	...	
,, Chloride	160	370	50 cold, 500 boiling	...	
,, Iodide ...	100	133	s.	...	
,, Sulphate	104	700	insol.	...	
Mercury Perchloride	7—8	8·54	33 cold, 90 boiling	25 with hydrochloracid	
Metol	s.	s.	s.	5·5	
Paramidophenol	1·2	s.	4·5	s. s.	v. s. in caustic alkalies.
Palladium Chloride ...	s.	s.	s.	s.	
Platinum Bichloride ...	100	200	v. s.	...	
Potassium Acetate ...	190	800	30 cold, 50 boiling	insol.	
,, Aceto-tungstate	s.	v. s.	s.	insol.	
,, Bicarbonate ...	33	50	insol.	insol.	
,, Bichromate ..	12	94	dec.	dec.	
,, Bromide	50	102	0·13 cold, 7 boiling	0·2	0·05 % in alcohol-ether
,, Carbonate ...	149	305	insol.	insol.	
,, Chlorate	6·5	50	insol.	insol.	
,, Chloride	32	57	s. s.	...	
,, Chloroplatinite	17	v. s.	insol.	insol.	
,, Chromate ..	50	60	insol.	insol.	
,, Citrate	166	232	insol.	insol.	
,, Cyanide	1000	part. dec.	1·2	...	
,, Ferricyanide ...	40	776	insol.	...	
,, Ferrocyanide	28	50	insol.	...	
,, Hydrate	200	400	s. s.	...	
,, Iodide	120	200	1·5	0·2	0·8 % in alcohol-ether.

TABLE OF SOLUBILITIES OF VARIOUS CHEMICALS (*Continued*).

	100 parts of cold water at 15° C., or 59° F., dissolve.	100 parts of boiling water dissolve.	100 parts of alcohol dissolve.	100 parts of ether dissolve.	Remarks.
Potassium Metabisulphite ...	33	v. s.	insol.	insol.	
,, Nitrate	30	335	insol. in cold, 2 in boiling	...	
,, Nitrite	100	200	...	...	
,, Oxalate	33	50	insol.	insol.	
,, Permanganate	6·5	10	insol.	...	
,, Silicate	33	100	dec.	dec.	
,, Sulphocyanide	217	v. s.	sol.	...	
,, Sulphide... ...	...	...	...	...	
,, (bi) Tartrate ...	0·4	insol.	7	insol.	
Potassium Tungstate	s.	insol.	s.	insol.	
Pyrocatretim	v. s.	v. s.	v. s.	v. s.	s. in alcohol-ether.
Pyrogallol	40	v. s.	v. s.	v. s.	
Pyroxylin	insol.	insol.	insol.	insol.	
Resorcin	86·4	228	s.	insol.	
Silver Albuminate ...	insol.	insol.	insol.	insol.	
,, Acetate	...	...	...	...	
,, Bromide	insol.	insol.	insol.	insol.	
,, Carbonate... ...	insol.	insol.	insol.	insol.	
,, Chloride	insol.	insol.	insol.	insol.	
,, Citrate	...	...	...	...	
,, Cyanide	...	...	...	...	
,, Iodide	insol.	insol.	insol.	insol.	
,, Nitrate	100	200	15 cold, 25 boiling	s.	
,, Nitrite	300	dec.	insol.	insol.	
,, Oxalate	0·4	s.	insol.	...	
,, Oxide...	insol.	insol.	insol.	insol.	
,, Sulphate	...	...	...	...	
Sodium Acetate	92	204	45	insol.	
,, Aceto-Tungstate	s.	v. s.	s.	insol.	
,, Bicarbonate ...	10	dec.	insol.	insol.	
,, Bichromate ...	v. s.	v. s.	dec.	dec.	
,, Bisulphite ...	v. s.	v. s.	insol.	insol.	
,, Bromide	85·5	154	6	0·08	20 % in glycerine.
,, Carbonate ...	93	445	insol.	insol.	
,, Chloride	35	39·6	insol.	...	
,, Citrate	28	204	45	insol.	
,, Hydrate	60	127	s.	insol.	
,, Hyposulphite...	100	v. s.	insol.	insol.	
,, Iodide	180	310	8·4	0·27	
,, Nitrate	88	100	3	...	
,, Nitrite	...	...	...	...	
,, Oxalate	3·5	7	insol.	insol.	
,, Phosphate ...	15	260	insol.	insol.	
,, Silicate	40	s. s.	dec.	dec.	
,, Stannate	61	s. s.	insol.	insol.	

TABLES OF SOLUBILITIES OF VARIOUS CHEMICALS (*Continued*).

	100 parts of cold water at 15° C., or 59° F., dissolve.	100 parts of boiling water dissolve.	100 parts of alcohol dissolve.	100 parts of ether dissolve.	Remarks.
Sodium Sulphate ...	50	200	s.	...	
,, Sulphite... ...	25	100	insol.	insol.	
,, Tartrate... ...	50	v. s.	insol.	insol.	
,, Tungstate ...	55	124	insol.	insol.	
Strontium Bromide ...	100	133	s. s.	...	
,, Chloride ...	55	100	s. s.	...	
,, Iodide ...	200	400	s. s.	...	
,, Nitrate ...	...	...	...	...	
Sulphocarbonide ...	9	v. s.	v. s.	insol.	
Thiosinamine	s. s.	s.	s.	s.	
Uranium Bromide ...	100	200	s.	...	
,, Chloride ...	v. s.	v. s.	v. s.	...	
,, Citrate... ...	s.	s.	insol.	insol.	
,, Iodide	...	...	...	...	
,, Nitrate ...	200	v. s.	33·3	25	
Zinc Acetate	...	...	...	...	
,, Bromide	320	v. s.	sol.	sol.	
,, Chloride	300	v. s.	v. s.	...	
,, Iodide	300	v. s.	v. s.	...	
,, Sulphate	142	200	insol.	...	

TABLE OF SOLUBILITIES OF VARIOUS ACIDS IN 100 PARTS OF WATER AT VARIOUS TEMPERATURES.

Temperature.	Benzoic Acid.	Boric Acid.		Oxalic Acid.	Tartaric Acid.	Ammonia Alum.
		Cryst.	Anhyd.			
0	...	1·9	1·1	5·2	115·0	5·2
10	·21	2·9	1·6	8·0	126·0	9·2
20	...	4·0	2·3	13·9	139·0	13·7
30	·42	...	...	23·0	156·0	19·3
40	·55	7·0	3·9	35·0	176·0	27·3
50	...	...	...	51·2	195·0	36·5
60	1·2	11·0	6·1	75·0	217·0	51·3
70	1·8	...	...	118·0	244·0	72·0
80	...	16·8	9·5	205·0	273·0	103·0
90	...	...	...	345·0	307·0	188·0
100	5·9	29·0	16·0		343·0	422·0

TABLE OF THE SOLUBILITIES OF THE PRINCIPAL HALOIDS FOR NEGATIVE COLLODION (Eder).

One part of the Salt dissolves at 15° C. in parts.

		1 Water.	Alcohol, Sp. Gr. ·794	Ether ·729	Alcohol 1 part. Ether 1 part.
Cadmium Bromide	$CdBr_24H_2O$	0·94	3·4	250	16
Ammonium „	NH_4Br	1·29	31·5	890	112
Sodium „	$NaBr2H_2O$	1·10	15·9	1200	...
Potassium „	KBr	1·62	750	5000	1700
Cadmium Iodide	CdI_2	1·13	0·98	3·6	2·0
Ammonium „	NH_4I	0·60	4·0	210	20
Sodium „	$NaI2H_2O$	0·55	12·0	360	...
Potassium „	KI	0·71	68·3	370	120
Ammonium Cadmium Bromide...	$2NH_4Br2CdBr_2H_2O$	0·73	5·3	280	24
„ „ „ ...	$4NH_4BrCdBr_2$	0·96	precipitated	precipitated	precipitated
Sodium Cadmium Bromide ...	$2NaBr2CdBr_25H_2O$	1·04	3·7	190	...
Potassium Cadmium Bromide ...	$KBrCdBr_2H_2O$	0·79	precipitated	precipitated	precipitated
„ „ „ ...	$4KBrCdBr_2$	1·40	precipitated	precipitated	precipitated
Ammonium Cadmium Iodide ...	$2NH_4I2CdI_2H_2O$	0·90	0·88	2·4	...
„ „ „ ...	$2NH_4ICdI_22H_2O$	0·58	0·70	8·9	1·8
Sodium Cadmium Iodide ...	$2NaICdI_26H_2O$	0·63	0·86	10·1	...
Potassium Cadmium Iodide ...	$KICdI_2H_2O$	0·94	...	...	...
„ „ „ ...	$2KICdI_22H_2O$	0·73	1·4	24·5	4·5

Table of the Solubilities of various Resins (Valenta).

sol. = soluble; s. sol. = slightly soluble; part. sol. = partly soluble; dif. sol. = soluble with difficulty; eas. sol. = easily soluble; insol. = insoluble; alm. insol. = almost insoluble; com. sol. = completely soluble; incom. sol. = incompletely soluble.

Name.	Spec. Grav. at 15° C.	Melting Point.	Alcohol.	Ether.	Chloroform.	Amyl Alcohol.	Carbon Disulphide.	Coal Tar Benzole.	Petroleum Ether.	Acetone.	Oil of Turpentine.	Fatty Oils.	Soda Solution.	Caustic Alkalies.	Remarks.
Ammoniacum	1·207	42°—45°	part. sol.	part. sol.	sol.	sol.	part. sol.	part. sol.	—	—	—	—	—	part. sol.	Sol. in conc. sulphuric acid; precipitated again with water.
Assafœtida ...	—	—	part. sol.	part. sol.	part. sol.	part. sol.	part. sol.	—	—	part. sol.	—	—	—	part. sol.	Dissolves easily in alcohol and ether.
Asphalt... ...	1·07—1·17	—	dissolves a little oily matter	about half	com. sol.	sol.	eas. sol.	com. sol.	in-com. sol.	sol.	slow but com. sol.	—	—	part. sol.	Incom. sol. in glacial acetic acid and aniline, insol. in acetic ether, sol. in oils of lavender and lemon and cherrylaurel. The portion insol. in alcohol and ether is the most light-sensitive. The acted upon by light asphalt is insol. or dif. insol. in turpentine.
Bdellium ...	—	45°—60°	part. sol.	part. sol.	—	—	part. sol.	—	—	—	—	—	—	—	
Benzoin ...	1·003	65°—80°	eas. sol.	eas. sol.	part. sol.	part. sol.	—	part. sol.	part. sol.	—	—	insol.	part. sol.	part. sol.	Sol. in cold acetic acid, and cold creosote.
Amber	1·005—1·07	—	s. sol.	s. sol.	s. sol.	s. sol.	insol.	insol.	insol.	s. sol.	s. sol.	insol.	—	—	
Amber ... ... melted.	—	280°	eas. sol.	eas. sol.	sol.	sol.	—	—	—	sol.	com. sol.	sol.	—	—	
Canada Balsam.	0·998	liquid	sol.	sol.	sol.	sol.	part. sol.	s. sol.	—	sol.	com. sol.	—	—	—	
Copaiba ...	0·916—0·989	liquid	com. sol.	com. sol.	com. sol.	com. sol.	com. sol.	com. sol.	part. sol.	—	—	sol.	—	part. sol.	
Copal	The behaviour towards solvents differs; the so-called soft copals partly dissolve or swell up, whilst the hard copals are scarcely attacked. On melting, some change takes place, as the previously insoluble copals dissolve readily in the ordinary solvents, especially linseed oil.														
,, melted															
Dammar ...	1·056	75°—100°	part. sol.	com. sol.	com. sol.	part. sol.	sol.	sol	sol.	—	sol.	com. sol.	—	—	Part. sol. in glacial acetic acid.

Dragon's Blood.	1·196	—	eas. sol.	part. sol.	com. sol.	eas. sol.	—	sol.	—	—	sol.	part. sol.	part. sol.	sol.	Insol. in castor oil, easily sol. in glacial acetic acid.
Elemi	1·018—1·080	120°	com. sol.	com. sol.	com. sol.	com. sol.	dif. sol.	part. sol.	dif. sol.	part. sol.	com. sol.	part. sol.	—	alm. insol.	
Galbanum	—	—	part. sol.	part. sol.	part. sol.	—	—	—	part. sol.	—	—	—	—	—	
Gamboge	—	100°	eas. sol.	eas. sol.	—	—	sol.	—	—	—	—	—	—	sol.	Sol. in oil of vitriol.
Guaiacum	1·22	85°	com. sol.	com. sol.	com. sol.	—	—	part. sol.	alm. insol.	sol.	part. sol.	part. sol.	—	com. sol.	
Gurjun Balsam.	1·040	liquid	com. sol.	—	com. sol.	sol.	—	part. sol.	com. sol.	—	com. sol.	—	—	—	
Liquid Amber	—	—	sol.	part. sol.	—	—	—	—	—	—	—	—	—	—	
Mastic	1·079	100°—183°	com. sol.	com. sol.	com. sol.	com. sol.	dif. sol.	sol.	sol.	sol.	sol.	alm. sol.	insol.	insol.	Tolerably eas. sol. in linseed oil.
Mecca Balsam	0·958	thin liquid	eas. sol.	eas. sol.	com. sol.	—	—	—	—	—	—	sol.	—	—	
Myrrh	1·128	—	part. sol.	com. sol.	eas. sol.	part. sol.	part. sol.	—	—	—	—	—	s. sol.	part. sol.	Sol. in glacial acetic acid.
Olibanum	1·221	110°	com. sol.	com. sol.	part. sol.	sol.	—	—	—	—	—	—	dif. sol.	insol.	
Opoponax	1·622	50°	sol.	part. sol.	part. sol.	sol.	—	—	part. sol.	—	—	—	part. sol.[1]	sol.	[1] With red coloration. Yellow colour produced.
Peru	1·14—1·16	liquid	com. sol.	part. sol.	com. sol.	com. sol.	—	part. sol.	part. sol.	—	part. sol.	part. sol.	—	part. sol.	
Resin	1·070	105°	sol.	sol.	sol.	sol.	—	sol.	part. sol.	sol.	sol.	sol.	sol.	sol.	
Sandarac	1·070—1·092	150°	com. sol.	com. sol.	part. sol.	—	s. sol.	part. sol.	dif. sol.	—	sol.	—	—	alm. insol.	Sol. 1:4 in alcohol, very s. sol. in boiling linseed oil, alm. insol. in acetic acid.
Shellac	1·139	—	sol.	part. sol.	part. sol.	com. sol.	insol.	insol.	insol.	insol.	s. sol.	s. sol.	part. sol.	part. sol.	Dissolves in watery hydrochloric and acetic acids, sol. in borax sol. and wood spirit.
Sagapenum	—	100°	com. sol.	part. sol.	—	—	—	—	part. sol.	—	s. sol.	s. sol.	—	dif. sol.	S. sol. in caustic ammonia.
Storax	—	—	sol.	com. sol.	part. sol.	—	—	—	—	—	—	—	—	part. sol.	Two kinds: storax liquid and in grains.
Turpentine	variable	liquid	com. sol.	com. sol.	com. sol.	sol.	part. sol.	part. sol.	part. sol.	sol.	com. sol.	sol.	part. sol.	com. sol.[2]	[2] Sol. in potash lye 1·27 sp. gr.
Tolu	1·17	60°— 5°	com. sol.[3]	part. sol.	com. sol.	sol.	alm. insol.	—	alm. insol.	—	sol.	alm. sol.	part. sol.	eas. sol.	[3] 1·6 parts alcohol.

Preparing Percentage Solutions.

(*Anthony's Annual.*)

By C. C. Sherrard, Ph.D.

The first table gives percentage solutions; the second gives parts in 1,000 or less. The use of the first is as follows: Run down column one until the correct percentage wanted is found, then move to the right along the line until the column is found giving the amount of fluid measure to be made up; at the intersection will be found the weight of salt required. It must be remembered that this is the amount of water to take, and not *q.s.* water to make the volume; also that these tables are true only for water, and not for alcohol or other fluids.

For Making any Quantity of Percentage Solutions.

To make	For each 1 fluid ounce of water take of the salt	For each 2 fluid ounces of water take of the salt	For each 3 fluid ounces of water take of the salt	For each 4 fluid ounces of water take of the salt	For each 5 fluid ounces of water take of the salt	For each 10 fluid ounces of water take of the salt	For each 16 fluid ounces of water take of the salt
	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
1 per cent	4·557	9·114	13·671	18·228	22·785	45·57	72·912
2 per cent	9·114	18·228	27·342	36·456	45·570	91·14	145·824
3 per cent	13·671	27·352	41·013	54·684	68·355	136·71	218·416
4 per cent	18·228	36·456	54·684	72·912	91·14	182·28	291·648
5 per cent	22·785	45·57	68·355	91·14	113·925	227·85	364·56
10 per cent	45·57	91·14	136·71	182·28	227·85	455·7	729·12
15 per cent	68·355	136·71	205·065	273·42	341·775	68·355	1093·68
20 per cent	91·14	182·28	273·42	364·56	455·70	911·4	1458·24
25 per cent	113·925	227·85	341·775	455·70	569·625	1139·25	1822·80
40 per cent	182·28	364·56	546·84	729·12	911·4	1822·8	2916·48

For Making any Quantity of Solution when stated in Parts per 1000, 100, *etc.*

To make solution of	For each 1 fluid ounce of water take of the salt	For each 2 fluid ounces of water take of the salt	For each 3 fluid ounces of water take of the salt	For each 4 fluid ounces of water take of the salt	For each 5 fluid ounces of water take of the salt	For each 10 fluid ounces of water take of the salt	For each 16 fluid ounces of water take of the salt
	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.	Grains.
1 in 1,000	·4557	·9114	1·3671	1·8228	2·278	4·557	7·291
1 in 500	·9114	1·8228	2·7342	3·6456	4·557	9·114	14·583
1 in 400	1·139	2·278	3·4177	4·557	5·695	11·392	18·228
1 in 300	1·519	3·035	4·557	6·076	7·59	15·19	24·304
1 in 200	2·2785	4·557	6·8355	9·114	11·39	22·785	36·456
1 in 100	4·557	9·114	13·671	18·228	22·785	45·57	72·912
1 in 50	9·114	18·228	27·342	36·456	45·57	91·14	145·824
1 in 25	18·228	36·456	54·684	72·912	91·14	182·28	291·648
1 in 10	45·570	91·140	136·710	182·280	227·85	455·73	729·120
1 in 5	91·14	182·28	273·42	364·56	455·7	911·4	1458·24

We may say that, in giving the above figures, the resulting solution is sufficiently correct as regards percentage composition, though it may measure slightly more than the water taken, owing to the increase in volume which always takes place in some degree when a solid passes into a solution in a given amount of liquid. This expansion is not appreciable for small amounts of the solid, say up to 5 per cent., but at 25 per cent, or more, it may be very noticeable.

Specific Gravity. See HYDROMETERS and HYDROMETRY.

Spectacle Lens. See MONOCLE and LENS.

Speed of Plates. See EXPOSURE and SENSITIVENESS.

Spherical Aberration. When a simple convex lens and short focus is used to project an image on to a focussing screen it will be found that the image is nowhere absolutely sharp; and the reason of this indistinctness is spherical aberration. Let L, fig. 108, represent a short-focus convex lens, and R′R′R R represent rays of light striking the lens; the marginal rays R R cross the axis of the lens or come to a focus at *f′*, a point nearer the lens than the central rays, R′R′; so that if an image at *f* be examined it will be seen to be surrounded by an aureola or ring of light, *a b*, which is formed by the spreading of the marginal rays after

meeting at the focus f'. This ring is called lateral spherical aberration, and the diameter of the same is termed the expression of the lateral aberration. The distance along the axis of the lens between the principal focus, or the focus of the central rays, R R′,

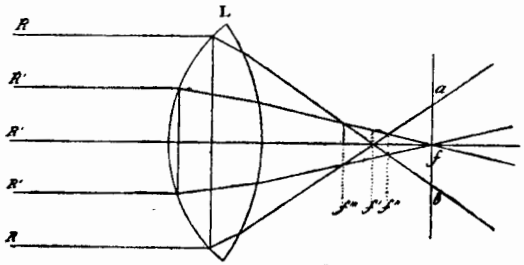


Fig. 108.

at f, and the focus of the marginal rays, R R, at f', is called longitudinal aberration. In this case the focus of the marginal rays, being shorter than that of the central rays, the aberration is called positive spherical aberration. The circle of least confusion or least aberration, or the smallest section it is possible to make

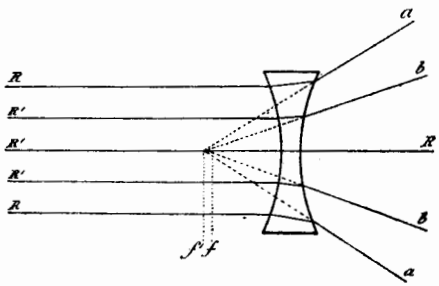


Fig. 109.

of the cone of rays, is situated between f'' and f'''. In negative or divergent lenses the central rays, R′ R′, emerge in the direction $b\,b$, and the marginal rays, R R, in the direction $d\,d$. The central rays prolonged cut the axis at f, which is then the principal focus, and the marginal rays produced cut the axis at f'; therefore the

focus of the marginal rays is longer than that of the central rays, and this is termed negative spherical aberration. The sphericity of the surfaces of a lens being the cause of spherical aberration, it necessarily follows that the more curved these surfaces are relative to the diameter of the lenses the greater is the spherical aberration; thus, lenses of comparatively short focus and large aperture, like portrait lenses, are more likely to suffer from spherical aberration. Any divergent or convergent lens suffering from this defect, in a greater or less degree, may be cured to a great extent by placing a diaphragm or stop in front of the lens,

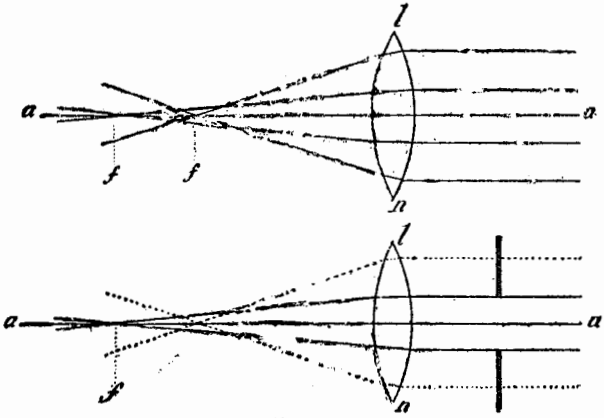


Fig. 110.

which actually reduces the lens to a smaller working aperture, and thus prevents the marginal rays from being refracted by the lens. The use of the diaphragm, however, will not completely cure spherical aberration. It reduces it, it is true, to a negligable quantity; thus let *ln*, fig. 110, represent a convex lens; it is obvious that the marginal rays will be refracted and meet at *f* whereas the central rays cross the axis *a a* at *f*, farther from the lens; by the insertion of a diaphragm the marginal rays are prevented from reaching the lens, and, therefore, only the central rays are used to form the image. Certain portrait lenses and others have been placed on the market, by means of which a certain amount of spherical aberration is designedly left outstanding or

can be introduced at will, giving the so-called diffusion of focus. Spherical aberration may be detected in a lens by very simple tests, and its effect is to render the image upon the focussing screen indistinct, so that it is impossible to focus accurately either the centre or the margins. An easy test is: To a window affix two small circles of opaque paper so as just to touch each other, and having focussed these on the centre of the screen, insert a diaphragm by the aid of a focussing magnifier, and see whether the images gain in sharpness. If they do, spherical aberration has not been totally eliminated. Another method is to cut a piece of opaque paper the exact size of the lens, and then cut the centre of this circle out, so as to leave a ring about one-seventh the diameter. Then lightly affix this ring to the front of the lens, and focus a sheet of newspaper, or the two circles of paper mentioned above; then remove the ring and affix the central circle to the lens, and again focus. There should be no alteration of focus if there is spherical aberration present.

"Spirit" Photography. The general scene having been arranged, together with any persons to whom the "spirit" is to manifest itself, about two-thirds of the exposure is given. The lens is now capped, and, while all others are still, the "spirit" steps into its place, and the remainder of the exposure is given. Sometimes it is more convenient to include the "spirit" in the first exposure, which should then be short. The lens being covered, the "spirit" walks away, and the exposure is completed. The conventional white sheet is generally most appreciated as a garment. For instructions how to produce a photograph depicting an interview between a person and his own ghost, see POLYPOSE. Also see PORTRAITURE.

Stannotype. A modification of Woodburytype (*q.v.*).

Stenopaic Photography (στενωπός, in sense of a narrow way). Synonymous with Pinhole Photography (*q.v.*).

Stereoscope (στερέος, solid, and σκοπεω, I look at). This instrument, which affords the best illustration of the nature of binocular vision, is largely dependent on photography for furnishing pictures possessing the required accuracy of drawing. A twin-lens camera is perhaps the most convenient for producing stereoscopic views, and is an essential when instantaneous pic-

tures are required. For subjects which are not liable to move any camera may be used, the two elements of the stereogram being taken at a distance apart which may vary from a few inches for near objects to several feet for distant objects. Mr. Chadwick's "Stereoscopic Manual," mentioned in our BIBLIOGRAPHY (p. 72), is a convenient handbook, and is written by one who is an enthusiast in connection with the stereoscope.

Stripping Negatives. See NEGATIVES, STRIPPING OF.

Sulpho-Pyrogallol. A term given to a solution of pyrogallic acid in conjunction with a sulphite, as first suggested by Berkeley. The original formula was :—

Pyrogallol	1 oz.
Sodium sulphite	4 ozs.
Citric acid	¼ oz.
Water	9 ozs.

Sulphuric Acid (Ger., *Schwefelsäure;* Fr., *Acide Sulfurique*). $H_2SO_4 = 98$. It is prepared by roasting iron or copper pyrites and oxidising the sulphur dioxide. Specific gravity: 1·845. It is used in photography as a clearing agent, and for many other purposes. It forms salts called sulphates. It is extremely corrosive and caustic. Great heat is evolved when it is mixed with water, the temperature being raised to nearly boiling point; great care, therefore, should be used in mixing it, or the measure or vessel may be broken.

Sulphurous Acid (Ger., *Schwefligwasserstoffsäure;* Fr., *Acide Sulfureux*). Sulphur dioxide is prepared by deoxidising sulphuric acid with charcoal; and this gas, when dissolved in water, forms a colourless liquid, with pungent sulphurous odour, and containing 5 per cent. of sulphurous anhydride, SO_2. Specific gravity, 1·025. It should be freshly prepared, as it changes by keeping into sulphuric acid. It is recommended for preserving pyrogallol, and forms one of the ingredients of Beach's Developer (*q.v.*). Care should be exercised in handling this, not to inhale the fumes, which are extremely irritating.

Synonymes. A list of synonymous photographic terms, such as is here given, may be very useful in various ways; but all

lists of synonymes, it must be remembered, are liable to cause occasional misunderstandings. It must, moreover, be understood that the terms are to be considered from a photographic point of view. For example, the equivalent we have given for Blechcassetten, although correct from a photographic point of view, would be wrong in a general sense.

A.

Abdruck. *Ger.* Print, impression.
Aberration. *Fr.*, *Ger.* Aberration.
Abschwächer. *Ger.* Reducer.
Abziehpapier. *Ger.* Stripping-paper, transferotype.
Accélérateur. *Fr.* Accelerator.
Accessoire. *Fr.* Accessory.
Acetate. *Fr.* Acetate.
Achromatische Linse. *Ger.* Achromatic lens.
Achromatisme. *Fr.* }
Achromatismus. *Ger.* } Achromatism.
Acide. *Fr.* Acid.
Acide azoteux. *Fr.* Nitrous acid.
„ **azotique.** *Fr.* Nitric acid.
Actinique. *Fr.* Actinic.
Adragant. *Fr.* Tragacanth.
Aethyläther. *Ger.* Ether, ethylic ether.
Aetzammoniak. *Ger.* Caustic ammonia, Liq. amm. ·880.
Aetzkali. *Ger.* Caustic potash.
Aetzkalk. *Ger.* Quick-lime.
Aetznatron. *Ger.* Caustic soda.
Affaiblir. *Fr.* To reduce.
Agrandissement. *Fr.* Enlargement.
Aktinisch. *Ger.* Actinic.
Alabasterverfahren. *Ger.* }
Albâtre, procédé d'. *Fr.* } Alabastrine process.
Alaun. *Ger.* Alum.
Albertypie. *Fr.*, *Ger.* Albertype, collotype.
Albumin. *Ger.* }
Albumine. *Fr.* } Albumen.
Albuminat. *Ger.* }
Albuminate. *Fr.* } Albuminate.
Albuminpapier. *Ger.* Albumen paper.
„ **verfahren.** *Ger.* „ process.

Synonymes

Alcali. *Fr.*
Alkali. *Ger.* } Alkali.

Alcool. *Fr.*
Alkohol. *Ger.* } Alcohol.

Aldehyde. *Fr., Ger.* Aldehyde.

Alun d'ammoniaque. *Fr.* Ammonia alum.

„ **de chrome.** *Fr.* Chrome alum.

Ambre jaune. *Fr.* Amber.

Ameisensäure. *Ger.* Formic acid.

Amidon. *Fr.* Starch.

„ **grillé.** *Fr.* Dextrin.

Ammoniaque liquide. *Fr.*
Ammoniak. *Ger.* } Ammonia.

Ampoule. *Fr.* Blister.

Anilindruck. *Ger.* Aniline printing.

Anreiber. *Ger.* Roller squeegee.

Antimoine gris. *Fr.* Sulphide of antimony.

Aplanatisch. *Ger.*
Aplanetique. *Fr.* } Aplanatic.

Apparat. *Ger.*
Appareil. *Fr.* } Apparatus.

„ **d'atelier.** *Fr.* Studio camera.

„ **automatique pour l'impression.** *Fr.* Automatic printer.

„ **de campagne.** *Fr.* Tourist camera.

„ **détective.** *Fr.* Detective camera.

„ **à main.** *Fr.* Hand camera.

„ **panoramique.** *Fr.* Panoramic camera.

Appui-tête. *Fr.* Head rest.

Aqua-vernis. *Fr.* Water varnish.

Aräometer. *Ger.*
Aréomètre. *Fr.* } Hydrometer.

Argent. *Fr.* Silver.

„ **corne.** *Fr.* Horn silver, or silver chloride.

Argentometer. *Ger.*
Argentomètre. *Fr.* } Argentometer.

Aristopapier. *Ger.*
Aristotype. *Ger.*
Aristotypie. *Fr.* } Gelatino-chloride emulsion printing-out papers, or occasionally gelatino-argentic printing-out papers.

Asphaltfirniss. *Ger.* Asphalt varnish.

„ **verfahren.** *Ger.* Asphalt process.

Astigmatismus. *Ger.* Astigmatism.

Atomgewichte. *Ger.* Atomic weight.

Aufnahme. *Ger.* Exposure.

Aufnahmeperson. *Ger.* Operator.
Aufziehen. *Ger.* To mount.
Augensblickbilder. *Ger.* Instantaneous picture, snapshot.
„ **verschluss.** *Ger.* Instantaneous shutter.
Aurate d'ammoniaque. *Fr.* Fulminating gold.
Auréole. *Fr.* Halo, or halation.
Auscopiren. *Ger.* To print out.
Ausrustung. *Ger.* Complete outfit.
Aussenaufnahmen. *Ger.* Outdoor photography.
Autotype. *Ger.* } Process-block making.
Autotypie. *Fr.* }
Azotate. *Fr.* Nitrate.
Azote. *Fr.* Nitrogen.
Azotite. *Fr.* Nitrite.

B.

Bad. *Ger.* }
Bain. *Fr.* } Bath.
„ **à clarifier.** *Fr.* Clearing bath.
„ **fixateur.** *Fr.* Fixing bath.
„ **virage.** *Fr.* Toning bath.
Balance cuvette. *Fr.* Rocking dish.
Balg Auszug. *Ger.* Bellows body.
„ **Camera.** *Ger.* Bellows camera.
Barytpapier. *Ger.* Baryta paper.
Bascule du châssis. *Fr.* Swing back.
Baume du Canada. *Fr.* Canada balsam.
Bec à gaz Auer. *Fr.* Incandescent gas light.
Beiwerk. *Ger.* Accessory.
Beleuchtung. *Ger.* Lighting.
„ **schirm.** *Ger.* Reflector.
Belichtung. *Ger.* Exposure.
Belmontine. *Fr.* Solid paraffin wax.
Bergcrystall. *Ger.* Quartz.
Bergmehl. *Ger.* Infusorial earth, fossil meal, or infusorite.
Bernstein. *Ger.* Amber.
„ **säure.** *Ger.* Succinic acid.
Beschleuniger *Ger.* Accelerator.
Beschneidegläser. *Ger.* Cutting shape.
Bichlorure de plomb. *Fr.* Lead chloride.
Bildfeld. *Ger.* Angle of view.
Bildformate. *Ger.* Size of print.
Bildmesser. *Ger.* View meter.

Bildsucher. *Ger.* View finder.
Bimstein. *Ger.* Pumice stone.
Bitume. *Fr.* Bitumen.
„ **liquide.** *Fr.* Naphtha.
Blanc d'Espagne. *Fr.* Whiting.
Blanchir. *Fr.* To bleach.
Blancs. *Fr.* Whites.
Blasebalgcamera. *Ger.* Bellows-body camera.
Blasen. *Ger.* Blisters.
Blaudruck. *Ger.* Ferroprussiate printing.
Blechcassetten. *Ger.* Metal sheaths or dark slides.
Blechrahmchen. *Ger.* Metal sheaths.
Bleiacetat. *Ger.* Acetate of lead.
Bleichkalk. *Ger.* Chloride of lime.
Bleichlorid. *Ger.* Lead chloride.
Bleichwasser. *Ger.* Eau de Javelle.
Bleizucker. *Ger.* Sugar of lead.
Blende. *Ger.* Diaphragm.
Bleu de quinoleine. *Fr.* Cyanine.
Blitzlicht. *Ger.* Flashlight.
Blutlaugensalz gelbes. *Ger.* Yellow prussiate of potash.
„ **rothes.** *Ger.* Red „ „
Bodenauszug. *Ger.* Baseboard.
Boîte à escamoter. *Fr.* Changing box.
Bombées. *Fr.* Cameo prints.
Bordure noire. *Fr.* Safe edge.
Borsäure. *Ger.* Boric acid.
Braunstein. *Ger.* Black oxide of manganese.
Brennpunkt. *Ger.* Focus, focal point.
Brennweite. *Ger.* Focal length.
Brenzcatechin. *Ger.* Pyrocatechin.
Brillant Albuminpapier. *Ger.* Double albumenised paper
Brom. *Ger.* Bromine.
„ **ammon.** *Ger.* Ammonium bromide.
„ **calcium.** *Ger.* Calcium.
„ **eosinsilber.** *Ger.* Eosinated bromide of silver.
„ **kalium.** *Ger.* Potassium bromide.
„ **lithium.** *Ger.* Lithium bromide.
„ **natrium.** *Ger.* Sodium bromide.
„ **silber.** *Ger.* Silver bromide.
Bromhydrate d'ammoniaque. *Fr.* Ammonium bromide.
Bromsilbercollodium. *Ger.* Collodio-bromide of silver.
„ **gelatine.** *Ger.* Gelatino-bromide of silver.

Bromsilbergellatine papier. *Ger.* Bromide paper.
Bromure de chaux. *Fr.* Calcium hypobromite or "bromide of lime."
Bromwasser. *Ger.* Bromine water.
„ **zink.** *Ger.* Zinc bromide.
Broncirte or **broncefarbene Schatten.** *Ger.* Bronzed shadows.
Brouillard lumineux. *Fr.* Halation.
Brûleur or bec de Bunsen. *Fr.* Bunsen burner.
Brustbild. *Ger.* Bust portrait.
Buchcamera. *Ger.* Book camera.
Bulles d'air. *Fr.* Air bubbles.
Bunsenbrenner. *Ger.* Bunsen burner.
Buste. *Fr.* Bust portrait.

C.

Cabinet noir. *Fr.* Dark room.
Caches. *Fr.* Masks.
Calcinirte Soda. *Ger.* Anhydrous sodium carbonate.
Camée-Bilder. *Ger.* Cameo prints.
Campher. *Ger.*
Camphre. *Fr.* } Camphor.
Caoline. *Fr.* Kaolin.
Caput mortuum. *Lat.* Oxide of iron.
Carbolsäure. *Ger* Carbolic acid.
Cartes Russes. *Fr.* Vignettes on dark ground.
Cartouches. *Fr.* Cartridges.
Cassette. *Ger.* Dark slide.
Cassettensehnäpper. *Ger.* Dark slide spring catch.
Celloidin. *Ger.* Celloidin, special form of pyroxylin.
„ **papier.** *Ger.* Collodio-chloride paper.
Celluloidschalen. *Ger.* Celluloid dishes.
Centralblende. *Ger.* Diaphragm between two lenses.
Centre optique. *Fr.* Optical centre.
Centrifugir Maschine. *Ger.* Centrifugal machine.
Cerat. *Ger.* Encaustic paste.
Ceresine. *Fr.* Solid paraffin wax.
Cerotine. *Ger.*
Cérotine. *Fr.* } Encaustic paste made from plant wax.
Chambre binoculaire. *Fr.* Stereoscopic camera.
„ **detective.** *Fr.* Detective camera.
„ **livre.** *Fr.* Book camera.
„ **noire.** *Fr.* Dark camera.
„ **à main.** *Fr.* Hand camera.
„ **à simple ouverture.** *Fr.* Pinhole camera.

Chambre à soufflet. *Fr.* Bellows body camera.
Champ. *Fr.* Field of a lens.
„ **de netteté.** *Fr.* Field of view.
„ **plat.** *Fr.* Flatness of field.
Charbon. *Fr.* Charcoal.
„ **animal.** *Fr.* Animal charcoal.
Chariot droit. *Fr.* Baseboard.
Chartotypie. *Ger.* Talbotype.
Châssis. *Fr.* Dark slide.
„ **double.** *Fr.* Double dark slide.
„ **à escamoter.** *Fr.* Changing dark slide.
„ **à imprimer.** *Fr.* Printing frame.
„ **multiplicateur.** *Fr.* Multiple dark slide.
„ **à rideau.** *Fr.* Roller-blind dark slide.
„ **à rouleaux.** *Fr.* Roll holder.
„ **triple.** *Fr.* Dark slide, to take 3 plates.
Chaux éteinte. *Fr.* Slake-lime.
„ **vive.** *Fr.* Quick-lime.
Chemigraphie. *Ger.* Zinc etching.
Chemische oder alkalische Entwickelung. *Ger.* Alkaline development.
„ **Brennpunkt.** *Ger.* Actinic focus.
„ **Schleier.** *Ger.* Chemical fog.
Chinolinblau. *Ger.* Cyanine.
„ **roth.** *Ger.* Quinoline, or chinoline red.
Chlor. *Ger.* } Chlorine.
Chlore. *Fr.* }
Chlorammonium. *Ger.* Ammonium chloride.
„ **barium.** *Ger.* Barium chloride.
„ **blei.** *Ger.* Lead chloride.
„ **calcium.** *Ger.* Calcium chloride.
„ **eisen.** *Ger.* Iron chloride.
„ **gold.** *Ger.* Gold chloride.
„ „ **kalium.** *Ger.* Gold and potassium chloride.
„ „ **natrium.** *Ger.* „ „ sodium chloride.
„ **iridium.** *Ger.* Iridium chloride.
„ **kalium.** *Ger.* Potassium chloride.
„ **kalk.** *Ger.* Lime chloride.
„ **lithium.** *Ger.* Lithium chloride.
„ **magnesium.** *Ger.* Magnesium chloride.
„ **natrium.** *Ger.* Sodium chloride.
„ **platin.** *Ger.* Platinum chloride.
„ **quecksilber.** *Ger.* Mercuric chloride.

Chlorhydrate. *Ger.* Hydrochlorate, or chloride.
Chlorsaures Kali. *Ger.* Chlorate of potassium.
„ **Silber.** *Ger.* Chlorate of silver.
Chlorsilber. *Ger.* Chloride of silver.
„ **collodium.** *Ger.* Collodio-chloride of silver.
„ **gelatine.** *Ger.* Gelatino-chloride of silver.
„ „ papier. *Ger.* Chloride paper.
Chlorstrontium. *Ger.* Strontium chloride.
„ **wasser.** *Ger.* Chlorine water.
„ „ **stoffsäure.** *Ger.* Hydrochloric acid.
„ **zink.** *Ger.* Zinc chloride.
Chromalaun. *Ger.* Chrome alum.
Chromatische Aberration. *Ger.* Chromatic Aberration.
Chromgelatine. *Ger.* } Bichromated gelatine.
„ **leim.** *Ger.* }
Chromo-Aristopapier. *Ger.* Baryta paper.
Chromophotographie. *Ger.* Colour Photography, often applied to Crystoleum painting.
Chromsäure. *Ger.* Chromic acid.
Chromsäures Kali, einfaches. *Ger.* Potassium chromate.
„ „ **zweifaches.** *Ger.* Potassium bichromate.
Cire. *Fr.* Wax.
Citronensäure. *Ger.* Citric acid.
„ **säures Eisenoxyd.** *Ger.* Citrate of iron.
„ „ „ **ammon.** *Ger.* Ammonio-citrate of iron.
„ „ **Silber.** *Ger.* Silver citrate.
Clair de lune. *Fr.* Moonlight effect.
Cliché. *Fr.* Negative or original used in reproduction.
Cliquet. *Fr.* Spring catch for dark slide.
Collage. *Fr.* Mounting.
Colle d'amidon. *Fr.* Starch paste.
„ **liquide.** *Fr.* Liquid glue.
„ **marine.** *Fr.* Marine glue.
„ **de poisson.** *Fr.* Fish glue.
Collodionage. *Fr.* } Collodionising.
Collodioniren. *Ger.* }
Collodion riciné. *Fr.* Enamel collodion.
„ **sensibilisé.** *Fr.* Sensitive collodion.
Collodium. *Ger.* Collodion.
„ **verfahren, trockenes.** *Ger.* Collodio-bromide process.
„ „ **nasses.** *Ger.* Wet collodion process.
Collodiumwolle. *Ger.* } Pyroxylin.
Colloxylin. *Ger.* }

Colophane. *Fr.* } Resin.
Colophonium. *Ger.* }
Combinationsdruck. *Ger.* Combination printing.
Compositbild. *Ger.* Composite portrait.
Concentrirt. *Ger.* Saturated (solution).
Condensateur. *Fr.* Condenser.
Contactdruck. *Ger.* Contact print.
Contretype. *Fr.* Reversed negative.
Controlluhr. *Ger.* Indicator, register.
Copie. *Ger.* Print.
Copirautomat. *Ger.* Automatic printing machine.
„ **camera.** *Ger.* Copying camera.
Copiren. *Ger.* Printing.
Copirrahmen. *Ger.* Printing frame.
Corallin gelbes. *Ger.* } Aurine.
Corelline jaune. *Fr.* }
Corindon. *Fr.* Emery.
Corps de la monture. *Fr.* Lens tube.
Coton azotique. *Fr.* } Pyroxylin.
„ **poudre.** *Fr.* }
Couche sensible. *Fr.* Sensitive film.
Coupe ovale. *Fr.* Print trimmer.
Courbure de champ. *Fr.* Curvature of field.
Coussin de feutre. *Fr.* Felt pads.
Couvercle de l'objectiv. *Fr.* Lens cap.
Crayeuse épreuve. *Fr.* Chalky print.
Crémaillère. *Fr.* Rack and pinion.
Creuset. *Fr.* Crucible.
Cristalline. *Fr.* Aniline.
Crochet. *Fr.* Dipper.
Crocus. *Ger.* Oxide of iron.
Cyankalium. *Ger.* Potassium cyanide.
Cyanofer. *Fr.* } Cyanotype.
Cyanotypverfahren. *Ger.* }
Cyanure. *Fr.* Cyanide.
Cyanwasserstoffseife. *Ger.* Potassium cyanide soap.

D.

Daguerreotypie. *Fr.* Daguerreotype.
Dammarharz. *Ger.* Gum Dammar.
Dauerpapier. *Ger.* Ready sensitised paper.
Deckung. *Ger.* Density.
Définition sur les bords. *Fr.* Marginal definition.

Dégradateur. *Fr.* Vignette.
Deltapapier. *Ger.* Gelatino-chloride paper.
Demiteintes. *Fr.* Half-tones.
Depôt pulvérulent blanc. *Fr.* White powdery deposit.
Destilliren. *Ger.* To distil.
Deutoxyde de mercure. *Fr.* Mercuric oxide.
Dialyse. *Fr.* Dialysis.
Diaphanaskop. *Ger.* Diaphanoscope, lanternoscope.
Diaphragme centrale. *Fr.* Central diaphragm.
„ **étoile.** *Fr.* Star stop.
„ **Iris.** *Fr.* Iris diaphragm.
„ **qui réduit l'intensité lumineuse du ciel.** *Fr.* Cloud stop.
„ **tournant.** *Fr.* Wheel diaphragm.
Diapositiv. *Ger.* Transparency.
Diazodruck. *Ger.* Diazotype printing.
Dichtigkeit. *Ger.* Density.
Distance focale. *Fr.* Focus.
Doigtier. *Fr.* Plate lifter.
Doppelcassette. *Ger.* Double dark slide.
Doppelgängerbild. *Ger.* Double photograph, one person in two positions on one plate.
Doppeljodid. *Ger.* Solution of silver iodide in potassium iodide.
Doppelobjectiv. *Ger.* Doublet lens.
Doppeltchromsäures Ammoniak. *Ger.* Ammonium bichromate.
„ **Kali.** *Ger.* Potassium bichromate.
Doppeltkohlensäures Natron. *Ger.* Sodium bicarbonate.
Doppeltransportverfahren. *Ger.* Double-transfer carbon process.
Dosenlibelle. *Ger.* A level.
Double tirage. *Fr.* Combination printing.
Drehblende. *Ger.* Revolving or wheel diaphragm.
Dreibeinstativ. *Ger.* Tripod stand.
Drillingscassette. *Ger.* Multiple dark slide.
Druck. *Ger.* Print.
Drucken. *Ger.* Printing.
Dunkelzelt. *Ger.* Dark tent.
„ **zimmer.** *Ger.* Dark room.
„ „ **lampe.** *Ger.* Dark room lamp.
Durcir. *Fr.* To harden.
Dynaktinometer. *Ger.* }
„ **metre.** *Fr.* } Actinometer.

E.

Eau bromée. *Fr.* Bromine water.

Synonymes

Eau chlorée. *Fr.* Chlorine water.
„ **de Javelle.** *Fr.* Chlorinated soda solution.
„ **mère.** *Fr.* Mother liquor.
„ **regale.** *Fr.* Aqua regia.
Ebenheit des Feldes. *Ger.* Flatness of field.
Ebonit. *Ger.* Ebonite.
Eburneumverfahren. *Ger.* Eburneum process.
Eclair magnesique. *Fr.* Magnesium flash light.
Eclairage. *Fr.* Lighting.
„ **à la Rembrandt.** *Fr.* Rembrandt lighting.
„ **inoffensif.** *Fr.* Non-actinic light.
Ecran d'eclairage. *Fr.* Reflector.
„ **jaune.** *Fr.* Yellow screen.
„ **strié.** *Fr.* Cross-line screen.
Ecrou du pied. *Fr.* Tripod head.
Effets du jour et du nuit. *Fr.* Dissolving views.
Einfaches objectiv. *Ger.* Single landscape lens.
Einfachtransportverfahren. *Ger.* Single-transfer carbon process.
Einfallswinkel. *Ger.* Angle of incidence.
Eingebrannte Photographien. *Ger.* Ceramic photographs.
Einlage. *Ger.* Printing-frame pad.
Einlagen. *Ger.* Carriers for dark slides.
Einstaubverfahren. *Ger.* Powder process.
Einstellen. *Ger.* To focus.
Einstell-loupe. *Ger.* Focussing magnifier.
Einstellschraube. *Ger.* Focussing screw.
Einstelltuch. *Ger.* Focussing cloth.
Eintaucher. *Ger.* Dipper.
Eisenblaudruck. *Ger.* Cyanotype process.
Eisenchlorid. *Ger.* Ferric chloride.
Eisenflecken. *Ger.* Particles of iron.
Eisenoxalat. *Ger.* Ferric oxalate.
„ **oxyde.** *Ger.* Ferric oxide.
„ „ **schwefelsaures.** *Ger.* Ferric sulphate.
„ **vitriol.** *Ger.* Ferrous sulphate.
Eisessig. *Ger.* Glacial acetic acid.
Eiweiss. *Ger.* Albumen.
Elemente. *Ger.* Elements.
Elfenbeinschwarz. *Ger.* Ivory black.
Emailfarbe. *Ger.* Enamel colours.
Emailler. *Fr.* To enamel.
Emailphotographien. *Ger.*
Emaux photographiques. *Fr.* } Ceramic enamels.

Emeri. *Fr.* Emery.
Empfindlichkeit. *Ger.* Sensitiveness.
Emulsion à collodion iodo-bromurée. *Fr.* Collodion iodo-bromide emulsion.
„ **à l'ébullition.** *Fr.* Boiled emulsion.
Encre de Chine. *Fr.* Chinese ink.
Englisch Roth. *Ger.* Oxide of iron.
Entfarben. *Ger.* To clear, decolorise.
Entwickelung. *Ger.* Development.
„ **sdruck.** *Ger.* A print by development, *e.g.* bromide.
Entwickler. *Ger.* Developer.
Eosinblaustich. *Ger.* Erythrosin.
Epreuve. *Fr.* Proof, print.
Epreuves bombées. *Fr.* Cameo prints.
„ **sans éclat.** *Fr.* Flat prints.
Escamoter les plaques. *Fr.* To change plates.
Esprit de bois. *Fr.* Wood spirit, methylated spirit.
Essence de goudron. *Fr.* Coal-tar oil.
„ **huile térébinthine.** *Fr.* Spirit of turpentine
„ **de poires.** *Fr.* Amyl acetate.
Essigsäure. *Ger.* Acetic acid.
Essigsäureamylester. *Ger.* Amyl acetate.
Essigsäures Blei. *Ger.* Lead acetate.
„ **Eisenoxydul.** *Ger.* Ferrous acetate.
„ **Natron.** *Ger.* Sodium acetate.
Essoreuse. *Fr.* Centrifugal machine.
Etendage. *Fr.* Coating (plates).
Etoffe jaune. *Fr.* Canary medium.
Euryskop. *Ger.* Euryscope.
Exposition. *Ger.* Exposure.
„ **messer.** *Ger.* Exposure meter.

F.

Faiblisseur. *Fr.* Reducer.
Fallverschluss. *Ger.* Drop shutter.
Farbenempfindlich. *Ger.* Colour sensitive.
Farbschleier. *Ger.* Green fog.
Farrine fossile. *Fr.* Infusorial earth. See BERGMEHL.
Fécule. *Fr.* Starch.
Fernobjectiv. *Ger.* Telephotographic lens.
Ferreux, sels ferreux. *Fr.* Ferrous salts.
Ferricyanure de potassium. *Fr.* Ferricyanide of potassium.
Ferridcyankalium. *Ger.* Ferridcyanide of potassium.

Ferrioxalat. *Ger.* Ferric oxalate.
Ferriques, sels ferriques. Ferric salts.
Ferroacetat. *Ger.* Ferric acetate.
Ferrotypie. *Fr., Ger.* Ferrotype.
Ferrotyplack. *Ger.* Benzole or crystal varnish.
Fiel de boeuf. *Fr.* Ox-gall.
Firniss. *Ger.* Varnish.
Fischleim. *Ger.* Isinglass.
Fixage. *Fr.* Fixation.
Fixirbad. *Ger.* Fixing bath.
„ **säures.** *Ger.* Acid fixing bath.
Fixirnatron. *Ger.* Hyposulphite of soda.
Flacon comptes gouttes. *Fr.* Dropping bottle.
Fleurs de zink. *Fr.* Oxide of zinc.
Floue, image floue. *Fr.* Flat or indefinite image.
Fluorwasserstoffsäure. *Ger.* Hydrofluoric acid.
Flussäure. *Ger.* Hydrofluoric acid.
Flussmittel. *Ger.* Flux.
Focale, distance focale. *Fr.* Focus, focal length.
Focimètre. *Fr.* Focimeter.
Focus-differenz. *Ger.* Non-coincidence of foci.
„ **messer.** *Ger.* Focimeter.
„ **tiefe.** *Ger.* Depth of focus.
„ **weite.** *Ger.* Focus, focal length.
Folien. *Ger.* Films.
Fond. *Fr.* Background.
Foyer. *Fr.* Focus.
Freilichtaufnahmen. *Ger.* Outdoor photography.
Fulmi-coton. *Fr.* Pyroxyline.
Fumigation. *Fr.* Fuming.

G.

Gaiacol. *Ger.* Guaiacol.
Gallussäure. *Ger.* Gallic acid.
Ganze Platte. *Ger.* Wholeplate, $8\frac{1}{2} \times 6\frac{1}{2}$ inches.
Gasgluhlicht. *Ger.* Incandescent gas light.
Gaz azote. *Fr.* Nitrogen.
„ **nitreux.** *Fr.* Nitrous oxide.
Geheimcamera. *Ger.* Detective camera.
Gélatine bichromatée. *Fr.* Bichromated gelatine.
Gelatinobromure. *Fr.* Gelatino-bromide.
Gelatinochlorure. *Fr.* Gelatino-chloride.
Gelatinotypie. *Fr.* Leimtype.

Gelbfarbung. *Ger.* Yellow stain.
„ **scheibe.** *Ger.* Yellow screen.
„ **schleier.** *Ger.* Yellow stain.
„ **wurzel.** *Ger.* Turmeric.
Gerben. *Ger.* To harden.
Gerbsäure. *Ger.* Tannic acid.
Gesichtsfeld. *Ger.*
Gesichts-winkel. *Ger.* } Angle of view, angle included by lens.
Giessen. *Ger.* To coat. (Lit. pour on.)
Glaçage. *Fr.* Enamelling.
Glaserkitt. *Ger.* Putty.
Glashaus. *Ger.* Studio.
Glimmer. *Ger.* Mica.
Glu marine. *Fr.* Marine glue.
Goldbad. *Ger.* Gold bath, toning bath.
Goldchloridkalium. *Ger.* Chloride of gold and potassium.
Goldgelber Stoff. *Ger.* Canary medium.
Goldsalz. *Ger.* Gold salt.
Goldsaures Ammoniak. *Ger.* Fulminating gold.
Gomme. *Fr.* Gum.
„ **élastique.** *Fr.* India-rubber.
„ **laque.** *Fr.* Shellac.
Gommeline. *Fr.* Dextrin.
Gravimeter. *Fr.* Hydrometer.
Gravure heliographique sur zinc. *Fr.* Zinc etching.
„ „ **en taille douce.** *Fr.* Photogravure.
Grünes Plattenputzpulver. *Ger.* Infusorial earth.
Grünschleier. *Ger.* Green fog.
Guajakharz. *Ger.* Guaiacum resin.
Guillotineverschluss. *Ger.* Drop shutter.
Gummi. *Ger.* Gum.
„ **elasticum.** *Ger.* India-rubber.
„ **lack.** *Ger.* Shellac.
„ **Quetschwalze.** *Ger.* Roller squeegee.

H.

Halo. *Fr.* Halation.
Härten. *Ger.* To harden.
Harzseife. *Ger.* Resin soap.
Hausenblaes. *Ger.* Isinglass.
Häute. *Ger.* Films.
Heiss-satinir maschine. *Ger.* Burnisher.
Heliogravure. *Ger.* Photogravure.

Hermetischer Verschluss. *Ger.* Hermetical seal.
Hervorrufung. *Ger.* Development.
Hintergrund. *Ger.* Background.
Hinterkleiden. *Ger.* Backing.
Hirschhornsalz. *Ger.* Ammonium carbonate.
Hohe lichter. *Ger.* High lights.
Höllenstein. *Ger.* Silver nitrate.
Holzalkohol. *Ger.* Methyl alcohol.
Holzessig—Holzessigsäure. *Ger.* Pyroligneous acid.
Holzgeist. *Ger.* Methyl alcohol.
Honig. *Ger.* Honey.
Hornsilber. *Ger.* Silver chloride.
Huile de lavande. *Fr.* Oil of lavender.
„ **lin.** *Fr.* Linseed oil.
Hydrogène. *Fr.* Hydrogen.
„ **sulfuré.** *Fr.* Sulphuretted hydrogen.
Hydroxygenlicht. *Ger.* Oxy-hydrogen light.
Hydrure de phenyle. *Fr.* Benzine.
Hyposulfite de soude. *Fr.* Hyposulphite of soda.

I.

Iconogène. *Fr.* Eikonogen.
Iconomètre. *Fr.* } View meter.
Ikonometer. *Ger.* }
Image confusé. *Fr.* Flat image.
Image double. *Fr.* Double image.
Impression par contact. *Fr.* Contact printing.
Infusorienerde. *Ger.* Infusorial earth.
Innenaufnahmen. *Ger.* Interiors.
Instantanés. *Fr.* Instantaneous shots.
Intensité. *Fr.* Intensity, density.
Intérieurs. *Fr.* Interiors.
Intérmediaires. *Fr.* Carriers.
Iode. *Fr.* Iodine.
Iodure. *Fr.* Iodide.
Irisblende. *Ger.* Iris diaphragm.
Isländisches Moos. *Ger.* Iceland Moss.
Ivoire végétal. *Fr.* Vegetable ivory.

J.

Jalousiecassette. *Ger.* Roller-blind dark slide.
Jalousieverschluss. *Ger.* Blind shutter.
Javelle'sche Lauge. *Ger.* Eau de Javelle.

Jenenser Glas. *Ger.* Jena glass.
Jod. *Ger.* Iodine.
Jodammonium. *Ger.* Ammonium iodide.
Jodbromsilber-Collodium emulsion. *Ger.* Iodo-bromide collodion emulsion.
Jodbromsilber-Gelatine emulsion. *Ger.* Iodo-bromide gelatine emulsion.
Jodcadmium. *Ger.* Cadmium iodide.
„ **calcium.** *Ger.* Calcium iodide.
„ **collodium.** *Ger.* Iodised collodion.
„ **eosin.** *Ger.* Erythrosin.
„ **kalium.** *Ger.* Potassium iodide.
„ **lithium.** *Ger.* Lithium iodide.
„ **natrium.** *Ger.* Sodium iodide.
„ **papier.** *Ger.* Iodised paper.
„ **quecksilber.** *Ger.* Mercuric iodide.
„ **tinctur.** *Ger.* Iodine tincture.
„ **wasserstoff.** *Ger.* Hydriodic acid.
„ **zink.** *Ger.* Zinc iodide.

K.

Kali Blausaures. *Ger.* Potassium cyanide.
Kaliumchromalaun. *Ger.* Chrome alum.
„ **eisencyanid.** *Ger.* Ferridcyanide of potassium.
„ „ **cyanur.** *Ger.* Ferrocyanide of potassium.
Kaliumnatriumtartrat. *Ger.* Rochelle salts.
„ **platinchlorür.** *Ger.* Chloroplatinite of potassium.
„ **wasserglas.** *Ger.* Silicate of potassium.
Kalk. *Ger.* Chalk.
„ **gebrannter.** *Ger.* Quick-lime.
„ **gelöschter.** *Ger.* Slaked lime.
Kalklicht. *Ger.* Limelight.
Kalkschleier. *Ger.* White powdery deposit (lime).
Kältemischungen. *Ger.* Freezing mixtures.
Kappenrohr. *Ger.* Flange, lens hood.
Kasein. *Ger.* Casein.
Kautschuk. *Ger.* India-rubber.
Kienruss. *Ger.* Lampblack.
Kieselguhr, geschlämmter. *Ger.* Elutriated infusorial earth.
Kieselsäuresalze. *Ger.* Silicates.
Kieselsäures Kali. *Ger.* Silicate of potash.
Kippschalen. *Ger.* Well dish.
Kitt. *Ger.* Putty.

Klammern. *Ger.* Clips.
Klappenverschluss. *Ger.* Flap shutter, sky shade shutter
Klärbad. *Ger.* Clearing bath.
Klarheit. *Ger.* Clearness.
Kleben. *Ger.* Mounting.
Kleesäure. *Ger.* Oxalic acid.
Kleister. *Ger.* Starch paste.
Knallgas. *Ger.* Hydrogen.
Kochemulsion. *Ger.* Boiled emulsion.
Kochsalz. *Ger.* Common salt.
Kohledruck. *Ger.* Carbon printing.
Kohlendisulfid. *Ger.* Carbon bisulphide.
Kohlensäure. *Ger.* Carbonate.
Königswasser. *Ger.* Aqua regia.
Kopfhälter. *Ger.* Head rest.
Kopfschirm. *Ger.* Reflector.
Korn. *Ger.* Grain.
Kraft. *Ger.* Density.
Kräftigung. *Ger.* Intensification.
Kräuseln. *Ger.* Frilling.
Kreidiges Bild. *Ger.* Chalky print.
Kreosot. *Ger.* Creasote.
Kronglas. *Ger.* Crown glass.
Krümmung. *Ger.* Curvature.
Kugelobjectiv. *Ger.* Globe lens.
Kupfer. *Ger.* Copper.
„ **vitriol.** *Ger.* Sulphate of copper.

L.

Laboratoire noire. *Fr.* Dark room.
Lack. *Ger.* Varnish.
Lackmus. *Ger.* Litmus.
Lampe de laboratoire. *Fr.* Dark room lamp.
Lampenruss. *Ger.* Lampblack.
Landschaftslinse. *Ger.* Landscape lens.
Lanterne américaine. *Fr.* Sciopticon lantern.
„ **magique.** *Fr.* Magic lantern.
Laque. *Fr.* Shellac.
Latentes Bild. *Ger.* Latent image.
Laterna magica. *Ger.* Magic lantern.
Laternbilder. *Ger.* Lantern slide.
Laufbrett. *Ger.* Baseboard.
Lavendelöl. *Ger.* Oil of lavender.

Ledercollodium. *Ger.* Enamel collodion.
Leinöl. *Ger.* Linseed oil.
Lentille. *Fr.* Lens.
Leuchtfarbe. *Ger.* Luminous paint.
Leveur des plaques. *Fr.* Plate lifter.
Libelle. *Ger.* Level.
Lichen d'Islande. *Fr.* Iceland moss.
Lichtbildkunst. *Ger.* Photography.
Lichtbildmesskunst. *Ger.* Photogrammetry.
Lichtdruck. *Ger.* Collotype.
Lichtempfindlichkeit. *Ger.* Sensitiveness.
Lichter, hohe. *Ger.* High lights.
Lichtfleck, centraler. *Ger.* Flare spot.
Lichthof. *Ger.* Halation.
Lichtkraft eines objectiv. *Ger.* Rapidity of a lens.
Lichtkupferdruck. *Ger.* Photogravure.
Lichtpapier. *Ger.* Waxed tissue paper.
Lichtpausverfahren. *Ger.* Cyanotype.
Lichtschleier. *Ger.* Light fog.
Lignin. *Ger.* Cellulose.
Lineaturen. *Ger.* Screen plates.
Linotypie. *Ger.* Enlargements on canvas.
Linse. *Ger.* Lens.
Locale Verstarkung. *Ger.* Local intensification.
Lochcamera. *Ger.* Pinhole camera.
Longuer de foyer. *Fr.* Focal length.
Losung. *Ger.* Solution.
Loupe de mis au point. *Fr.* Focussing magnifier.
„ **redressante.** *Fr.* Erecting eyepiece.
Lourde, épreuves lourdes. *Fr.* Flat prints.
Luftblasen. *Ger.* Air bells.
Luftperspektiv. *Ger.* Aerial perspective.
Lumière diffuse. *Fr.* Diffused light.
„ **de Drummond.** *Fr.* Limelight.
„ **éclair.** *Fr.* Flashlight.
Lumières, grandes lumières. *Fr.* Lights, high lights.
Lut de vitrifier. *Fr.* Putty.

M.

Macgilp. *Ger.* Maglip.
Magazin. *Ger.* Magazine.
Magnesiumblitzlicht. *Ger.*
„ **putzlicht.** *Ger.*
} Magnesium flashlight.

Magnium. *Ger.* Magnesium.
Makrophotographie. *Ger.* Macrophotography, enlarging.
Mangane. *Fr.* Black oxide of manganese.
Mangansuperoxyde. *Ger.* Black oxide of manganese.
Marienbad. *Ger.* Hot-water bath.
Marienglas. *Ger.* Alabaster.
Marineleim. *Ger.* Marine glue.
Marquer automatique. *Fr.* Automatic indicator.
Marques. *Fr.* Spots.
Masken. *Ger.* Masks.
Masquer. *Fr.* To back (plates); also to mask.
Mastix. *Ger.* Mastic.
Matrize. *Ger.* Negative.
Mattlack. *Ger.* Matt varnish.
Mattolein. *Ger.* Matt varnish (Dammar 1 part, turpentine 5 parts).
Mattscheibe. *Ger.* Ground glass, focussing screen.
Maturation. *Fr.* Ripening.
Megilp. *Ger.* } Maglip.
Megilpe. *Fr.* }
Mehlig. *Ger.* Mealy.
Ménisque. *Fr.* Meniscus.
Mennige. *Ger.* Minium, red lead.
Mensur. *Ger.* Graduated measure.
Mercure. *Fr.* Mercury.
Mercurographie. *Ger.* Mercurography.
Mère lessive. *Fr.* Mother liquor.
Messbildverfahren. *Ger.* Photogrammetry.
Metallflecken. *Ger.* Metallic spots.
Methylalkohol. *Ger.* Purified wood spirit.
Miel. *Fr.* Honey.
Mikrophotographie. *Ger.* Microphotography.
Milch. *Ger.* Milk.
Milchglas. *Ger.* Opal glass.
Milchsäure. *Ger.* Lactic acid.
Milchsäures Silber. *Ger.* Lactate of silver.
Minium. *Fr.* Red lead.
Mise au point. *Fr.* Focussing.
Modell. *Ger.* Sitter.
Molken. *Ger.* Whey.
Momentaufnahmen. *Ger.* Instantaneous exposures.
„ **verschluss.** *Ger.* Instantaneous shutter.
Mondscheineffect. *Ger.* Moonlight effect.
Monochrom. *Ger.* Monochrome.

Monosulfure de potassium. *Fr.* Liver of sulphur.
Mortier. *Fr.* Mortar.
Moscovade. *Fr.* Cane sugar.
Muscovit. *Ger.* Mica.
Mutterlauge. *Ger.* Mother liquor.

N.

Nadelstiche. *Ger.* Pinholes.
Natrium. *Ger.* Sodium.
„ **weinstein.** *Ger.* Tartrate of soda and potash.
Naturalphotographie. *Ger.* Naturalistic photography.
Nebelbild. *Ger.* Dissolving view.
Négatif de dessins au trait. *Fr.* Line negative.
„ **sur papier.** *Fr.* Paper negative.
Negativ. *Ger.* Negative.
„ **bad.** *Ger.* Negative bath.
„ **lack.** *Ger.* Negative varnish.
„ **papier.** *Ger.* Negative paper.
„ **retouche.** *Ger.* Negative retouching.
„ **ständer.** *Ger.* Drying rack.
„ **waschkasten.** *Ger.* Plate washer.
Neige, battre en neige. *Fr.* Snow, to beat to snow (metaphorically applied to albumen).
Netteté. *Fr.* Sharpness (of image).
Netznegativ. *Ger.* Line screen.
Nicol'sches Prisma. *Ger.* Nicol's prism.
Nitrirterzucker. *Ger.* Nitro-glucose.
Nitroglucosepapier. *Ger.* Nitro-glucose paper.
Nitrostärke. *Ger.* Xyloïdine.
Niveau d'air, niveau à bulles d'air. *Fr.* Level.
Nivellirgestell. *Ger.* Level.
Noir animal. *Fr.* Ivory black.
„ **de fumée.** *Fr.* Lampblack.
„ **d'ivoire.** *Fr.* Ivory black.
„ **de platine.** *Fr.* Platinum black.

O.

Objectif. *Fr.* Objective, lens.
„ **achromatique.** *Fr.* Achromatic lens.
„ **double.** *Fr.* Doublet lens.
„ **à grand angle.** *Fr.* } Wide-angle lens.
„ **grand angulaire.** *Fr.* }
„ **à portraits.** *Fr.* Portrait lens.

Objectif rectilineare grand angle. *Fr.* Wide-angle rectilinear.
„ **simple.** *Fr.* Single lens.
„ **symétrique.** *Fr.* Symmetrical lens.
„ **téléphotographique.** *Fr.* Telephotographic lens.
Objectiv. *Ger.* Objective, lens.
„ **brett.** *Ger.* Lens board.
„ **deckel.** *Ger.* Lens cap.
„ **fassung.** *Ger.* } Lens tube.
„ **rohr.** *Ger.* }
„ **satz.** *Ger.* Casket lens.
„ **verschluss.** *Ger.* Instantaneous shutter.
Obturateur. *Fr.* Shutter.
„ **à clapet.** *Fr.* Flap shutter.
„ **à guillotine.** *Fr.* Drop shutter.
„ **à rideau.** *Fr.* Blind shutter.
„ **à secteurs.** *Fr.* Sector shutter.
Ochsengalle. *Ger.* Ox-gall.
Oeffnung der linse or **des Objectivs.** *Ger.* Lens aperture.
Oel. *Ger.* Oil.
Opalplatten. *Ger.* Opal plates.
Oppositions. *Fr.* Contrasts.
Orthoskopisches Objectiv. *Ger.* Orthoscopic lens.
Optische Brennpunkt. *Ger.* Visual focus.
„ **Sensibilisatoren.** *Ger.* Optical sensitisers.
Ouverture de l'objectif. *Fr.* Lens aperture.
Oxalsäure. *Ger.* Oxalic acid.
Oxalsaures Eisenoxyd. *Ger.* Ferric oxalate.
„ „ **Ammon.** *Ger.* Ammonio-ferric oxalate.
„ „ **Natron.** *Ger.* Sodio-ferric oxalate.
„ **Eisenoxydul.** *Ger.* Ferrous oxalate.
Oxalsäures Kali neutrales. *Ger.* Neutral oxalate of potash.
„ **Natron.** *Ger.* Sodium oxalate.
„ **Silber.** *Ger.* Silver oxalate.
Oxyammoniaque. *Fr.* Hydroxylamin hydrochlorate.
Oxydes. *Fr.* Oxides.
Oxygène. *Fr.* Oxygen.
Oxyphénol. *Fr.* Pyrocatechin.
Ozon. *Ger.* Ozone.

P.

Panier laveur. *Fr.* Plate washer.
Panoramalinse. *Ger.* Panoramic lens.
Papier albuminé. *Fr.* Albumenised paper.

Papier albuminé brillant. *Fr.* Double albumenised paper.
„ **couché.** *Fr.* Baryta paper.
„ **dioptique.** *Fr.* Waxed tissue paper.
„ **au gelatino-chlorure.** *Fr.* Gelatino-chloride paper.
„ „ „ **bromure.** *Fr.* Gelatino-bromide paper.
„ **iodurée.** *Fr.* Iodised paper.
„ **négatif.** *Fr.* } Negative paper.
„ **negativ.** *Ger.* }
„ **nitroglucose.** *Fr.* Nitro-glucose paper.
„ **photographique.** *Fr.* Photographic plain paper.
„ **positif pelliculaire.** *Fr.* Transferotype paper.
„ **reactif.** *Fr.* Test paper.
„ **salé.** *Fr.* Plain salted paper.
„ **de Saxe.** *Fr.* Saxe paper.
„ **sensible albuminé.** *Fr.* Ready sensitised paper.
„ **similiplatine.** *Fr.* Simili-platine paper.
Papyrographie. *Ger.*, *Fr.* Papyrography.
Parasoleil. *Fr.* Lens hood.
Patronen. *Ger.* Cartridges.
Peinture de Balmain. *Fr.* Luminous paint.
Pellicules. *Fr.* Films.
„ **à celluloides.** *Fr.* Celluloid films.
„ **d'huilage.** *Fr.* Negative paper.
Perdre de l'intensité. *Fr.* To lose depth, intensity, vigour.
Perlsalz. *Ger.* Sodium phosphate.
Pétrole. *Fr.* Naphtha.
Phenylamin. *Ger.* } Aniline.
Phenylamine. *Fr.* }
Phenylsäure. *Ger.* Carbolic acid.
Phosphin. *Ger.* Chrysanilin.
Phosphor. *Ger.* } Phosphorus.
Phosphore. *Fr.* }
Phosphorographie. *Ger.* Phosphorography.
Phosphorsaures Natron. *Ger.* Sodium phosphate.
„ **Silber.** *Ger.* Silver phosphate.
Photochemigraphie. *Ger.* Zinc etching.
Photochromie. *Ger.* Often applied to Crystoleum painting.
Photocopie. *Fr.* Positive, print.
Photogalvanographie. *Ger.* Photo-galvanography.
Photoglyptie. *Ger.* Woodbury-type printing.
Photogrammetrie. *Ger.* Surveying by photography.
Photographie ohne Objectiv. *Ger.* Pinhole photography.
„ **stéréoscopique.** *Fr.* Stereoscopic photography.

Photographie sur bois. *Fr.* Photography on wood.
„ **vitrifiées.** *Fr.* Enamels.
Photogravure directe. *Fr.* Line and half-tone block-making.
„ **de mercure.** *Fr.* Mercurography.
„ **sur zinc.** *Fr.* Zincography.
Photolithophane. *Ger.* Photography on porcelain.
Photo livre. *Fr.* Book camera.
Photomecanique. *Fr.* Photo-mechanical.
Photomechanische verfahren. *Ger.* Photo-mechanical process.
Photomètre. *Fr.* Photometer.
Photominiatür. *Ger.* Crystoleum painting.
Photoplastigraphie. *Ger.* Photo-sculpture.
Photorelief. *Ger.* Woodbury-type.
Photosculptur. *Ger.* Photo-sculpture.
Phototel. *Ger.* } A process of transmitting photos along a
Phototelegraphie. *Fr.* } wire by electricity.
Phototopographie. *Ger.* Photographic surveying.
Phototype. *Fr.* Negative.
Phototypogravure. *Fr.* Line and half-tone block-making.
Photoxylographie. *Ger.* Photography on wood blocks.
Photozinkographie. *Ger.* Photozincography.
Physikalische Entwickelung. *Ger.* Physical development.
Pied. *Fr.* Stand.
„ **d'atelier.** *Fr.* Studio stand.
„ **canne.** *Fr.* Walking-stick stand.
„ **parapluie.** *Fr.* Umbrella stand.
„ **table.** *Fr.* Studio or table stand.
Pierre infernale. *Fr.* Silver nitrate.
„ **ponce.** *Fr.* Pumice stone.
Pince à clichés. *Fr.* Plate lifter.
Pinces américaines. *Fr.* American wooden clips.
Planchette d'objectif. *Fr.* Lens board.
„ „ **se déplaçant dans les deux sens.** *Fr.* Shifting lens board.
Planitude des champs. *Fr.* Flatness of field.
Plaque entière. *Fr.* Whole plate.
„ **souple.** *Fr.* Films.
Platindruck. *Ger.* Platinotype process.
Platine. *Fr.* Platinum.
Platinkaliumchlorür. *Ger.* Chloroplatinite of potash.
Platinmohr. *Ger.* Platinum black.
Platinpapier. *Ger.* Platinotype paper.
Platinschwarz. *Ger.* Platinum black.

Platten. *Ger.* Plates.
Plattentrockenständer. *Ger.* Drying rack.
Plattenformate. *Ger.* Plate sizes.
Plattenhalter pneumatischer. *Ger.* Pneumatic holder.
Plattenheber. *Ger.* Plate lifter.
Plattenwaschkasten. *Ger.* Plate-washing tank.
Plattenwechselvorrichtung. *Ger.* Plate-changing arrangement.
Plattenzähler. *Ger.* Indicator.
Plein air. *Fr.* Open air.
Plissement. *Fr.* Frilling.
Point de rosée. *Fr.* Dew point.
Porcelaine transparente. *Fr.* Opal glass.
Porte-objectiv. *Fr.* Lens board.
„ **plaques.** *Fr.* Plate sheaths.
Portrait à l'intérieur. *Fr.* Indoor portraiture.
„ **en plein air.** *Fr.* Outdoor portraiture.
Porträtaufnahme. *Ger.* Portraiture.
Porträtbust. *Ger.* Bust portrait.
Porträtobjectiv. *Ger.* Portrait lens.
Pose. *Fr.* } Exposure.
Pose, temps de. *Fr.* }
„ **insuffisante.** *Fr.* Insufficient, under-exposure.
Positif. *Fr.* Positive.
„ **pour projection.** *Fr.* Lantern slide.
„ **sur verre.** *Fr.* Transparency.
Positiv. *Ger.* Positive.
Positivlack. *Ger.* Positive varnish, crystal varnish.
Positivpapier. *Ger.* Raw paper.
Positivretouche. *Ger.* Retouching prints.
Potasche. *Ger.* Potassium carbonate.
Poudrage, procédé par. *Fr* Powder process.
Poudre-coton. *Fr.* Pyroxylin.
Poudre d'émail. *Fr.* Enamel powder.
Präservativ. *Ger.* } Preservative.
Préservateur. *Fr.* }
Pressbausch. *Ger.* Felt printing-frame pad.
Presse à satiner. *Fr.* Rolling machine.
„ „ **à chaud.** *Fr.* Burnishing machine.
Primulinverfahren. *Ger.* Primuline process.
Prisma. *Ger.* Prism.
Procédé au charbon. *Fr.* Carbon process.
„ **du double transfert.** *Fr.* Double-transfer carbon process.
Profondeur de foyer. *Fr.* Depth of focus.

Projectionsapparat. *Ger.* Optical lantern.
Pupitre à retoucher. *Fr.* Retouching desk.
Pyrogall. *Fr.* }
Pyrogallol. *Ger.* } Pyrogallic acid.
Pyrogallussäure. *Ger.* }
Pyrophotographie. *Ger.* Enamels.
Pyroxyle. *Fr.* Pyroxylin.

Q.

Quart de plaque. *Fr.* Quarter plate.
Quecksilber. *Ger.* Mercury.
Quecksilberchlorid. *Ger.* Mercuric chloride.
Quecksilberchlorür. *Ger.* Mercurous chloride.
Quecksilberjodid. *Ger.* Mercuric iodide.
Quecksilberverstärker. *Ger.* Mercury intensifier.
Quetscher. *Ger.* Squeegee.

R.

Raclette. *Fr.* Squeegee.
Randschärfe. *Ger.* Marginal definition.
Rasterplatte. *Ger.* Ruled or line screen.
Räuchern. *Ger.* To fume.
Reagenspapier. *Ger.* Test paper.
Récolte des résidus. *Fr.* Recovery of residues.
Rectilinearlinse. *Ger.* Rectilinear lens.
Réducteur. *Fr.* Reducer.
Reductionsmittel. *Ger.* Reducers.
Réflecteur. *Fr.* Reflector.
Reflectorschirm. *Ger.* Reflector.
Reibschale. *Ger.* Mortar.
Reifen. *Ger.* To ripen.
Reisecamera. *Ger.* Tourist camera.
Reisestativ. *Ger.* Tourist stand.
Reliefdruck. *Ger.* Woodbury-type printing.
Rembrandtbeleuchtung. *Ger.* Rembrandt lighting.
Renforçateur. *Fr.* Intensifier.
„ **à l'azotate de plomb.** *Fr.* Lead intensifier.
„ **à l'azotate d'urane.** *Fr.* Uranium intensifier.
„ **au mercure.** *Fr.* Mercury intensifier.

Renforçement. *Fr.* Intensification.
Résidus. *Fr.* Residues.
Résine de dammar. *Fr.* Gum Dammar.
„ „ **gaïac.** *Fr.* Gum Guaiacum.
Retardateur. *Fr.* Restrainer.
Retouche. *Fr.* Retouching.
Retouchirlack. *Ger.* Retouching medium.
Retouchirpult. *Ger.* Retouching desk.
Révélateur. *Fr.* Developer.
Revolveblende. *Ger.* Wheel diaphragms.
Rhodanammonium. *Ger.* Ammonium sulphocyanide.
Rhodankalium. *Ger.* Potassium sulphocyanide.
Rochellesalz. *Ger.* Rochelle salts.
Rohcollodium. *Ger.* Plain collodion.
Rohpapier. *Ger.* Plain paper.
Röhrenlibelle. *Ger.* Level.
Rohrzucker. *Ger.* Cane sugar.
Rollcassette. *Ger.* Roll holder.
Rosolsäure. *Ger.* Aurine.
Rotationsapparat. *Ger.* Panoramic camera.
Rotheisenstein. *Ger.* } Ochre.
Röthel. *Ger.* }
Rothschleier. *Ger.* Red fog.
Rouge de quinoleine. *Fr.* Chinoline red.
Rouleau à collage. *Fr.* Roller squeegee.
Rückstande. *Ger.* Residues.
Russische bilder. *Ger.* Vignettes on black ground.

S.

Sac à escamoter. *Fr.* Changing bag.
Safran des Indes. *Fr.* Turmeric.
Salmiak. *Ger.* Sal-ammoniac.
Salon de pose. *Fr.* Studio.
Saloncamera. *Ger.* Studio camera.
Salpeter. *Ger.* } Potassium nitrate.
Salpêtre. *Fr.* }
Salpetergas. *Ger.* Nitrogen.
Salpetersalzsäure. *Ger.* Aqua regia.
Salpetersäure. *Ger.* Nitric acid.
Salpetersäures Ammoniak. *Ger.* Ammonium nitrate.
„ **Blei.** *Ger.* Lead nitrate.

Salpetersäures Eisenoxydul. *Ger.* Ferrous nitrate.
„ **Uranoxyd.** *Ger.* Ferric nitrate.
„ **Uranoxydul.** *Ger.* Uranium nitrate.
Salpetrigesäure. *Ger.* Nitrous acid.
Salpetrigsäures Kali. *Ger.* Potassium nitrite.
Salzpapier. *Ger.* Plain salted paper.
Salzsäure. *Ger.* Hydrochloric acid.
Salzsäures Blei. *Ger.* Lead chloride.
„ **Hydroxylamin.** *Ger.* Hydroxylamin hydrochloride.
Sammellinse. *Ger.* Convergent or positive lens.
Sandarak. *Ger.* } Sandarac.
Sandaraque. *Fr.* }
Sandbad. *Ger.* Sand bath.
Saponite. *Fr.* Talc, French chalk.
Satinage. *Fr.* Burnishing.
Satiniren. *Ger.* To burnish.
Sauerstoff. *Ger.* Oxygen.
Säuren. *Ger.* Acids.
Säures schwefligsaures Kali. *Ger.* Potassium metabisulphite.
„ „ **Natron.** *Ger.* Acid sulphite of soda.
„ **weinsäures Kali.** *Ger.* Cream of tartar.
Savon à l'acide cyanhydrique. *Fr.* Cyanide soap.
Schalen. *Ger.* Dishes.
Schärfe. *Ger.* Definition, sharpness.
Schatten. *Ger.* Shadows.
Schaukelcuvette. *Ger.* Automatic rocker.
Scheidewasser. *Ger.* Nitric acid.
Schellack. *Ger.* Shellac.
Schichtseite. *Ger.* Film side.
Schiessbaumwolle. *Ger.* Pyroxyline.
Schirmstativ. *Ger.* Umbrella stand.
Schlämmkreide. *Ger.* Whiting.
Schleier. *Ger.* Fog.
Schlippe'sches Salz. *Ger.* Schlippe's salt.
Schlitten. *Ger.* Baseboard.
Schmelzfarben. *Ger.* Enamel colours.
Schmelzfarbenbilder. *Ger.* Enamels.
Schmelztiegel. *Ger.* Crucible.
Schnee. *Ger.* Snow.
Schnellphotographie Amerikanische. *Ger.* Ferrotype.
Schraffurplatten. *Ger.* Line screen.
Schwärzen tiefste. *Ger.* Deepest shadows.
Schwefel. *Ger.* Sulphur.

Schwefelammonium. *Ger.* Ammonium sulphydrate.
Schwefelantimon. *Ger.* Antimony sulphide.
Schwefelantimon-Schwefelnatron. *Ger.* Schlippe's salt.
Schwefeläther. *Ger.* Sulphuric ether.
Schwefelcyanammonium. *Ger.* Ammonium sulphocyanide.
Schwefelcyankalium. *Ger.* Potassium sulphocyanide.
Schwefelkohlenstoff. *Ger.* Carbon disulphide.
Schwefelleber. *Ger.* Liver of sulphur.
Schwefelmilch. *Ger.* Milk of sulphur.
Schwefelsäure. *Ger.* Sulphuric acid.
Schwefelsäures Eisenoxydul. *Ger.* Ferrous sulphate.
„ „ **ammon.** *Ger.* Ammonio-sulphate of iron.
Schwefelsäures Kupfer. *Ger.* } Copper sulphate.
„ „ **oxyd.** *Ger.* }
Schwefelsilber. *Ger.* Silver sulphide.
Schwefeltonung. *Ger.* Sulphur toning.
Schwefelwasserstoff. *Ger.* Sulphuretted hydrogen.
Schwefelwasserstoff-Ammoniak. *Ger.* Ammonium sulphydrate.
Schweflige Saure. *Ger.* Sulphurous acid.
Schwefligsaures Natron. *Ger.* Sodium sulphite.
Schwimmwaage. *Ger.* Hydrometer.
Sectorenverschluss. *Ger.* Sector shutter.
Seignettesalz. *Ger.* Rochelle salts.
Sel. *Fr.* Salt.
„ **ammonia.** *Fr.* Sal-ammoniac.
„ **de cuisine.** *Fr.* Common salt.
„ „ **Saturne.** *Fr.* Sugar of lead.
„ „ **Schlippe.** *Fr.* Schlippe's salt.
„ „ **Seignette.** *Fr.* Rochelle salts.
Selen. *Ger.* Selenium.
Selle's Uranverstärker. *Ger.* Selle's uranium intensifier.
Sensibilisatoren, chemischer. *Ger.* Chemical sensitisers.
Sensibilisiren. *Ger.* To sensitise.
Sensibilité. *Fr.* Sensitiveness.
Sensitocolorimeter. *Ger.* Colour sensitometer.
Sicherheitsrand. *Ger.* Safe edge.
Silber. *Ger.* Silver.
Silberalbuminat. *Ger.* Silver albuminate.
Silberbad. *Ger.* Silver bath.
Silberbromid. *Ger.* Silver bromide.
Silberchlorid. *Ger.* Silver chloride.
Silberchlorür. *Ger.* Silver subchloride.
Silberdruck. *Ger.* Silver print.

Silberglanz. *Ger.* Silver sulphide (native).
Silberjodid. *Ger.* Silver iodide.
Silbermesser. *Ger.* Argentometer.
Silbernitrat. *Ger.* Silver nitrate.
Silbernitrit. *Ger.* Silver nitrite.
Silberoxalat. *Ger.* Silver oxalate.
Silberoxyd. *Ger.* Silver oxide.
Silbersalpeter. *Ger.* Silver nitrate.
Silbersulfid. *Ger.* Silver sulphide.
Silbersulphat. *Ger.* Silver sulphate.
Silicate. *Fr.* Silicate.
Similiplatinpapier. *Ger.* Simile-platine paper.
Smirgel. *Ger.* Emery.
Soda. *Ger.* Sodium carbonate.
Solution qui se conserve. *Fr.* Stock solution.
Soufflet. *Fr.* Bellows.
Soufre. *Fr.* Sulphur.
Soulèvements. *Fr.* Blisters.
Sousexposition. *Fr.* Over-exposure.
Speckstein. *Ger.* Talc, French chalk.
Spektralanalyse. *Ger.* Spectrum analysis.
Spektrum. *Ger.* Spectrum.
Support à vis calantes. *Fr.* Levelling stand.
Surexposition. *Fr.* Over-exposure.

T.

Taches. *Fr.* Spots, stains.
„ **métalliques.** *Fr.* Metallic spots.
Tafelglas. *Ger.* Ordinary sheet glass.
Tamis en crin. *Fr.* Hair sieve.
Tanninverfahren. *Ger.* Tannin process.
Tassen. *Ger.* Dishes.
Tauchcuvette. *Ger.* Dipping bath or trough.
Taucher. *Ger.* Dipper.
Teinte. *Fr.* Tint.
„ **jaune.** *Fr.* Yellow stain.
Teinteur pour positifs. *Fr.* The cut-out part of a mask, disc.
Tele-objectiv. *Ger.* Telephotographic lens.
Temps de pose. *Fr.* Exposure.
Tente. *Fr.* Dark tent.
Terpentinöl. *Ger.* Spirits of turpentine.

Tetrabromfluorescein. *Ger.* Eosin.
„ **kalium.** *Ger.* Erythrosin.
Thaupunkt. *Ger.* Dew point.
Thierische substanzen. *Ger.* Animal substances.
Thierkohle. *Ger.* Animal charcoal.
Tiefe des focus. *Ger.* Depth of focus.
Tintencopirverfahren. *Ger.* Ink process.
Tirage. *Fr.* Printing.
Tischstativ. *Ger.* Studio or table stand.
Tonen. *Ger.* Toning.
Tonfixirbad. *Ger.* Combined toning and fixing bath.
„ **patronen.** *Ger.* Combined toning and fixing cartridges.
Topophotographie. *Ger.* Photographic surveying.
Tournesol. *Fr.* Litmus.
Tragant. *Ger.* } Tragacanth.
Tragantschleim. *Ger.* }
Trame artificielle. *Fr.* Screen plate, line screen.
Transfert. *Fr.* Transfer.
Transparentbild. *Ger.* Transparency.
Traubenzucker. *Ger.* Glucose.
Traumaticin. *Ger.* Solution of india-rubber in chloroform.
Triebrohr. *Ger.* Lens tube. Sliding tube.
Trockenplatten. *Ger.* Dry plates.
Trockenplattenlack. *Ger.* Dry-plate varnish.
Trockenschrank. *Ger.* Drying cupboard.
Trockenständer. *Ger.* Drying rack.
Tropfglas. *Ger.* Drop glass.
Trous d'épingle. *Fr.* Pin holes.
„ **d'objectif.** *Fr.* Casket lenses.
Tusche. *Ger.* Indian ink.
Tuyau mouture de l'objectif. *Fr.* Lens tube.
Typogravure. *Fr.* Process-block making.

U.

Ueberbelichtung. *Ger.* } Over-exposure.
Ueberexposition. *Ger.* }
Ueberfangglas. *Ger.* Flashed glass.
Uebermangansaures Kali. *Ger.* Potassium permanganate.
Unschädliches Licht. *Ger.* Safe light.
Unterbelichtung. *Ger.* Under-exposure.
Unterchlorigsaures Calcium. *Ger.* Chloride of lime.

Unterexposition. *Ger.* Under-exposure.
Unterschwefligsaures Goldoxydulnatron. *Ger.* Sel d'or.
„ **Natron.** *Ger.* Sodium hyposulphite
Unze. *Ger.* Ounce.
Urancopirverfahren *Ger.* Uranium printing process.
Uranglas. *Ger.* Uranium glass.
Urannitrat. *Ger.* } Uranium nitrate.
Uranylnitrat. *Ger.* }
Uranverstärker. *Ger.* Uranium intensifier.

V.

Ventouse pneumatique. *Fr.* Pneumatic holder.
Verbleichen. *Ger.* To bleach.
Verbranntes Bild. *Ger.* Burnt out, over-exposed picture.
Vergilben. *Ger.* To yellow, to turn yellow.
Vergrössern. *Ger.* To enlarge.
Vergrösserungsapparat. *Ger.* Enlarging apparatus.
Vernis. *Fr.* Varnish.
„ **dépoli.** *Fr.* Matt varnish.
„ **à négatifs.** *Fr.* Negative varnish.
„ **siccatif.** *Fr.* Meglip.
Verre. *Fr.* Glass.
„ **dépoli.** *Fr.* Ground glass.
„ **de Muscovie.** *Fr.* Mica.
„ **d'urane.** *Fr.* Uranium glass.
Verschluss. *Ger.* Shutter (instantaneous).
Verschwommenes Bild. *Ger.* Fuzzy image.
Verstärker. *Ger.* Intensifier.
Verstärkung. *Ger.* Intensification.
Verzeichnung. *Ger.* Distortion.
Verzögerer. *Ger.* Restrainer.
Viertelplatte. *Ger.* Quarter plate.
Vignetten. *Ger.* Vignettes.
Vignettirdeckel. *Ger.* Vignetting board.
Vinaigre de bois. *Fr.* Pyroligneous acid.
„ **glacial.** *Fr.* Glacial acetic acid.
Virage. *Fr.* Toning.
Vis de rappel. *Fr.* Focussing screw.
Viseur. *Fr.* Finder.
Visirscheibe. *Ger.* Focussing screen.
Visitkarte. *Ger.* Carte-de-visite.

Vitriolsaure. *Ger.* Sulphuric acid.
Voile. *Fr.* Fog.
„ **jaune.** *Fr.* Yellow fog.
„ **noir.** *Fr.* Black fog.
„ **rouge.** *Fr.* Red fog.
„ **vert.** *Fr.* Green fog.
Volet à coulisses du châssis. *Fr.* Shutter of dark slide.
Vorbad. *Ger.* Preliminary bath.
Vorderblende. *Ger.* Diaphragm in front of lens.
Vorrathslösung. *Ger.* Stock solution

W.

Wachs. *Ger.* Wax.
Waschkasten. *Ger.* Plate or print washer.
Wasser. *Ger.* Water.
Wasserfirniss. *Ger.* Water varnish.
Wasserfrei. *Ger.* Anhydrous.
Wasserglas. *Ger.* Potassium silicate.
Wasserstoff. *Ger.* Hydrogen.
Wasserstoffsuperoxyd. *Ger.* Hydrogen peroxide.
Wasserwaage. *Ger.* Water level, spirit level.
Wechselkasten. *Ger.* Changing box.
Wechseln der Platten. *Ger.* Changing plates.
Wechselsack. *Ger.* Changing back.
Weinsäure. *Ger.* } Tartaric acid.
Weinsteinsäure. *Ger.* }
Weinstein. *Ger.* Potassium bitartrate.
Weitwinkelobjectiv. *Ger.* Wide-angle lens.
Wiedergewinnung des gebrauchten Silbers. *Ger.* Recovery of silver residues.
Wölbung des Bildes. *Ger.* Curvature of the field.
Wolframsäures Natron. *Ger.* Sodium tungstate.
Wolkenblende. *Ger.* Cloud stop.
Woodburydruck. *Ger.* Woodbury-type printing.

X.

Xyloïdine. *Ger., Fr.* Xyloidine.
Xylophotographie. *Ger.* Photography on wood.

Z.

Zählvorrichtung. *Ger.* Indicator, register.
Zahnstangentrieb. *Ger.* Rack and pinion.

Zaponlack. *Ger.* Varnish of pyroxylin and amyl acetate.
Zauberphotographien. *Ger.* Magic photographs.
Zeitaufnahmen. *Ger.* Time exposure.
Zelt. *Ger.* Tent.
Zerstreutes Licht. *Ger.* Diffused light.
Zerstreuunglinse. *Ger.* Negative or divergent lens.
Zimmeraufnahmen. *Ger.* Indoor portraiture.
Zink. *Ger.* Zinc.
Zuckerkalk-entwickler. *Ger.* Calcium saccharate developer.
Zu Schnee schlagen. *Ger.* To beat to a froth.
Zweifach chromsäures Kali. *Ger.* Potassium bichromate.

Talbotype. See CALOTYPE.

Tannic Acid (Ger., *Gerbsäure;* Fr., *Tannin*). $C_{27}H_{22}O_{17}=618$. This is not a true acid, but a glucoside obtained from galls. Solubility: 10 in 8 of water, 10 in 8 of alcohol, sparingly soluble in ether, its photographic use being limited almost, if not entirely to the old collodion process.

Tartaric Acid Ger., *Weinsteinsäure;* Fr., *Acide Tartarique*)., $H_2C_4H_4O_6=150$. Prepared from the impure cream of tartar in the lees of wine by precipitation by chalk, and subsequent addition of sulphuric acid. Solubility: 1 in ·66 of cold water, 1 in ·5 of boiling water; soluble also in alcohol and ether. Its use in photography is limited, being sometimes used instead of citric acid, and for preserving sensitised paper.

Telephotographic Lens. See LENS.

Telephotoscopy. See ELECTRIC TELEPHOTOSCOPY.

Testing, Chemical. See ANALYSIS.

Test Papers. Small slips of bibulous paper soaked in a solution of litmus or other dye, and used for testing any liquid for its alkalinity or acidity.

Thermometer and Thermometry. The thermometer is an instrument used for determining the temperatures of different substances, liquids, and gases. These instruments are so generally known that but little description is needed; but, as several

different methods of marking them are in vogue, the following explanation and rules may make all clear:—There are three principal methods of division—Réaumur, Celsius or Centigrade, and Fahrenheit. Réaumur takes 0° as the temperature of freezing water, and divides the scale between this point and boiling water into 80°. This system is generally dying out. Centigrade, or Celsius' system, has 0° as the freezing point and 100° as the boiling point. This system is gradually gaining ground. Fahrenheit's system has 32° as the freezing point and 212° as the boiling point. This is the system in common use in England. To convert degrees of one scale into those of another the following rules must be used:—

To convert Réaumur into Centigrade.
Multiply by 5 and divide by 4.
Example: 80° R × 5 ÷ 4 = 100° C.

To convert Réaumur into Fahrenheit.
Multiply by 9, divide by 4, and add 32.
Example: 80° R. × 9 ÷ 4 + 32 = 212° F.

To convert Centigrade into Réaumur.
Multiply by 4 and divide by 5.
Example: 100° C. × 4 ÷ 5 = 80° R.

To Convert Centigrade into Fahrenheit.
Multiply by 9, divide by 5, and add 32 to the result.
Example: 100° C. × 9 ÷ 5 + 32 212° F.

To Convert Fahrenheit into Réaumur.
Subtract 32, multiply by 4, and divide by 9.
Example: 212° F. − 32 × 4 ÷ 9 = 80° R.

To Convert Fahrenheit into Centigrade.
Subtract 32, multiply by 5, and divide by 9.
Example: 212° F. − 32 × 5 ÷ 9 = 100° C.

See Absolute Temperature.

TABLE FOR CONVERSION OF FAHRENHEIT, CENTIGRADE, AND RÉAUMUR.

F.	C.	R.	F.	C.	R.	F.	C.	R.
+212	**+100**	**+80**	170	76·67	61·33	128	53·33	42·67
211	99·4	79·56	169	76·11	60·89	127	52·78	42·22
210	98·89	79·11	168	75·55	60·44	126	52·22	41·78
209	98·33	78·67	**167**	**75**	**60**	125	51·67	41·33
208	97·78	78·22	166	74·44	59·56	124	51·11	40·89
207	97·22	77·78	165	73·89	59·11	123	50·55	40·44
206	96·67	77·33	164	73·33	58·67	**122**	**50**	**40**
205	96·11	76·89	163	72·78	58·22	121	49·44	39·56
204	95·55	76·44	162	72·22	57·78	120	48·89	39·11
203	**95**	**76**	161	71·67	57·33	119	48·33	38·67
202	94·44	75·56	160	71·11	56·89	118	47·78	38·22
201	93·89	75·11	159	70·55	56·44	117	47·22	37·78
200	93·33	74·67	**158**	**70**	**56**	116	46·67	37·33
199	92·78	74·22	157	69·44	55·56	115	46·11	36·89
198	92·22	73·78	156	68·89	55·11	114	45·55	36·44
197	91·67	73·33	155	68·33	54·67	**113**	**45**	**36**
196	91·11	72·89	154	67·78	54·22	112	44·44	35·56
195	90·55	72·44	153	67·22	53·78	111	43·89	35·11
194	**90**	**72**	152	66·67	53·33	110	43·33	34·67
193	89·44	71·56	151	66·11	52·89	109	42·78	34·22
192	88·89	71·11	150	65·55	52·44	108	42·22	33·78
191	88·33	70·67	**149**	**65**	**52**	107	41·67	33·33
190	87·78	70·22	148	64·44	51·56	106	41·11	32·89
189	87·22	69·78	147	63·89	51·11	105	40·55	32·44
188	86·67	69·33	146	63·33	50·67	**104**	**40**	**32**
187	86·11	68·89	145	62.78	50·22	103	39·44	31·56
186	85·55	68·44	144	62·22	49·78	102	38·89	31·11
185	**85**	**68**	143	61·67	49·33	101	38·33	30·67
184	84·44	67·56	142	61·11	48·89	100	37·78	30·22
183	83·89	67·11	141	60·55	48·44	99	37·22	29·78
182	83·33	66·67	**140**	**60**	**48**	98	36·67	29·33
181	82·78	66·22	139	59·44	47·56	97	36·11	28·89
180	82·22	65·78	138	58·89	47·11	96	35·55	28·44
179	81·67	65·33	137	58·33	46·67	**95**	**35**	**28**
178	81·11	64·89	136	57·78	46·22	94	34·44	27·56
177	80·55	64·44	135	57·22	45·78	93	33·89	27·11
176	**80**	**64**	134	56·67	45·33	92	33·33	26·67
175	79·44	63·56	133	56·11	44.89	91	32·78	26·22
174	78·89	63·11	132	55·55	44·44	90	32·22	25·78
173	78·33	62·67	**131**	**55**	**44**	89	31·67	25·33
172	77·78	62·22	130	54·44	43·56	88	31·11	24·89
171	77·22	61·78	129	53·89	43·11	87	30·55	24·44

TABLE FOR CONVERSION OF FAHRENHEIT, CENTIGRADE, AND RÉAUMUR (*Continued*).

F.	C.	R.	F.	C.	R.	F.	C.	R.
86	**30**	**24**	43	6·11	4·89	1	—17·22	—13·78
85	29·44	23·56	42	5·55	4·44	0	—17·78	—14·22
84	28·89	23·11	**41**	**5**	**4**	— 1	—18·33	—14·67
83	28·33	22·67	40	4·44	3·56	— 2	—18·89	—15·11
82	27·78	22·22	39	3·89	3·11	— 3	—19·44	—15·56
81	27·22	21·78	38	3·33	2·67	— **4**	—**20**	—**16**
80	26·67	21·33	37	2·78	2·22	— 5	—20·55	—16·44
79	26·11	20·89	36	2·22	1·78	— 6	—21·11	—16·89
78	25·55	20·44	35	1·67	1·33	— 7	—21·67	—17·33
77	**25**	**20**	34	1·11	0·89	— 8	—22·22	—17·78
76	24·44	19·56	33	0·55	0·40	— 9	—22·78	—18·22
75	23·89	19·11	**32**	**0**	**0**	—10	—23·33	—18·67
74	23·33	18·67	31	— 0·55	— 0·40	—11	—23·39	—19·11
73	22·78	18·22	30	— 1·11	— 0·89	—12	—24·44	—19·56
72	22·22	17·78	29	— 1·67	— 1·33	—**13**	—**25**	—**20**
71	21·67	17·33	28	— 2·22	— 1·78	—14	—25·55	—20·44
70	21·11	16·89	27	— 2·78	— 2·22	—15	—26·11	—20·89
69	20·55	16·44	26	— 3·33	— 2·67	—16	—26·67	—21·33
68	**20**	**16**	25	— 3·89	— 3·11	—17	—27·22	—21·78
67	19·44	15·56	24	— 4·44	— 3·56	—18	—27·78	—22·22
66	18·89	15·11	**23**	— **5**	— **4**	—19	—28·33	—22·67
65	18·33	14·67	22	— 5·55	— 4·44	—20	—28·89	—23·11
64	17·78	14·22	21	— 6·11	— 4·89	—21	—29·44	—23·56
63	17·22	13·78	20	— 6·67	— 5·33	—**22**	—**30**	—**24**
62	16·67	13·33	19	— 7·22	— 5·78	—23	—30·55	—24·44
61	16·11	12·89	18	— 7·78	— 6·22	—24	—31·11	—24·89
60	15·55	12·44	17	— 8·33	— 6·67	—25	—31·67	—25·33
59	**15**	**12**	16	— 8·89	— 7·11	—26	—32·22	—25·78
58	14·44	11·56	15	— 9·44	— 7·56	—27	—32·78	—26·22
57	13·89	11·11	**14**	—**10**	— **8**	—28	—33·33	—26·67
56	13·33	10·67	13	—10·55	— 8·44	—29	—33·89	—27·11
55	12·78	10·22	12	—11·11	— 8·89	—30	—34·44	—27·56
54	12·22	9·78	11	—11·67	— 9·33	—**31**	—**35**	—**28**
53	11·67	9·33	10	—12·22	— 9·78	—32	—35·55	—28·44
52	11·11	8·89	9	—12·78	—10·22	—33	—36·11	—28·89
51	10·55	8·44	8	—13·3	—10·67	—34	—36·67	—29·33
50	**10**	**8**	7	—13·89	—11·11	—35	—37·22	—29·78
49	9·44	7·56	6	—14·44	—11·56	—36	—37·78	—30·22
48	8·89	7·11	**5**	—**15**	—**12**	—37	—38·33	—30·67
47	8·33	6·67	4	—15·55	—12·44	—38	—38·89	—31·11
46	7·78	6·22	3	—16·11	—12·89	—39	—39·44	—31·56
45	7·22	5·78	2	—16·67	—13·33	—**40**	—**40**	—**32**
44	6·67	5·33						

Thinness of Negative. This may be the effect of three causes: first, under-exposure; second, over-exposure; and third, under-development. Thinness from under-exposure is usually caused by the whole plate veiling over before sufficient density can be obtained, due to the use of excessive alkali (see UNDER-EXPOSURE). In the case of over-exposure it is due to the energetic action of the developer, consequent upon the too great action of light (see OVER-EXPOSURE). In under-development the result is thinness, consequent upon the developer not reducing sufficient silver salt to the metallic state. This is generally distinguished from over- or under-exposure by the absence of fog or veiling.

Thiocarbamide (Ger., *Sulphoharnstoff, Thiocarbamid;* Fr. and Ital., *Thiocarbamid*). Synonym, Thiourea. CH_4N_2S. This organic compound was proposed by Dr. Bogisch as a fixing agent for chloride of silver, but its great utility is for the removal of stains of pyro or other developers, for removing green fog and silver stains, for which purpose the following solutions are recommended.

Thiocarbamide	20 grs.
Citric Acid	10 ,,
Water	2 ozs.

or,

Thiocarbamide	20 grs.
Alum	20 ,,
Acetic Acid	10 minims.
Water	2 ozs.

Thiocarbamide in the developer has a remarkable tendency to bring about reversal.

Thiosinnamine (Ger., *Allylsulphoharnstoff, Thiosinamin;* Fr. and Ital., *Thiosinamin*). Synonym: Allylsulphurea. $CSNH_2NHC_3H_5$ is an organic compound obtained by the action of ammonia on oil of mustard. It was suggested by Liesegang as a fixing agent for chloride of silver, but it has not come into general use. Like thiocarbamide it tends to bring about reversal if added to the developer. Thiosinnamine is said, like glucose, to prevent the evolution of gas in the case of the hydroxylamine developer.

Thought Photographing. See RETINAL IMPRESSION.

Titles on Prints. Numerous dodges have been suggested for this, such as writing backwards on the negative, employing type, carbon tissue, etc. A useful method is to write the title first of all on the paper before printing with some aqueous non-actinic or opaque colour, such as gamboge or Indian ink, the same being washed off prior to toning; or the following may be used after toning:—

Iodide of potassium	10 parts.
Water	30 ,,
Iodine	1 ,,
Gum	1 ,,

Write with this on a dark portion of the print, when the letters will soon become visible by the conversion of the image into iodide of silver, which will be dissolved by the usual fixing bath.

Toning. If a silver print is placed direct into the fixing bath an unpleasant brick-red colour is the result. The operation of toning consists in changing this colour by the partial substitution of gold or some other metal for the silver in the print. The chemistry involved in toning is comparatively simple. All toning baths contain gold in such a state that it is readily deposited upon any reducing substance which may be placed in it. There are practically three conditions of toning bath to consider; first, the acid, secondly, the neutral, and, thirdly, the alkaline toning bath. At the present time the acid bath is but little used; it strongly attacks the image, gives bluish tones, and causes very slow toning. When a weak acid, such as acetic, boric, or phosphoric, is added to a neutral bath, the tones are reddened and the image weakened. When in practice a neutral salt, such as acetate, borate, or phosphate of soda, is added to acid solution of chloride of gold the hydrochloric acid immediately combines with the base and sets free the weaker acid. The second class of toning baths are those which give the most beautiful purple tones, and as they are comparatively stable they may be used over and over again, and strengthened by the addition of more neutral solution of gold. The third class, or alkaline baths, have a tendency to give rather

more bluish shades than the neutral. The addition of carbonate of soda, or any alkaline carbonate, to solution of chloride of gold neutralises the free acid, chloride of sodium being formed; and if an excess of alkali be present, stable compounds of gold are formed, which are not reduced by silver. If no alkali be present in excess, the toning power lasts longer, only toning takes place somewhat more slowly. With freshly mixed alkaline baths it is stated by Lainer and Davanne that one atom of gold only replaces three atoms of silver.

$$AuCl_3 + 3Ag = 3AgCl + Au.$$

With a small excess of alkali the chloride of gold is decomposed into aurous chloride according to Davanne and Girard. And an old bath in this state, for the change takes place but slowly, replaces one atom of silver with one atom of gold.

$$AuCl + Ag = AgCl + Au.$$

And the prints in the latter case are most vigorous and permanent. Finally, the toning baths become quite colourless and will not tone. Numerous formulæ have been given for toning baths, and in many cases merely the quantities of the salts are altered. In many cases the new formulæ are recommended as giving exceptionally fine tones or possessing some particular property which in many cases can be explained by the fact that the addition of more of one ingredient may convert the bath from a neutral to an alkaline one. Mercier in his valuable little treatise, "Virages et Fixages," formulates the following rules which are instructive.

1. When, in making a toning bath, ingredients more or less alkaline are used, the proportion of such ingredients necessary to decolorise the bath is less the more alkaline it is. Taking as a typical bath one containing chloride of gold 1 part, water 1,000 parts, the following are the necessary proportions of salts to decolorise the bath completely in six hours: caustic potash 0·7 parts, potassium bicarbonate 2 to 3 parts, sodium tungstate 12 to 18 parts, sodium phosphate 25 to 30 parts, borax 4 to 5 parts. When only slightly soluble substances are used, then the above rule should read: When a solution of chloride of gold is treated with a substance slightly alkaline and slightly

soluble, the decoloration is more rapid the more alkaline the substance is.

2. If the salts employed are alkaline oxides, the bath decolorises and becomes fit for use the quicker the greater the quantity of salt employed.

3. All neutral or slightly alkaline toning baths used immediately they are colourless, tone very rapidly and tend to give violet-black tones.

4. All neutral or slightly alkaline toning baths lose their activity gradually; the more alkaline the bath the quicker this takes place.

5. Acid toning baths (those reddening litmus paper very slowly) do not become colourless when made with pure mineral salts; those prepared with organic salts become colourless when they approach neutrality, or when prepared with reducing salts.

6. Acid toning baths preserve their toning power indefinitely, and their activity is greater the less acid they are.

7. The tones obtained with the different papers and different baths depend upon the amount of gold deposited; the quicker the prints tone, and the more complete the toning action, the nearer the tone approaches to a blue black.

The colour obtained by toning varies with each bath, and in many cases with each different brand of paper, and the tone depends to a great extent, too, upon the negative. Some authorities even state that the tone of the print is fixed when the plate is developed, but the author cannot quite bear out this statement. Good bold negatives with plenty of contrast give more easily purple and black tones than weak muddy negatives devoid of any contrast, vigour, or sparkle. The following are the baths most commonly used at the present time, with some notes on the same:—

1. Acetate Bath.

Chloride of gold	...	...	...	...	1 gr.
Acetate of soda	...	...	...	...	30 grs.
Distilled water	...	...	...	...	10 ozs.

Neutralise the gold with a pinch of common chalk mixed with ½ oz. of water, allow to settle, pour off the solution, and add to the acetate dissolved in the water. The bath must be kept at

least twenty-four hours before use, and works better even when older. It gives brownish purple tones, which are very pleasing. The bath keeps fairly well if distilled water is used, and if no actinic light is allowed to gain access to it. If the bath be required for immediate use, hot water must be used, and the bath may be used as soon as cold. After toning, the bath should not be thrown away, but filtered and kept for use instead of water for diluting the next bath. The author prefers keeping a concentrated solution as follows :—

Chloride of gold	15 grs.
Acetate of soda	480 ,,
Distilled water, to make	7½ ozs.

For use, mix ½ oz., equal to 1 gr. of gold, to ½ pint water for every sheet of paper to be toned. After use, the bath may be filtered and preserved to dilute the next bath.

2. Bicarbonate and Acetate Bath.

Chloride of gold	15 grs.
Bicarbonate of soda...	30 ,,
Acetate of soda	360 ,,
Distilled water	15 ozs.

Add the gold and bicarbonate of soda to 2 ozs. of water, shaking occasionally, and keep till colourless; then add the acetate and remainder of water, and keep for six hours, and dilute as for the acetate bath. The same directions apply to this bath as to No. 1. Rich purple-black tones are obtained.

3. Borax Bath.

Chloride of gold	1 gr.
Borax...	20 grs.
Distilled water	10 ozs.

4. Bicarbonate Bath.

Chloride of gold	1 gr.
Bicarbonate of soda	30 grs.
Distilled water	10 ozs.

These give warm brown tones, the latter inclining to purplish black. They can be used as soon as made, but will not keep.

5. Phosphate Bath.

Chloride of gold	1 gr.
Phosphate of soda	20 grs.
Distilled water	10 ozs.

Gives warm purplish tones. May be used as soon as mixed Will not keep.

6. Compound Bath.

Stock Solution.

Borax	330 grs.
Acetate of soda	180 „
Bicarbonate of soda	90 „
Distilled water	20 ozs.

Toning Bath.

Stock solution	10 drms.
Chloride of gold	1 gr.
Distilled water	10 ozs.

Mix two hours before using. Retain the bath after each toning, and use instead of water for new toning bath. This gives exceedingly rich brown tones, and is a great favourite of the author's.

7. Carbonate Bath.

Chloride of gold	1 gr.
Carbonate of soda	15 grs.
Distilled water	10 ozs.

Mix half an hour before use. Will not keep. Tone to purplish blue, and fix. The resulting colour is a good brown, free from any purplish tinge. But to get a true sepia tone use water at about 170° F., add the gold, and use in ten minutes.

8. Chloride of Lime Bath.

Chloride of gold	15 grs.
Common chalk	150 „
Chloride of lime	24 „
Lime water	15 ozs.

Add the gold to the chalk, and mix into a paste with a little lime water, and leave for one hour; filter, and wash the filter with

the remainder of the lime water in which is dissolved the chloride of lime. Add 1 oz. of the above to 10 ozs. of water for every sheet of paper to be toned. When old, and the bath refuses to tone, add a little chloride of gold, and leave for fifteen minutes; or if no smell of chlorine, add a grain of chloride of lime. This gives purplish black tones, and keeps well.

9. Acetate and Chloride Bath.

Chloride of gold	15 grs.
Acetate of soda	360 ,,
Chloride of lime	135 ,,
Common chalk	360 ,,
Distilled water	15 ozs.

The directions for mixing this are the same as for the chloride of lime bath, the acetate being added in solution last. This gives warm black tones, and keeps well.

10. Acetate and Borax Bath.

Chloride of gold	15 grs.
Acetate of soda	150 ,,
Borax	15 ,,
Distilled water	15 ozs.

Mix the gold and acetate in 3 ozs. of water, and keep for six hours. Add the borax dissolved in remainder, and use at once. This keeps fairly well, and gives brownish black tones.

11. Carbonate of Lime Bath.

Chloride of gold	15 grs.
Carbonate of lime (chalk)	75 ,,
Distilled water	15 ozs.

Mix the gold and chalk and water, and leave for one hour. Keeps fairly well, and gives brownish purple tones.

12. Tungstate Bath.

Chloride of gold	15 grs.
Tungstate of soda	300 ,,
Distilled water (at 212° F.)	15 ozs.

Use when cooled. Gives very fine purplish brown tones.

Keeps fairly well. Add an ounce of stock bath to the old bath for every sheet of paper used.

13. Uranium Toning Baths.

Uranium nitrate Chloride of gold	of each	1 gr.
Bicarbonate of soda	... ...	20 grs.
Distilled water	... ...	10 ozs.

This bath must be used as soon as mixed, and should be distinctly alkaline in test papers. It gives very fine purplish black tones, and the author has found the best results follow complete elimination of free silver by salt-and-water bath previous to toning. The prints when toned should also be placed in salt and water.

Chloride of gold	4 grs.
Uranium nitrate	4 „
Chloride of sodium (salt)	60 „
Acetate of sodium	60 „
Distilled water	32 ozs.

Neutralise the gold and uranium, previously dissolved in a little water, with bicarbonate of soda. The prints should be rather deeply printed, and washed free from silver, and then toned. This bath gives fine blacks, and with plain or matt-surfaced paper the results can hardly be told from bromide prints. The following is the best fixing bath for this, and the prints should be washed in salt and water after toning:—

Hyposulphite of soda	2 ozs.
Salt	1 oz.
Bicarbonate of soda	¼ „
Water	1 pint.

Uranium may also be added to any of the ordinary gold toning baths in use. Thus far the author has given formulæ for toning baths which he has tried, and can speak from personal experience. The following were baths in use some twenty or thirty years back, and some were much approved of. The author regrets, however, that he has not had time to experiment with them:—

15. Lead and Gold Bath.

Nitrate of lead	30 grs.
Chloride of sodium (salt)	40 „
Hyposulphite of soda	240 „
Chloride of gold	1 gr.
Distilled water	10 ozs.

Mix in warm water. Use at once. Bath won't keep. Gives rich blacks. Fix in fresh hypo. Permanency of tones not guaranteed.

16. Bromide Bath.

Chloride of gold	1 gr.
Carbonate of soda	15 grs.
Sodium bromide	½ gr.
Distilled water	10 ozs.

Use at once. Won't keep. Gives rich brown or chocolate tones. The more bromide is added the redder the tone.

17. Lime Water and Acetate Bath.

Chloride of gold	15 grs.
Acetate of soda	180 „
Lime water	15 ozs.

Gives purplish tones. Keeps fairly well.

18. Sel d'Or.

Chloride of gold	1 gr.
Hyposulphite of soda	4 grs.
Hydrochloric acid	4 drops.
Distilled water	10 ozs.

Dissolve the gold in half the water, and add to the hypo dissolved in remainder of water, stirring constantly; then add the acid. Burton strongly recommends this bath. After toning, put prints into a soda bath and then fix. So far all the baths given have referred to ordinary albumenised paper. The following are specially recommended for printing-out emulsions, whether on glass or paper, such as Aristotype. In fact, for the latter paper these are the only baths which really give beautiful results:—

19. Sulphocyanide Bath.

Chloride of gold	1 gr.
Sulphocyanide of potash	12 grs.
Hyposulphite of soda	½ gr.
Distilled water	4 ozs.

The prints should be rather deeply printed, and soaked in a solution of alum (1 in 10) first for five minutes, then given a dip into a bath of carbonate of soda, and then toned faced downwards; afterwards dipped in soda and fixed in fresh hypo.

20. Fixing and Toning Bath.

Hyposulphite of soda	6 ozs.
Sulphocyanide of potash	1 oz.
Acetate of soda	1½ ozs.
Alum	96 grs.
Distilled water	21 ozs.

Fill the bottle containing this solution with clippings of paper or bad prints, or add 100 grs. of chloride of silver, and leave for twenty-four hours, filter, and add

Chloride of gold	15 grs.
„ „ ammonium	30 „
Distilled water	6 ozs.

The same directions for using this bath as for No. 19. The author prefers the use of No. 19, and fixing separately, as with this there is no certainty as to when the gold is exhausted and sulphur toning begins. The prints change to a bright yellow, and run the scale of colours to a brilliant purplish black. Both these, Nos. 19 and 20, may be used for albumenised paper prints.

A few Maxims for Toning. Prints should be thoroughly freed from free silver, except in the case of all baths containing chloride of lime and sulphocyanides; with these free silver is an absolute necessity. After toning, the prints should be invariably placed in a bath of salt, and washed in one or two changes of water; this prevents any further toning action, and a whole batch of prints may be toned before hypo is touched in any shape or form. It is absolutely necessary to keep the toning bath, dish, or fingers uncontaminated by any other chemicals, or spots and stains will be the result. The prints should be

handled as little as possible before toning, and they should be kept in constant motion whilst toning, which operation should be conducted in weak daylight, it being more difficult to judge of the true tone by artificial light. When prints are given a preliminary bath of salt and water, a brilliant brown tone, called "Payne Jenning's Brown," results, this artist invariably using this bath—a preliminary bath of carbonate of soda, and fuming the paper before printing, tending to give purple tones.

Loss of Tone in Fixing. This is so often a complaint that no excuse will be made for an attempt to explain this annoying defect. Some baths are particularly liable to it; and some samples of gold, which the author has tested to try and find a reason for this defect, were contaminated with chloride of copper, most likely an accidental adulterant from the use of an alloy of gold and copper in the shape of scrap gold, old jewellery, or coins, for the production of the auric salt. If copper be present, part of the image would be toned by a coloured compound of copper, which would dissolve in the hypo. Many years ago the addition of alkaline gold to the fixing bath was recommended, and the author has proved this to be of great value to prevent loss of tone, sel d'or being actually formed. The following is the formula referred to :—

Chloride of gold	1 gr.
Carbonate of soda	20 grs.
Hypo	4 ozs.
Water	20 ,,

Add the gold and soda mixed together to the hypo solution, stirring constantly. Mr. Anthony, of New York, recommends making the fixing bath distinctly acid both to test paper and sight by a slight turbidity, by the addition of acetic acid, and then neutralising the free acid by the addition of carbonate of soda or liquor ammonia till distinctly alkaline to test paper. This the author has tried and found useful; but in every case the fixing bath should be distinctly alkaline, either by carbonate of soda or ammonia.

Yellowness of the Whites of Prints. This is at once a sure sign of the acidity of the fixing bath, and consequent sulphur toning. Nothing can be done but to immediately destroy the print, and make the fixing bath alkaline. It more generally

makes its appearance in cases of over-toning, when some secondary action seems to take place.

Black Deposit in Toning Baths. On keeping for some time, especially when extreme cleanliness and exclusion of actinic light has not been attended to, all toning baths deposit, more or less, a purplish black precipitate, which is metallic gold in an extremely fine state of division; and when this deposit has occurred the bath is utterly useless. To renovate these old baths the following plan may be adopted:—Collect the precipitate, wash it well, and shake up with distilled water acidulated with nitric acid (1 to 80); add to this a solution of chloride of lime, made by mixing 80 grs. of chloride of lime with 1 oz. of water, and filtering; add the last solution gradually to the deposit of gold mixed with water, and heat to the boiling point; it will then be found that as more chloride of lime solution is added the gold will dissolve. When entirely dissolved, it may be kept for future use, and sufficient chalk added each time to neutralise any free acid before using. Another method of preserving any alkaline toning bath is, after use, to add sufficient hydrochloric acid to make the bath distinctly acid and of a yellow colour. When required for use, it is only necessary to add sufficient alkali to render the bath colourless, and it will work as well as a fresh-made one. All toning baths should be distinctly alkaline; and if not so, alkali should be added.

All amateurs will hail with welcome a bath which will tone albumen prints, no matter how long they have been printed, or how faded and yellow they may be. The following is the process invented by M. Jaudaurek of Vienna, which is of great value:—

Solution A.

Distilled water	17 ozs.
Tungstate of soda	154 grs.

Solution B.

Carbonate of lime (chemical, pure) ...	60 grs.
Chloride of lime	15 „
„ „ gold	60 „
Distilled water	15 ozs.

This solution should be made in a yellow glass bottle, well

shaken and allowed to stand for twenty-four hours: then filtered into another yellow glass bottle, and kept well stoppered. When the prints have been washed, they should be placed one by one is the following toning bath:—

Solution	A	5 ozs.
,,	B	70-140 m.

They should not tone too quickly; about ten minutes in summer should be the shortest time. If they tone quicker than this reduce the quantity of solution B. After toning wash the prints and place in the—

Fixing Bath.

Solution A.	5 ozs.
Sodium Hyposulphite	230 grs.

They should be allowed to remain in this till the yellow colour has quite disappeared, which may take some hours. After this has disappeared wash in the usual way.

Tragacanth (Ger., *Tragant, Tragantschleim;* Fr., *Adragante;* Ital., *Dragante*). A gummy exudation from the stem of *Astragalus verus*, collected in Asia Minor. It should be nearly white, and sparingly soluble in cold water; more so in hot; entirely insoluble in alcohol.

Transfers. By this term is meant the pictures produced by transferring an image developed upon a temporary support, and affixed afterwards to its final support. These are usually made by the carbon or collodion process; but lately a special transferotype paper has been introduced, which gives very pleasing effects. This consists of a film of insoluble gelatino-bromide emulsion, affixed to a temporary support of paper by a soluble substratum. The method of exposure and after-treatment is precisely the same as for bromide paper, but they can be toned after transfer by the following process:—

Solution A.

Ferricyanide of potash	100 grs.
Distilled water	24 ozs.

Solution B.

Uranic nitrate	... 100 grs.
Distilled water	... 24 ozs.

Keep these separate, and mix only for immediate use. Take equal parts of A and B, mix, and immerse the transferred picture in the bath till the desired tone is obtained. Fix again in

Hyposulphite of soda	... 3 ozs.
Water	... 16 ,,

The darker the print the deeper the tone. As this process intensifies (it is practically nothing but uranium intensification) medium light prints give the best results. The above formula gives warm red tones; for rich browns, leave the prints in toning solution till they begin to turn; then immerse in weak alum solution, wash, and fix. To transfer these, lay the wet print upon the surface to which it is to be transferred, which may be either polished or ground opal glass, clear or ground glass, porcelain, wood, ivory, canvas, or any other material which will stand hot water. The surface must be perfectly free from grease or dirt; squeegee the wet print carefully on to it, and put under a weight and blotting paper to dry. When dry pour hot water at about 160° F. upon the paper till it begins to blister; then raise one corner carefully with a knife, and strip the paper off, and gently rub the picture with a wet pad of cotton-wool. The paper may be stripped any time after the picture has been on its support thirty minutes, but it is better to let it dry. Lantern slides, plaques, tiles, and lamp shades may all be ornamented in this manner.

Translucent. See LIGHT.

Transparent. See LIGHT.

Tripod. See STAND.

Under-Exposure is when the duration of exposure of the sensitive surface is not sufficiently prolonged to impress the details of the object on the sensitive surface. Its effects are thinness of negative, without detail. When under-exposure is suspected, the only thing to do is to reduce the bromide in the developer, and coax the image out with very slow and careful

development. To increase density, intensification may be resorted to, but nothing can improve the lack of detail.

Uranium (Ger., *Uran;* Fr., *Urane;* Ital., *Uranio*). U = 240. A rare metal never found in a pure state, but as an impure oxide, called pitchblende. It is used in the form of nitrates for preparing a printing-out paper, and for intensification.

Uranium Chloride (Ger., *Uraniumchlorid;* Fr., *Chlorure d'uranium;* Ital., *Cloruro di uranio*). $UO_2Cl_2H_2O = 361$. Very soluble in alcohol and water. It has been used for toning and as a sensitive salt for a platino-uranotype process (*q.v.*).

Uranium Nitrate (Ger., *Uranylnitrat, Salpetersäures Uranoxyd;* Fr., *Azotate d'urane, Nitrate d'urane;* Ital., *Azotato di uranio*). Uranic nitrate is prepared by digesting pitchblende in hydrochloric acid, to dissolve out the other metals, then roasted with charcoal twice, and the residue dissolved in nitric acid, and purified by crystallisation. It is a brilliant yellowish-green crystalline salt, very deliquescent. Solubility 215 per cent. in cold water, 33·3 per cent. in alcohol, and 25 per cent. in ether. It is decomposed by light when in contact with organic matter into a uranous nitrate.

Uranium Printing. The colours obtained by the use of uranium salts are decidedly pleasing, tending to a terra-cotta or copper colour, which may be varied at will. The sensitising solution may be prepared as follows:—

Uranium nitrate	80 grs.
Distilled water	1 oz.

Preserve in the dark. The papers may be floated on this for five minutes, or the solution may be applied with a brush or tuft of cotton wool. The following may also be used:—

Uranium nitrate	80 grs.
Mercuric nitrate	20 ,,
Distilled water	1 oz.

Or

Uranium nitrate	80 grs.
Cupric nitrate or sulphate	20 ,,
Distilled water	1 oz.

The papers should be exposed under a negative in sunlight until

all the principal detail is visible, and then floated on a developer till the tone desired is obtained.

Potassium ferridcyanide	50 grs.
Distilled water	1 oz.

This will give a reddish-brown tint.

Silver nitrate	25 grs.
Distilled water	1 oz.

This will give a greyish image, which can be toned after washing in a combined toning and fixing bath.

Chloride of gold	1 gr.
Distilled water	1 oz.

This should be brushed over the image, and gives a purplish-black. The prints after development should be washed in a bath of hydrochloric acid, 1 to 80, and then again washed thoroughly.

Uranium Toning. See BROMIDE PAPER and PLATINOTYPE.

U.S. or Uniform System. See DIAPHRAGMS.

Varnish. A solution of resinous bodies in a volatile solvent, used for covering the film of a negative with a coating of matter impermeable to air and damp.

The following is a table of the principal varnishes of commerce :—

1. Copal, for fine paintings.
2. Japanners' copal.
3. Best body.
4. Carriage.
5. Best white hard.
6. Best white hard, for violins.
7. Best brown hard.
8. Turpentine.
9. Crystal.
10. Amber.
11. Paper.
12. Sealing-wax.
13. Black.

Ingredients.	1	2	3	4	5	6	7	8	9	10	11	12	13
Shellac ... ... lbs.	...	...	...	...	...	2	2	...	...	...	...	1½	1
Mastic ... ... „	...	...	...	...	...	1	...	...	...	...	...	...	...
Sandarac ... „	...	...	...	...	2	4	...	...	...	...	...	...	...
Dammar... ... „	...	...	...	...	...	...	...	...	...	...	4	...	...
Resin ... ... „	...	...	...	...	...	...	...	...	4	...	...	...	...
Amber ... ... „	...	...	...	...	...	...	...	...	...	6	...	...	...
Benzoin ... ... „	...	...	...	...	...	1	...	...	...	...	...	...	...
Copal ... ... „	8	7	8	8	...	...	...	...	...	...	...	...	...
Sp. of wine ...gals.	...	..	...	...	1	5	1	...	...	...	...	1	1
Turpentine, oil of ... ... „	3	3	3½	5½	...	...	...	1	1	4	1	...	...
Linseed, oil of „	2	½	2	2½	...	...	...	...	...	2	...	...	...
Turpentine ... lbs.	...	...	...	...	...	2	...	...	...	...	...	...	...
do. varnish ... pts.	...	...	...	...	...	...	1	...	...	...	...	...	...
do. Venice ... ozs.	...	...	...	...	18	...	18	...	...	...	...	...	...
Powdered glass.. ... lbs.	...	...	...	...	...	4	...	...	...	...	...	...	...
Black sealing-wax ... ... „	...	...	...	...	...	...	...	...	...	...	...	...	3
Red do. ... ... „	...	...	...	...	...	...	..	...	...	...	...	2½	...

The function of the powdered glass is purely mechanical. (For a table of the solubilities of various resinous materials, see p. 548). For photographic purposes special varnishes are required, and the following will be found very good ones:—

Negative Varnish.

(1)

Orange shellac	1¼ oz.
Mastic	¼ „
Sandarac	1¼ „
Oil of turpentine	¼ „
Venice turpentine	¼ „
Camphor	10 grs.
Methylated spirit, 66 over proof	20 ozs.

Or

(2)

Orange shellac	2 ozs.
Sandarac	2 „
Canada balsam	60 grs.
Oil of lavender	1 oz.
Methylated spirit	16 ozs.

Or

(3)

White hard varnish	15 ozs.
Methylated spirit	25 „

The above varnishes must be flowed over the negative, and then dried before a brisk fire. The following may be applied without warming:—

(4)

Negative varnish	5 ozs.
Liq. ammonia ·880	Add sufficient to cause the cloudiness first formed to disappear.

Or

White hard varnish...	10 ozs.
Liq. ammonia ·880	As above.
Water	5 ozs.

Burton has strongly recommended the following:—

Sandarac	1 lb.
Venice turpentine	4 fluid ozs.
Oil of turpentine	8 „ „
Alcohol (sp. gr. ·825)	1 gallon.

The alcohol should be poured over the gum, which will dissolve in a few hours without heat, if the vessel be occasionally shaken. The Venice turpentine is then added, and the measure rinsed out with the oil of turpentine, which is also added. The varnish is then ready for use.

Black Varnish.

Benzine	1000 parts.
India-rubber...	6 „
Asphalt	300 „
Lamp black	Quant. suff.

Matt Varnish.

This can be prepared from :—

(1)

Sandarac	100 parts.
Mastic (in tears)	20 ,,
Ether	1000 ,,
Benzine	500 ,,

(2)

Sandarac	60 ,,
Gum Dammar	60 ,,
Ether	1000 ,,
Benzine	350 to 400 parts

The more benzine is added the coarser the grain, and *vice versa*. Lainer strongly recommends :—

Ether	100 parts.
Sandarac	10 ,,

Dissolve by agitation, filter, and add—

Toluol	35 to 40 parts.

Varnish, Removal of. It is often necessary to remove the varnish from a gelatine negative in order that intensification or reduction may be resorted to, and this is a very simple matter when the varnish is of a resinous nature. A porcelain dish of suitable size is made warm by immersion in hot water, and it is then wiped dry and the negative placed therein, film upwards. Enough methylated spirit to cover the plate is now poured in and the dish is rocked for a few seconds, when the film is gently scrubbed with a tuft of cotton wool. Two more changes of methylated spirit will now serve to sufficiently clear away all traces of the varnish, after which the plate may be transferred to a vessel of water, or may be wiped dry with a soft cloth.

View Finder. This is a little instrument used for instantaneous photography to show when the moving object is in the middle of the field of view and in the middle of the plate. One form is a plano or double-concave lens mounted on the front of the camera, the eye being placed at the back of the camera. A good form of this finder is with a concave lens mounted with a mirror at an angle of 45° behind it. Another good method is to

utilise the camera obscura, which may be made at a trifling cost out of a spectacle double-convex lens of about 1½ to 2-in. focus mounted in a brass tube, a mirror at an angle of 45°, and a piece of ground glass on the top with a shade. In the accompanying diagram showing the arrangement, A B C D is a rectangular box of card or wood, L a lens in the mirror, G the ground glass, S movable shade, which can be raised or lowered at will. Another method is to use the focussing screen, which, when turned back over the top of the camera, should have lines drawn on it as shown in the diagram; then, when the eye is placed at A, and looking along A B, the object, when opposite this, will be in the centre of the plate. Or a double-convex lens of exactly the same focus as the photographic lens may be mounted on

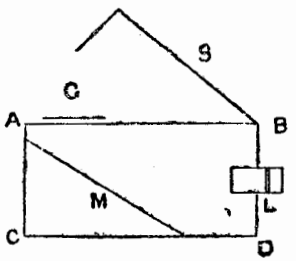


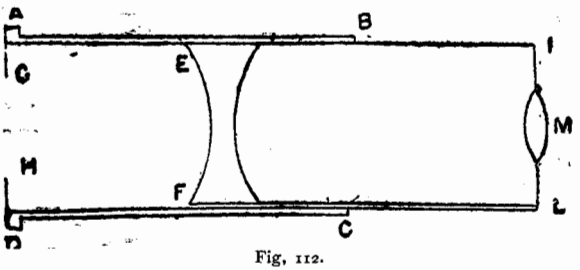
Fig. 111.

the front of the camera, and the focussing cloth thrown over the whole so as to form a second or temporary camera. A new class of view finder has recently been introduced, the pioneer being Messrs. Adams & Co.'s "Bright" view finder. In this we have two positive lenses with a reflector at 45° between them, but the lenses form one doublet optical system, and form a real image near the surface of the instrument. This aerial image can be seen very distinctly even when the object is feebly illuminated, and with the eye at a considerable distance from the finder. The "Radiant" view finder of Messrs. Marion involves the same principle, but a reflecting prism, one surface of which is ground to form a convex lens, replaces the silvered reflector and one of the lenses of Messrs. Adams & Co.'s instrument. In a somewhat similar instrument constructed by

M. Turillon, of Paris, the reflector hinges so that when the camera is held to the eye level it is not in use, but for cases in which the camera is held low the reflector is used. Cross lines are marked on both lens and reflector, the exact coincidence of the two crosses serving for a very accurate orientation of the camera, and M. Turillon prefers to use a finder exactly corresponding with the focus of the objective used. A finder of this type must necessarily be placed at some distance from the eye; hence, the use of the reflecting form, rather than the direct vision form, may often have the substantial advantage of allowing the eye to look in a direction from which no considerable glare of extraneous light reaches it.

View Meter. An instrument used to gauge the amount of view included by the lens upon the focussing screen without the trouble of setting up the camera. The following, which has now been placed upon the market commercially, is a very good form:—

A B C D, a brass tube bearing at one end a cap in which is an



Fig, 112.

opening (G H), bearing a proportionate size to the plate used: for instance, for quarter-plates, or $4\frac{1}{4}$ by $3\frac{1}{4}$, the opening may be $\frac{17}{16}$ in. by $\frac{13}{16}$; or for half-plate, $\frac{20}{16}$ by $\frac{18}{16}$. This opening frames the view, and limits its extent according to the distance the inner tube is drawn out. E F is a double concave lens of $1\frac{1}{2}$-in. focus, and M a double convex lens of 3-in. focus; when the eye is applied to the convex lens the picture is viewed in miniature. P will show front view of cap.

To use this it must be adjusted to the lenses with which it will be worked. To do this it is only necessary to erect the

camera, focus carefully, and, marking two prominent objects on the edges of the screen, adjust the small view-meter till the same objects are exactly on the edges of the field of view in that. Now mark on the inner sliding tube with a knife or file the exact point to which it was pulled out or in, and this will always include the amount of view included by that lens. By

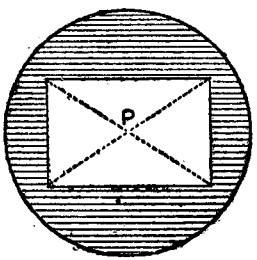


Fig. 11.

fastening two fine wires across the cap P, as shown by the dotted lines, it will serve well also as a view-finder, as, when the moving object is at the point of intersection of the crossed wires, it will be in the centre of the plate. It may also be used as some guide to the probable exposure by placing inside the cap a circle of blue glass, so as to cut off the rays which are more especially chemically active.

Vignetting. This consists of shading off the margins of a picture, so as to cause the figure or subject to gradually fade away. There are numerous methods of effecting this: one is by the use of glass with oval or other shaped openings surrounded by a gradually deepening margin of coloured non-actinic glass. These, however, are not satisfactory. Another method is that employed by the French operators of using graduated thicknesses of tissue paper with serrated edges. Another method is to use wooden covers with openings having the underneath edges bevelled off. But the best of all is to use stout sheet lead or pure tinfoil, and to cut the sized opening required, and either to slightly turn up the edges or serrate them, so as to soften the outline; and the farther the vignetting shape is placed from the negative the larger the vignette and the softer the outline.

When the so-called Russian vignettes or images on a black ground are required, a very good method is to use a vignetter in front of the lens or between the lens and the plate. When used in front of the lens a card or metal plate with the particular shaped opening is supported in front of the lens, and gently moved backwards and forwards an inch or two during exposure, the distance in front of the lens being found by adjustment. When used in the camera the most convenient form is that of an American invention which is practically a large iris diaphragm placed about a third of the focus from the lens. Obviously cards or metal plates may be used in the same way.

Viviscope. See ZOETROPE.

Voice, Photographing the. Czermak, in 1862, photographed the vocal cords in action, and in 1878 Professor Blake, who worked in the laboratory of the Brown University (U.S.), obtained very minutely defined records of speech itself. A beam of sunlight was reflected from a small mirror, so suspended that every movement of a telephone disc would alter its angle. This beam was received on a sensitive plate moved by clockwork.

Vulcanite. Syn. with EBONITE (*q.v.*).

Washing Negatives and Prints.—Upon the perfection of the washing process practically depends the life of negatives and prints, as the presence of hyposulphite of soda, or silver, tends to fading of negatives and prints, and yellowness of the whites of the latter. There are numerous commercial washing tanks and troughs, which answer their purpose admirably. Running water is the most effective means for the elimination of the undesirable faults, but when the water supply is limited, the prints or negatives should be allowed to soak in water for ten minutes, and then the water changed; and this operation repeated six times will usually be sufficient for negatives and prints. Messrs. Grundy & Haddon have proved that ten minutes' thorough washing is quite sufficient to eliminate all the hyposulphites that can be eliminated, and it is a recognised fact that very prolonged soaking of prints in water is liable to initiate a decomposition of the organic matter of the films.

Wastes. See RESIDUES.

Water. $H_2O = 19$. The purity of water is a matter of importance in relation to many photographic operations, and the purest water which occurs in nature is rain water; but rain water collected in towns contains ammonia and organic impurities dissolved from the atmosphere, to say nothing of the solid matters washed from the roofs of the houses. Those desiring to obtain a cheap and fairly satisfactory substitute for distilled water, can often do so by collecting rain water during the course of a heavy storm, but after both atmosphere and housetops have been well washed, and it is very easy to arrange a shifting gutter, so that the cleaner water is collected in a separate cistern. Spring water, river water, and all municipal or public supplies contain mineral and organic impurities; those most affecting photo-

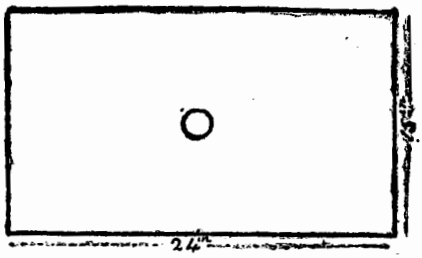


Fig. 114.

Fig. 115.

Fig. 116.

graphic work being soluble chlorides (sodium and sometimes magnesium) which give a white precipitate with silver nitrate; also lime salts which curdle soap. Distillation is the most satisfactory method of removing such impurities, and a convenient form of still for the photographer is one, the making of which is thus described in *The Amateur Photographer* of January 1, 1897:—"Obtain a sheet of zinc about 24 by 15 ins., and make a hole about ½ in. in diameter in the middle of this sheet, 6 in. from the side, as shown in fig. 114, then solder the narrow ends of your piece of zinc together so as to form a cylinder 15 in. high and nearly 8 in. in diameter. A short tube should be fixed in the hole to act as a kind of spout. Then out of a piece of tin or thin zinc make a funnel about 2 in. deep such as fig. 115 (or this can be purchased if desired), and a tube 6 in. or 8 in. long, ½ in. in diameter, or so as to fit the hole in the side; fix this on to the

funnel, as shown in fig. 116, pass this tube through the hole, leaving the funnel as near the middle of the cylinder as possible. The tube should protrude some little distance from the outside of the cylinder; make this water-tight either by solder or by packing. Next form a bottom out of zinc, and solder carefully on to the end farthest away from the funnel. Then proceed to make a cone-shaped lid, about 9 ins. in diameter at the top; this can be done by forming a circle out of tin or zinc, 12 ins. in diameter, and cutting a piece out, 7⅝ in. at the edges, and meeting in the centre (fig. 117). Then lay one part over the other, just 1 in. at the edge, solder, and make water-tight. This is for covering the cylinder, and ought to hang 5 ins. from the top.

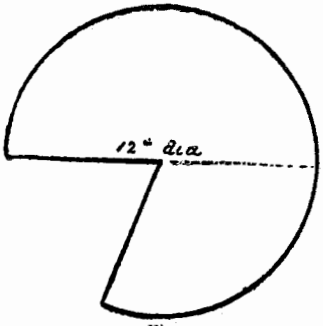


Fig. 117.

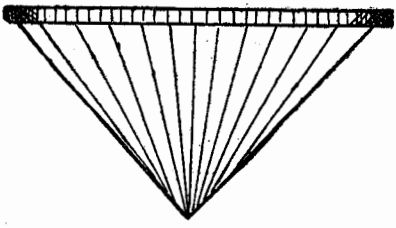


Fig. 118.

The lip of the cone must stand directly over the funnel. From these directions and illustrations any metal worker will make the apparatus at small cost. Stout tin will serve well. In order to use, pour about a quart of water into the cylinder, fix on the top so that no steam can possibly escape, and fill the cone with cold water. Heat to boiling point with an ordinary gas-stove or spirit-lamp. The steam rises and settles on the cone, where it is condensed by the cold water outside. It then trickles down, drops into the funnel, passes down the tube, and is caught in a jar or bottle placed for the purpose as shown in the illustration (fig. 119). After using, and before putting on one side, everything should be rinsed out, cleaned, and dried, especially the cone top, funnel, and tube, in order to free them from dirt or

chemicals, as the slightest adulteration of the (supposed) distilled water might seriously damage any solution of which it may form a part. Other apparati have been used, and can be

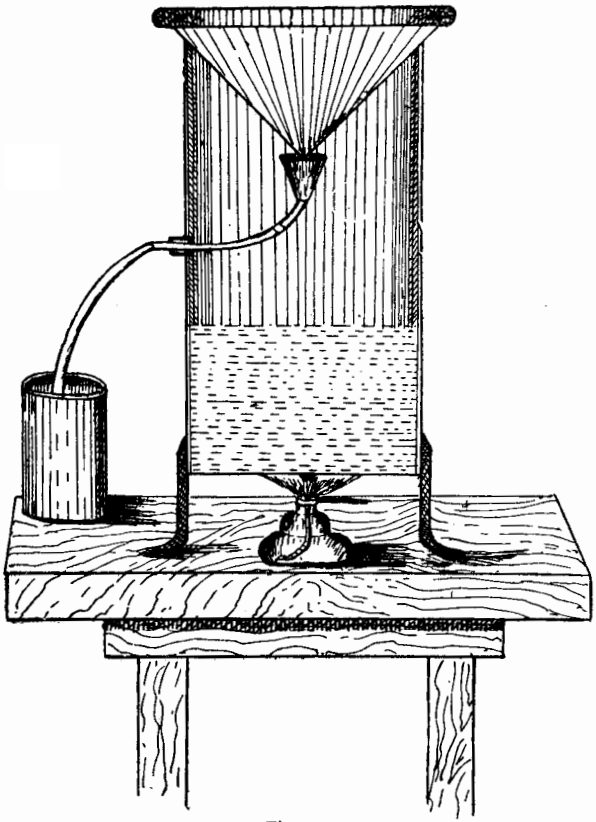


Fig. 119.

adapted, such as an ordinary kitchen stewpan in place of the cylinder. It is made on the same principle as the one described. In place of the tin funnel and tube, a long clay tobacco tipe (known as a churchwarden) will serve."

In preparing distilled water, that first coming over (say about one-twentieth) should be rejected, as liable to contain ammonia and volatile impurities. Another form of still, and one which involves still less special fitting or construction is shown in

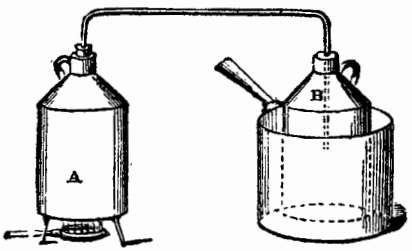


Fig. 120.

fig. 120, the constituents being a tin can, A, in which the water is boiled, a bent glass tube (see GLASS WORKING) fitted to A by means of a perforated cork. Another tin can, B, into which the bent tube passes loosely, stands in a saucepan containing cold water.

Weighing and Measuring. In ordinary photographic operations extreme accuracy in weighing and measuring is not required; and as regards balances, an ordinary shopkeeper's pair of scales will serve for the larger quantities, and a pharmacist's dispensing scales for smaller quantities. The larger scales are best of the platform type, in which the beam is below the pans, and they may conveniently weigh up to about 7 lb., but they should give a clear indication of a difference of 10 grs. The smaller scales should, if practicable, be of much better quality than the cheapest kind sold; indeed, it is hard to obtain a satisfactory dispensing balance with drawer and stand for less than £1 5*s.* or £1 10*s.*, although a cheap substitute may be had in a box, and without the stand, for 2*s.* 6*d.* or 3*s.* A good pair of dispensing scales will indicate $\frac{1}{10}$th of a grain, and will turn immediately or decidedly with a grain; and its use effects a considerable saving of time as compared with those that are less sensitive. Continually taking down and rehanging tends very much to damage and wear down the knife edges; hence it is best to always keep the scales hung, and to use a flat glass shade for

a cover, as shown in fig. 121; indeed, some such protection to the finer scales is essential, if they are to be kept always ready for use and in good order; still, it may be remarked, that a light cover constructed of cardboard may shield off the dust as effectually as a glass shade. A movable glass pan is very desirable, a watch glass serving very conveniently, and a metal counterpoise can be constructed. A small thin glass beaker

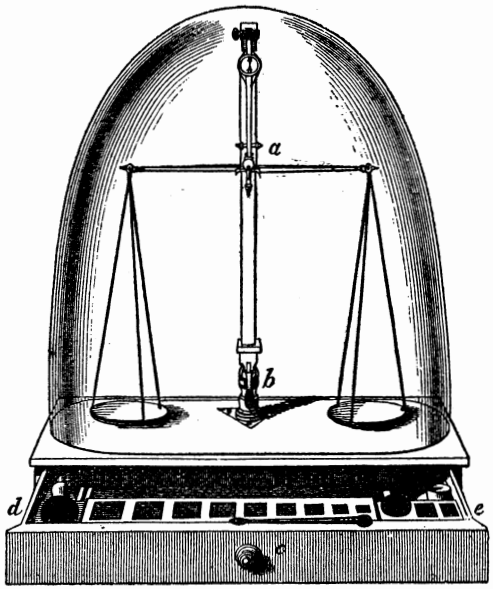


Fig. 121.

provided with counterpoise is useful, as sometimes it is desirable to weigh liquids rather than to measure them. The hook suspension for the glass pan is preferred by some as giving more ready access to the pan, and it is generally provided as an alternative arrangement. For measuring liquids the usual glass graduated measures are ordinarily most convenient, although in the case of very small quantities and hot liquids other arrangements are desirable. Hot liquids—and almost the only hot

liquid the photographer has to measure is hot water—are most conveniently measured in thin German glass beakers, which can be obtained from the dealers in chemical apparatus, and which will seldom break when hot water is poured in. Graduation by marking on the outside with a writing or scratching diamond is not always satisfactory, as the scratches are often starting points for fracture; hence it is generally better to gum on a strip of paper, to mark the graduations on this, and finally to varnish. In thus graduating a measure it is convenient to weigh in successive quantities of water, and a mark is made on the paper strip at each addition. The beaker being counterpoised on the scale pan, the required weights are put into the other pan (a fluid ounce of water is the volume occupied by an ounce avoirdupois), and equilibrium is brought about by pouring water in the beaker; the final adjustment being most conveniently made with a pointed syringe. The usual minim measure is not convenient for measuring very small quantities, and estimation of such small quantities by counting drops is a tedious strain on the observing powers, moreover, very inaccurate, as drops even of the same liquid vary very much in size. For example, a drachm of water may give from 31 to 54 drops, according to the shape of the vessel from which it is allowed to drop. Mr. Alsop's minim-meter (fig. 122) is one of the most convenient arrangements. It is virtually a small syringe, and in using it the piston is raised half an inch or so, and the point of the syringe is then dipped into the liquid and the required quantity is drawn up, or a little more may be drawn up; and any excess, beyond the quantity required, is forced out by carefully depressing the piston, after which the measured quantity is expelled. A certain amount of air should always intervene between the piston and the liquid to be measured. The measure is readily cleaned by separating the parts and washing them separately. A length of glass tube of suitable size and tolerably uniform in the bore will make a number of these minim measures (see GLASS WORKING); and instead of

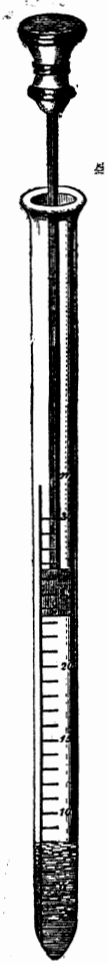


Fig. 122.

the piston, a blind or imperforate india-rubber teat (obtainable from any druggist) may be used—this being slipped over the upper end of the tube. The confusion which reigns in the photographic world with regard to weights and measures is very notable, arising in great measure from the numerous systems of weights and measures used in different countries. Solid chemicals are sold by avoirdupois weight, whilst many formulæ are written in what is called apothecaries' weight. It has been proposed to use the metric system, but at present there seems no likelihood of its coming into general use. As a standard for dry substances the grain has been employed in this DICTIONARY, and for liquids the minim, or the ounce of 480 minims, except in some cases where a few grains more or less would make no appreciable difference. We do not intend to enter into any arguments as to the desirability or otherwise of a decimal system, but we simply give the tables of weights in general use.

Apothecaries' Weight.

20 grains	...	...	...	=	1 scruple (℈).
3 scruples	...	...	...	=	1 drachm (ʒ).
8 drachms	...	...	...	=	1 ounce (℥).

The above weights are used by pharmacists for the compounding of prescriptions, but a simple statement as to the number of grains is now preferred by most medical men.

FRENCH FLUID MEASURES.

The cubic centimètre, usually represented by "c.cm.," is the unit of the French measurement for liquids. It contains nearly seventeen minims of water; in reality, it contains 16·896 minims. The weight of this quantity of water is one gramme:—

1	cubic centimètre	=	17	minims (nearly).					
2	cubic centimètres	=	34	,,					
3	,,	=	51	,,					
4	,,	=	68	,,	or 1	drachm	8	minims.	
5	,,	=	85	,,	,, 1	,,	25	,,	
6	,,	=	102	,,	,, 1	,,	42	,,	
7	,,	=	119	,,	,, 1	,,	59	,,	
8	,,	=	136	,,	,, 2	drachms	16	,,	
9	,,	=	153	,,	,, 2	,,	33	,,	
10	,,	=	170	,,	,, 2	,,	50	,,	
20	,,	=	340	,,	,, 5	,,	40	,,	

30	cubic centimètres	=	510	minims,	or	1	ounce	0	drachm	30 minims.
40	,,	=	680	,,	,,	1	,,	3	drachms	20 ,,
50	,,	=	850	,,	,,	1	,,	6	,,	10 ,,
60	,,	=	1020	,,	,,	2	ounces	1	,,	0 ,,
70	,,	=	1190	,,	,,	2	,,	3	,,	50 ,,
80	,,	=	1360	,,	,,	2	,,	6	,,	40 ,,
90	,,	=	1530	,,	,,	3	,,	1	,,	30 ,,
100	,,	=	1700	,,	,,	3	,,	4	,,	20 ,,

The Conversion of French into English Weights.

Although a gramme is equal to 15·4346 grains, the decimal is one which is not convenient for photographers; hence in the following table it is assumed to be $15\frac{2}{5}$ grains, which is a near approach to *practical* accuracy:—

1	gramme	=	$15\frac{2}{5}$	grains.					
2	grammes	=	$30\frac{4}{5}$	,,					
3	,,	=	$46\frac{1}{5}$	,,					
4	,,	=	$61\frac{3}{5}$	,,	.....	or	1 drachm	$1\frac{3}{5}$	grain.
5	,,	=	77	,,	.....	,,	1 ,,	17	grains.
6	,,	=	$92\frac{2}{5}$	,,	.....	,,	1 ,,	$32\frac{2}{5}$	,,
7	,,	=	$107\frac{4}{5}$	,,	.....	,,	1 ,,	$47\frac{4}{5}$	,,
8	,,	=	$123\frac{1}{5}$	,,	.....	,,	2 drachms	$3\frac{1}{5}$	,,
9	,,	=	$138\frac{3}{5}$	,,	.....	,,	2 ,,	$18\frac{3}{5}$	,,
10	,,	=	154	,,	.....	,,	2 ,,	34	,,
11	,,	=	$169\frac{2}{5}$	,,	.....	,,	2 ,,	$49\frac{2}{5}$	,,
12	,,	=	$184\frac{4}{5}$	,,	.....	,,	3 ,,	$4\frac{4}{5}$	,,
13	,,	=	$200\frac{1}{5}$	,,	.....	,,	3 ,,	$20\frac{1}{5}$	,,
14	,,	=	$215\frac{3}{5}$	,,	.....	,,	3 ,,	$35\frac{3}{5}$	,,
15	,,	=	231	,,	.....	,,	3 ,,	51	,,
16	,,	=	$246\frac{2}{5}$	,,	.....	or	4 ,,	$6\frac{2}{5}$	,,
17	,,	=	$261\frac{4}{5}$	,,	.....	,,	4 ,,	$21\frac{4}{5}$	,,
18	,,	=	$277\frac{1}{5}$	,,	.....	,,	4 ,,	$37\frac{1}{5}$	,,
19	,,	=	$292\frac{3}{5}$	,,	.....	,,	4 ,,	$52\frac{3}{5}$	,,
20	,,	=	308	,,	.....	,,	5 ,,	8	,,
30	,,	=	462	,,	.....	,,	7 ,,	42	,,
40	,,	=	616	,,	.....	,,	10 ,,	16	,,
50	,,	=	770	,,	.....	,,	12 ,,	50	,,
60	,,	=	924	,,	.....	,,	15 ,,	24	,,
70	,,	=	1078	,,	.....	,,	17 ,,	58	,,
80	,,	=	1232	,,	.....	,,	20 ,,	32	,,
90	,,	=	1386	,,	.....	,,	23 ,,	6	,,
100	,,	=	1540	,,	.....	,,	25 ,,	40	,,

CONVERSION OF MINIMS, DRACHMS, OUNCES, AND PINTS TO CUBIC CENTIMETRES AND LITRES.

	Minims to c.cm.	Drachms to c.cm.	Ounces to c.cm.	Pints to Litres.
1	0·05916	3·5495	28·396	0·56792
2	0·11832	7·0990	56·792	1·13584
3	0·17748	10·6485	85·188	1·70376
4	0·23664	14·1980	113·584	2·27168
5	0·29580	17·7475	141·980	2·83960
6	0·35496	21·2970	170·376	3·40752
7	0·41412	24·8465	198·772	3·97544
8	0·47328	28·3960	227·168	4·54336
9	0·53244	31·9455	255·564	5·11128

CONVERSION OF GRAINS AND OUNCES INTO GRAMMES.

	Grains to Grammes.	Ounces to Grammes.	Grains in the Ounce to Grammes in 100 c.cm.
1	0·06479	28·3495	0·22817
2	0·12958	56·9660	0·45635
3	0·19437	85·0485	0·68452
4	0·25916	113·3980	0·91269
5	0·32395	141·7475	1·14086
6	0·38874	170·0970	1·36904
7	0·45353	198·4465	1·59721
8	0·51832	226·7960	1·82538
9	0·58311	255·1455	2·05356

Troy weight (used for gold, silver, and platinum). The ounce of 480 grs. is divided into 20 pennyweights of 24 grs.

Avoirdupois Weight.

16 drachms ... ... = 1 ounce.
16 ounces ... ... = 1 pound.

1 lb. = 16 ozs. = 256 drms. = 7,000 grs. (This weight is used by all dealers for retailing chemicals, etc. 1 oz. = 437·5 grs.).

Liquid Measure.

60 minims ... ... = 1 drachm (f. ʒ).
8 drachms ... ... = 1 ounce (f. ʒ).
20 ounces ... ... = 1 pint (O).
8 pints ... ... = 1 gallon (C).

1 gal. (Cj) = 8 pts. (Oviij) = 160 ozs. (f. ℥, 160) = 1,280 drms. (f. ʒ, 1,280) = 76,800 minims.

The following is the Metric System of weights and measures in use in France and on the Continent generally, and in the United States, and in England amongst scientific chemists. The division in each case is by 10, so that it is extremely easy to calculate the division or multiples of any weight.

Lineal Measure.

1,000 millimetres	... ...	=	1 metre.
100 centimetres	... ...	=	1 ,,
10 decimetres	... ...	=	1 ,,
10 metres	... ...	=	1 decametre.
100 ,,	... ...	=	1 hectometre.
1,000 ,,	... ...	=	1 kilometre.

The metre is the unit, and is equal to 39·37 English inches.

Liquid Measure.

1,000 millilitres	... ...	=	1 litre.
100 centilitres	... ...	=	1 ,,
10 decilitres	... ...	=	1 ,,
10 litres	... ...	=	1 decalitre.
100 ,,	... ...	=	1 hectolitre
1,000 ,,	... ...	=	1 kilolitre.

The litre is the unit, and is equal to 35·216 fluid ozs. Liquid measures are usually expressed, however, as cubic centimetres, or c.cm.; = 16·8 minims.

Dry Measure.

1,000 milligrammes	...	=	1 gramme.
100 centigrammes	...	=	1 ,,
10 decigrammes	...	=	1 ,,
10 grammes	... ...	=	1 decagramme.
100 ,,	... ...	=	1 hectogramme.
1,000 ,,	... ...	=	1 kilogramme.

The gramme is the unit, and is equal to 15·432 grs.

For converting these weights into English, the following tables will be found sufficiently accurate for all purposes:—

Conversion of Grammes into Grains.

1 gramme	...	...	=	15·432 grains.
2 grammes	...	...	=	30·864 ,,
3 ,,	...	...	=	46·926 ,,
4 ,,	...	...	=	61·628 ,,
5 ,,	...	...	=	77·160 ,,
6 ,,	...	...	=	92·592 ,,
7 ,,	...	...	=	108·024 ,,
8 ,,	...	...	=	123·466 ,,
9 ,,	...	...	=	138·898 ,,

Conversion of Grains into Grammes.

1 grain	...	...	=	·0648 gramme.
2 grains	...	...	=	·1296 ,,
3 ,,	...	...	=	·1944 ,,
4 ,,	...	...	=	·2592 ,,
5 ,,	...	...	=	·3240 ,,
6 ,,	...	...	=	·3888 ,,
7 ,,	...	...	=	·4536 ,,
8 ,,	...	...	=	·5184 ,,
9 ,,	...	...	=	·5832 ,,

Supposing it is desired to convert 506·94 grammes into grains, the table is used as follows:—

500 grammes	...	...	=	7716·0 grains.
6 ,,	...	...	=	92·592 ,,
·90 gramme	...	...	=	13·889 ,,
·04 ,,	...	...	=	·617 ,,
				7823·098 ,,

The numbers taken from the tables simply require the altering of the position of the decimal point.

The following may be useful for obtaining an approximate weight:—

	Weight.
1 sovereign, new	123·274 grains.
1 shilling	87.273 ,,
48 pennies	1 lb. avoirdupois.

	Weight.
1 halfpenny and 1 threepenny-piece	¼ ounce.
1 florin and 1 sixpence	½ ,,
3 pennies	1 ,,
4 half-crowns and 1 shilling ...	2 ounces.
4 florins, 1 half-crown, 2 pennies	4 ,,

It has become somewhat general lately to give formulæ in parts, and this, though not strictly accurate, unless everything be taken by weight, as is common in chemical laboratories, gives a basis for a somewhat convenient method of approximately translating metric measures into English weights and measures by assuming a gramme and a cubic centimètre to be identical; which, however, is only true when the cubic centimètre is a measure of water or of a fluid having the same specific gravity.

Frequently we find a solution spoken of as "a 48-grain bath," "a 60-grain bath," etc.; and this means that each ounce of the solution contains 48 or 60 grains of the salt.

Ten per cent. solutions are, again, somewhat of a trouble to some, and the trouble arises from the fact that we are in the habit of measuring liquids, and that the avoirdupois ounce contains only 437·5 grains, whilst a fluid ounce contains 480 minims. To make a 10 per cent. solution of any salt we proceed as follows:—Let us take, for instance, an ounce of pyro., and it is required to make a 10 per cent. solution; that is to say, we require a solution, every 10 minims of which shall represent 1 grain of pyro.; then, having 437·5 grains of pyro., the total bulk of the solution will be $437{\cdot}5 \times 10 = 4375$ minims $= 9$ oz. 55 minims. Any other strength solution may be made in the same way, but such a solution is not a 10 per cent. solution in the strictest sense of the term.

Wet Collodion Process. Either negatives or positives can be produced; and the latter, when taken upon thin enamelled-iron plates, are known as ferrotypes or tintypes. The following is a short *résumé* of the process:—A well-cleaned glass plate is coated with iodised collodion, and as soon as the collodion has set, this coated plate is immersed in a bath made as follows:—

Nitrate of silver	240 grs.
Potassium iodide	1 gr.
Distilled water	8 ozs.

Dissolve the silver salt in 2 oz. of water, and the potash in ½ oz. Add the latter to the former, and add the remainder of the water. Filter, and test for acidity. If the blue litmus paper is not turned red after an immersion of some short period, a few drops of a dilute nitric acid (1 in 12) should be added till the bath is decidedly acid. The plate is exposed whilst still wet, the exposure being about ten times that for gelatine dry plates of ordinary rapidity under similar circumstances. For development any of the following may be used, but the author prefers Nos. 2, 3, and 4, the last being especially useful, as shorter exposure is required, and more detail is brought out. With No. 5 longer exposure is required, but extreme contrast is obtained :—

No. 1.

Ferrous sulphate	300 grs.
Glacial acetic acid	200 mins.
Methylated spirit	½ oz.
Distilled water	10 ozs.

No. 2.

Ferrous sulphate	200 grs.
Cupric	100 ,,
Glacial acetic acid	200 mins.
Methylated spirit	½ oz.
Distilled water	10 ozs.

No. 3.

A.

Ferrous sulphate	240 grs.
Cupric	30 ,,
Distilled water	5 oz.

B.

Nitrate of baryta	30 grs.
Glacial acetic acid	2 drms.
Methylated spirit	½ oz.
Distilled water	5 ozs.

Dissolve A and B separately, then mix and filter.

No. 4.

Ferrous sulphate	300 grs.
Glacial acetic acid	200 mins.
Formic acid (sp. gr. 1·060)...	100 ,,
Methylated spirit	240 ,,
Distilled water	10 ozs.

No. 5.

Ferrous sulphate	200 grs.
Glacial acetic acid	180 mins
Lump sugar	100 grs.
Methylated spirit	240 mins.
Distilled water	10 ozs.

No. 6.

Ammonio-sulphate of iron	250 grs.
Glacial acetic acid	250 mins.
Methylated spirit	240 ,,
Distilled water	10 ozs.

To develop the exposed plate, it should be fixed upon a pneumatic holder and a little of the developer poured evenly on to the surface, and gently rocked backwards and forwards till the image is sufficiently developed, when it may be poured off. The image nearly always requires intensification for negative work, and the following may be used :—

Ferrous sulphate	5 grs.
Citric acid	10 ,,
Distilled water	1 oz.

Add immediately before using a few drops of

Silver nitrate	10 grs.
Distilled water	1 oz.

Pour on to the unfixed negative, and rock backwards and forwards till dense enough. Then fix in

Potassium cyanide	120 grs.
Distilled water	10 ozs.

Wash thoroughly, dry, and varnish. Those desiring complete

instruction in the wet collodion process should obtain Mr. Chas W. Gamble's "Wet Collodion Photography," published at the office of *The Amateur Photographer*.

Wide-Angle Lens. See LENS.

Wood, Photographing upon. This is mainly of interest from the point of view of furnishing a guide to the wood engraver and to replace the old custom of sketching the subject on the whitened block of boxwood. As the kind of drawing which the wood engraver generally prefers is one in tint and wash rather than line, the photograph forms the most satisfactory kind of guide; but any method in which a film is put upon the block, or in which liquids are freely used is unsatisfactory, as a film interferes with the freedom of the engraver in working, and liquids swell the wood and make the surface rough. An old method, suggested in 1858 by Mr. William Crookes, is to rub a little of the white precipitated oxalate of silver upon the wood block. Supposing that the block is four inches square, as much oxalate of silver as will lie on a threepenny-piece will suffice. This having been sprinkled on the surface of the wood it is well rubbed on with a small tuft of rag, a few drops of very thin gum-water being used. The amount of moisture thus communicated to the block need not be more than in the usual process of facing with white pigment; indeed, the operation is practically the same. Before exposure, the sensitiveness of the oxalate surface may be increased by fuming with ammonia (see FUMING). The progress of the printing, which should be under a reversed negative (see REVERSED NEGATIVES), cannot be watched in the usual way, but if negative and block are carefully adjusted into one corner of a deep printing-frame, it becomes practicable to remove the block from time to time and to replace it in exact register. Another method is to sensitise a strip of stout paper in the same way and at the same time as the boxwood block is sensitised, and to expose this as a guide strip under a negative of similar density to that used for the print on the block. If the engraver is to work by lamplight and immediately, no fixing will be required; but in other cases a partial fixing—or, rather, a partial desensitising—may be effected by moistening a few sheets of blotting-paper with a saturated solution of ammonium chloride, or sal ammoniac, and laying this on the surface of the block, contact being

established by a plate of glass and a weight. Ten minutes is generally sufficient, and the moisture communicated to the block need not be so much as in making the usual drawing in washes of Indian ink. The oxalate of silver used should be precipitated in contact with excess of silver nitrate; or, better still, it should, after precipitation, be infused as a solution of silver nitrate, containing about 28 grs. to the ounce.

Woodburytype. This is a very beautiful photo-mechanical process, and consists of exposing a thick film of bichromated gelatine to light under a negative; and when fully exposed it is washed to dissolve the unacted-upon soluble portions, and after being soaked in alum is dried. When dry, the gelatine print, which at this period looks like a delicate piece of silk with the image in relief, is placed on to a bed of metal, and a pressure of from four hundred to five hundred tons brought to bear on it. This forces the gelatine into the metal, and makes an impression the same as a seal on hot sealing wax, the film of gelatine itself being unharmed and used over and over again. The metal sheet bearing an impression now becomes a mould, and this is placed in a press, and some special liquid gelatine ink is poured on to it, and a sheet of non-absorbent paper placed over. The press is now closed, and pressure being applied, it is obvious that the ink will leave the high-lights and collect in the shadows. When the gelatine ink has set, the paper is removed, bearing the image, and is fixed in alum and dried.

Stannotype. This is also an invention of Mr. Woodbury, and in this process an image in intaglio is produced by exposure of a bichromated gelatine film under a positive, and this is coated with tinfoil, and used for printing from in almost the same manner as in Woodburytype.

Wood Spirit, or Wood Naphtha. This is a crude form of methylic alcohol (see ALCOHOL, METHYLIC), and is used in the preparation of methylated spirit. The crude wood spirit is sometimes used instead of alcohol as a solvent in varnish making, and it usually contains about 10 per cent. of acetone.

Wothlytype. An old method of making prints on collodionised paper, the nitrate of silver and nitrate of uranium being combined in the collodion. A plain photographic paper, such as Rives

paper, is sized with arrowroot and then coated with a sensitised collodion prepared as follows:—

Plain collodion	4 ozs.
Castor oil	4 drops.
Canada balsam	2 „
Ammonio-nitrate of uranium	160 grs.
Silver nitrate	6 „

After exposure in the printing-frame, an ordinary alkaline toning bath should be used, after which the print is fixed in a hypo-sulphite bath and washed.

Yellow Fog. See FOG.

Yellowness of Prints. See TONING.

Yellow Stain. See CLEARING BATH.

Zinc (Ger., *Zink;* Fr., *Zinc;* Ital., *Zinco*). Zn = 65. Exists as calamine or carbonate, as sulphide in zincblende, as oxide, and occasionally in a pure state. It is used in several photo-mechanical processes, and its salts, the bromide, iodide, and chloride, which are formed in somewhat similar manner to the cadmium salts, are not much used. Zinc hypochlorite has lately been recommended for making hypo eliminator.

Zincography. A photo-mechanical printing process, in which the image is impressed upon a zinc plate by means of a greasy ink, and an etching fluid being applied which eats away the groundwork, leaving the image in relief, so that it can be printed from like ordinary type.

Zoetrope (ζάω, or ζώω, I am active, or live, and τρόπος, a style or fashion). The application of photography to the Zoetrope —or wheel of life—is no new thing, as over twenty years ago Mr. Baden Pritchard made a series of photographs of a steam-engine, moving it forward a little between the taking of each picture; and when the series was viewed in the zoetrope, there was produced a most realistic appearance of the steam-engine in motion. We must, however, go back much farther than this for the first idea of the lantern or projection zoetrope,

something of the kind having been patented by Jundzill in 1856; but we believe the first exhibition of animated photographs on the screen in London was in 1882, when Muybridge exhibited the horse in motion at the Royal Institution. About the beginning of 1896 exhibitions of animated photographs on the screen became suddenly popular, and almost every maker of apparatus for this purpose gave a new and strange name to his particular form of the lantern or projection zoetrope. In the modern forms the series of negatives is taken on a long band of celluloid at the rate of about 900 per minute. A band of positives is printed from this by rolling the negative band and a band of coated celluloid together so that they shall run in contact in front of a source of light; and the exhibition is effected by means of a lantern, which automatically unrolls the positive band, and projects each photograph in succession upon the screen.

Zöllner's Printing Process. A method for reproducing drawings, plans, etc., and depending on the formation of the blue —or, in some cases, virtually black—iodide of starch. If a paper strongly sized with starch in the ordinary process of its manufacture is used, no special preparation with starch will be required. Such a paper will be known by its immediately taking an almost black tint when immersed in a weak solution of iodine in iodide of potassium. If special preparation with starch is required, a paste consisting of 1 oz. of starch (white Glenfield starch is very suitable) in 10 ozs. of water is brushed evenly over one surface of the paper with a soft brush, after which the sensitising solution is prepared as follows:—

Ferric chloride	1 part.
Water	2 parts.

Add to

Saturated solution of potassium oxalate...	8 parts.
Water	11 ,,

The paper, having been floated on this for 30 to 60 secs., is dried in the dark and exposed under a writing or tracing, the exposure being about the same as for a print on albumenised paper. After exposure scarcely any image is visible, but it appears

rapidly when the paper is brushed over with the following preparation :—

Albumen from two eggs, well beaten.	
Water	1½ oz.
Iodide of potassium	80 grs.

As soon as the image is developed, the print is rinsed in water for a few seconds and allowed to dry. It is important to develop as soon as possible after exposure, as the iron reduced to the ferrous state by the action of light may become reoxidised.

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