THE BOOK OF PHOTOGRAPHY

PRACTICAL, THEORETIC AND APPLIED

EDITED BY

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WITH 935 ILLUSTRATIONS
FORTY-EIGHT FULL-PAGE PLATES AND NUMEROUS ENGRAVINGS AND WORKING DRAWINGS

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PLATES AND FILMS.

How Dry Plates and Films Differ.

The photographic plate, as manufactured nowadays, consists of a sheet of glass coated with either gelatine or collodion containing sensitive salts of silver. The processes of manufacture may be divided into two sections, the emulsion processes and the bath processes. The bath processes are generally known as "Wet Plate," and will be described later. They are now scarcely ever used except for photo-mechanical work, for which they are preferred owing to the great contrast obtainable, and by itinerant photographers. Nearly all plates made nowadays are coated with emulsion, and are commonly known as dry plates. Films are sheets of celluloid, mica, or even gelatine, coated with an exactly similar emulsion to that used in the glass dry plate. The difference, therefore, between plates and films lies in the support only; the actual image-forming substance being the same. For either, therefore, the first requirement is to make the emulsion.

How the Emulsion is Made.

Emulsions may be prepared with either of the silver halogens—bromide, iodide, or chloride. The iodide is seldom used except as an addition to the bromide, and the chloride is merely employed for the making of slow emulsions, such as may be used for lantern slides or printing purposes; for example, the ordinary gelatino-chloride paper or P.O.P., but as this is referred to in another chapter nothing further need be said of it. The gelatino-bromide emulsion, then, may be taken, either with or without iodide, as a type of the proceeding to be followed. For the better understanding of the subject, and to avoid confusion of the operation, it should at once be stated that emulsion making may be divided into the following operations, which are usually conducted in the order given, although that order is not arbitrary.

Compounding the Formula.

Simplicity will be the great recommendation for any formula, and that may at least be claimed for the one about to be given, as it contains nothing except what is absolutely essential to the production of the sensitive emulsion. It is as follows: (*a*) gelatine 30 grains, water 1 oz.; (*b*) silver nitrate 175 grs., water ½ oz.; (*c*) potassium bromide 140 grains, water 1 oz.; (*d*) gelatine 240 grs., water 2oz. It will be noted that each of the ingredients is to be dissolved separately. An alternative formula, which gives a more rapid emulsion, is as follows: (*a*) Nelson's gelatine No. 1 soluble, 30 grs., water 1 oz.; (*b*) silver nitrate 175 grs., water ½ oz.; (*c*) potassium bromide 130 grs., water 1 oz.; (*d*) potassium iodide 5 grs., water 1 oz.; (*e*) hard gelatine 240 grs., water 2 oz.

How Sensitiveness is Governed.

The first question likely to be asked by the novice is what governs the sensitiveness of the emulsion, and this may be broadly stated to be the ripening or boiling to which it is subjected. (There are, however, other methods of emulsion making which do not necessitate boiling; which will be dealt with later, but the principle is the same.) In order that this

boiling may bring about the required condition of the silver it is necessary that potassium bromide (KBr) should be in excess, and an examination of the formula should be made in order to ascertain whether that condition has been carried out. The equation given by chemists as taking place in the formation of silver bromide from potassium bromide and silver nitrate is stated thus:—

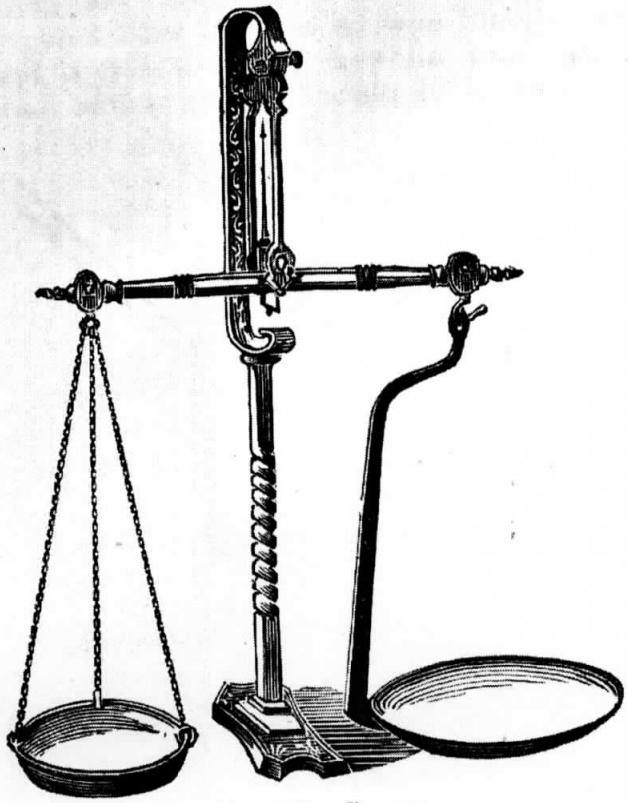

Fig. 128.—SCALES.

$$AgNO_3 + KBr = AgBr + KNO_3$$
$$\left(\frac{108+14+48}{170}\right)\left(\frac{39+80}{119}\right)\left(\frac{108+80}{188}\right)\left(\frac{39+14+48}{101}\right)$$

From this it will be seen that 117 parts of silver nitrate react with 119 parts of potassium bromide. Therefore, the 175 parts given in the first named formula will react with 122½ parts of potassium bromide, thus leaving 17½ grains in excess of that actually required. Now it has been found that the length of boiling is dependent upon the amount of potassium bromide present; that is to say, the less potassium bromide in excess, the longer the emulsion may be boiled. For example, with only 1 grain in excess, the emulsion may be boiled for six hours; with 20 grains in excess, it may be boiled for twenty minutes; or with 160 grains in excess, for seven minutes. If these times are exceeded, the emulsion commences to show signs of fogging, any trace of which would, of course, be exceedingly injurious. The increase of sensitiveness is said to be due to the enlargement of the particles, which may be explained by the theory of crystallisation. Just as a crystal of alum will grow in a saturated solution of the same substance, so the potassium bromide as a solvent of the haloids will cause growth of the particle. The particles, being

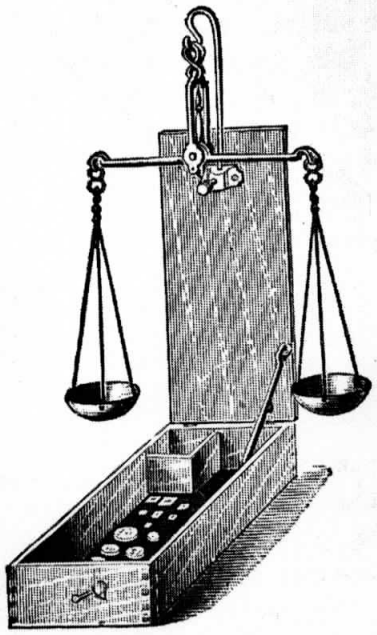

Fig. 129.—SCALES.

larger, are able to absorb more light; and, consequently, more work may be done, and a greater amount of silver reduced, in the same time, or by the expenditure of the same energy; therefore, the plate becomes more rapid. As this is a point that will be dealt with in a later section of the book, nothing further need be said on the subject, except that attention may be called to the fact that a similar explanation may be given as to why the proportion of emulsion on the plate affects the sensitiveness.

WEIGHING.

This must be done with extreme accuracy. The rough sort of weighing practised by many photographers is only likely to

lead to disaster. A chemical balance, the pattern shown in either Fig. 128 or Fig. 129 being quite suitable for this purpose, should be employed in preference to those in general use. It need not, however, possess the extreme delicacy of adjustment of the best of such instruments. Place filter paper on the pan of each scale. Having weighed out the substances, place each aside on a separate

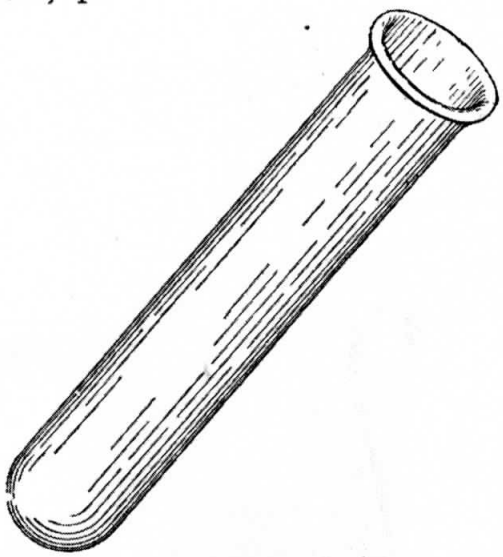

Fig. 130.—Boiling Tube.

paper; be careful not to get them mixed, although there should be no fear of doing so, except perhaps in the case of the gelatine, as the silver nitrate and potassium bromide are easily distinguishable crystals, the former occurring in flakes and the latter in cubes. In using a balance of the above kind, the substance should be placed upon the scales and then the arm gently raised. If the pointer indicates too much or too little, the arm should be lowered before the alteration is made. The 240 grains need not be weighed up at the present time. The other gelatine should be of a soft variety, Nelson's No. 1 being very suitable. Silver nitrate should be recrystallised and absolutely pure, while the same remark applies to the potassium bromide; needless to say, distilled water should be used throughout the operation.

Dissolving.

Pour a little water on the gelatine, contained in a beaker or a jam jar, rinse round rapidly and drain off; this will get rid of any dust, otherwise liable to adhere to it. The silver nitrate is then added to ½ oz. of water in a boiling tube, and the solution warmed until dissolved. The boiling tube is a test tube of rather large bore used for boiling solutions, as shown in Fig. 128. A strip of blotting paper, folded in four, is wrapped round it to form a handle. The potassium bromide will readily dissolve in cold water. The gelatine should now be covered with 1 oz. of water and allowed to swell for a few minutes, then placed on the water bath

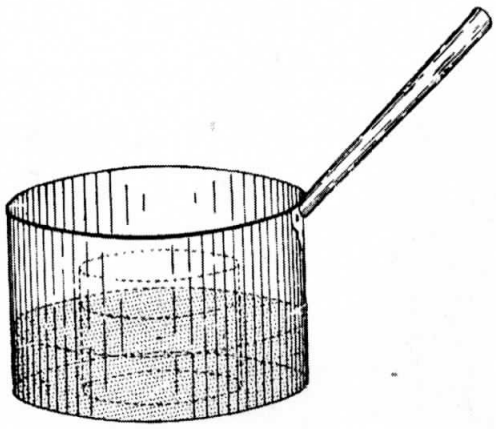

Fig. 131.—Emulsion Pot in Saucepan.

until dissolved. Roughly speaking, a water bath much resembles a glue pot.

Mixing.

A suitable vessel must be obtained for mixing. It is, perhaps, more convenient that this should be opaque, or of a ruby or orange colour. Further, it must have a wide mouth, to allow of stirring, and easy addition of other solutions. It must be glazed and free from cracks, preferably possessing a lid which can be made to fit down quite light-tight. Ointment pots, capable of holding 10 or 12 oz., certainly seem very suitable. There is a form, similar to that shown in the illustration, which has been found very convenient. Having chosen a suitable vessel, it must be stood in a saucepan or anything capable of holding hot water (see Fig. 131). For experimental purposes, an ordinary enamelled mug, now obtainable at most hardware shops, may

be used. The advantage over a saucepan is that there is no handle liable to be knocked against in the dark. When the gelatine is completely dissolved, which may be aided by stirring it all the time with a glass rod, pour in the silver nitrate, and beat up thoroughly together, to ensure its being completely mixed. All the operations up to this point may be conducted in ordinary white light; but the following, in which the emulsion is

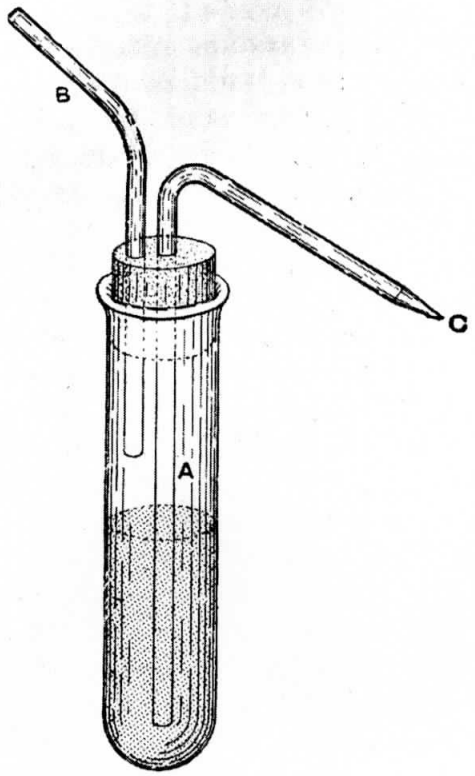

Fig. 132.—Sprayer.

formed, must be carried out in a red light, of which the less the emulsion is exposed to the better.

Spraying.

The apparatus required for this purpose consists of a boiling tube, fitted with two bent glass tubes, as shown in Fig. 132. The tube (A) passes through a tightly fitting cork to the centre of the boiling tube at the bottom, and is drawn off to a fine point at C. This is done by holding the glass tube in a gas jet (an ordinary gas flame is better than a Bunsen for this purpose) until red hot, when the tube may be pulled in two, which brings it to a fine point, as shown in Fig. 133. When cold the extreme end is snipped off, and leaves a tiny hole through which the solution can pass. The tube, B, remains above the solution, and by blowing through it the solution is forced up through the tube, A, and emitted in a fine spray. Fill the sprayer with the solution of potassium bromide, and insert the cork and tubes, so that the tube, A, is almost, but not quite, on the bottom; this will ensure all the solution being driven out. Hold the sprayer in the left hand, apply the lips to the tube, B, and blow through same, all the time stirring the gelatine solution vigorously with a glass rod. For stirring the emulsion, a glass spatula, or a flat strip of glass tied with white thread to a glass rod, will be found exceedingly useful. Do not get the spray too near, or

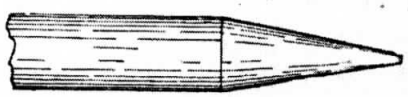

Fig. 133.—Glass Tube, Showing Point.

it will not be sufficiently spread. Immediately the operation is commenced, a white compound will be seen to form in the gelatine, and the tendency it shows to cling together will be ample proof of the necessity for keeping the solution violently agitated. After adding a little of the solution in this manner, if the vessel is provided with an air-tight top, it may be put on. Holding the jar in a cloth, the whole should then be shaken violently. Continue adding the solution in this way, with intervals of shaking, until both are mixed. Too much emphasis cannot be laid upon the necessity of thoroughly mixing, as upon it depends the fineness of grain and indirectly the sensitiveness of the emulsion; for a badly mixed emulsion, consisting of coarse particles, will admit of little boiling and consequently be less sensitive. In the opinion of some, this is best effected by adding the solution little by little, as just described; but, on the other hand, a worker of considerable experience has stated that the best plan is to add

the whole of the solution straight away, and to rely entirely upon violent agitation of the mixture.

Boiling and Testing.

Whichever is done, the emulsion is again placed on the water bath and the latter raised to boiling point. Two or three times during the boiling of the emulsion, the jar containing it should be lifted out covered up, and shaken violently. Before commencing boiling, the glass rod used for mixing should be smeared across a sheet of plain glass, and then viewed by daylight. If the emulsion has been properly mixed, it should have an orange red tint by transmitted light. At intervals during the boiling of the emulsion, further smears should be made side by side on the same glass, and again examined in daylight or white light. It will be found that the tint of each of these differs, and directly the emulsion shows signs of a blue tinge by transmitted light, boiling should be at once stopped, or chemical fog will set in. About twenty minutes boiling will be a safe time, with the formula given above. The 240 grains of gelatine, which should be of a hard variety, that is, having a high melting point, may now be dissolved in the quantity of water stated, and added to the emulsion before washing. But, on the whole, it is perhaps preferable to complete the washing before doing so. If the samples of emulsion taken as tests during the boiling are placed under a high power microscope, they will prove exceedingly interesting, for the gradual enlargement of the grains will be apparent by comparing them. The sensitiveness of the emulsion may be increased still further by digesting for from twelve to eighteen hours after boiling and before freeing from the potassium nitrate.

Shredding and Washing.

Now this potassium nitrate, if allowed to remain, would practically destroy the sensitiveness of the emulsion, and must therefore be removed. Fortunately, it is very soluble, and may be easily washed out. An hour's washing in distilled water is ample to remove every trace, and even less than this may be considered safe. Of methods of washing, there is practically a choice of two. In the first the emulsion is broken up into a convenient form for dealing with, either scraping with a silver fork or squeezing through canvas or coarse netting. The shreds should measure about $\frac{1}{8}$ in., and they are then well soaked for several hours according to the practice of some workers. In the other method, the plates are coated while still containing the potassium nitrate, and are then washed in a tank, in the same manner as a negative may be dealt with. In any case, the emulsion should not be used at once, but should be set aside for a day or two; as a further ripening goes on, resulting in an increase of speed. It is a good plan, when adding the bulk of the gelatine of the emulsion, to include 1 grain of Thymol dissolved in one dram of alcohol. This is used as a preservative. The question might be asked, why the bulk of the gelatine has not been added in the first instance. In reply it may be stated that gelatine loses its power of setting when kept for a length of time at a high temperature, so that the less heating it has the better. Especially will this be the case, if the emulsion is to be used a little at a time, and consequently to be warmed up repeatedly. Sufficient only of the gelatine should be added, therefore, to form the emulsion.

Cooling or Precipitating.

When the boiling has proceeded sufficiently far, the vessel containing the emulsion is set aside in a dark cupboard to solidify and ripen (by ripening is meant the increase of speed which results from keeping); or it may be precipitated immediately by the use of alcohol. The best plan perhaps is to pour out the emulsion into a flat dish. The dish should be one scrupulously clean, and preferably one which has not been used for any other purpose. A flat porcelain or glass dish, similar to those used in developing, will answer well. A form often employed is

shown in Fig. 134; even a pie dish may be used, but it is open to the objection that the enamel is usually not good, and frequently cracked. In any case, enamelled iron dishes should not be used. The advantage in using a dish, over a beaker or jar, is that it presents a much larger surface to the air, and consequently sets more rapidly. At the same time, it must be remembered that the emulsion should be placed in a cool place where there is a free passage of air, otherwise it will not set for a considerable time. Do not shut it up in a box, or in a close cupboard. After about two hours the emulsion will have set, the actual time varying with the temperature and the dryness of the air, as

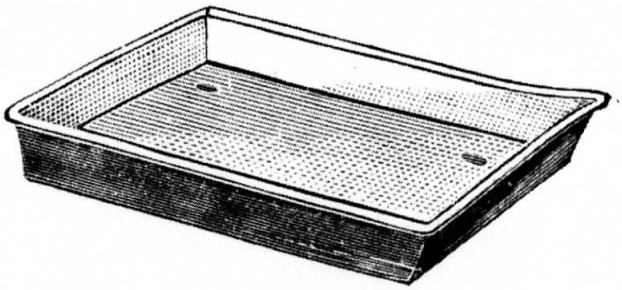

Fig. 134.—Flat Dish for Ripening Emulsion.

will no doubt have been gathered from the foregoing remarks. In commercial practice it is usual to cool the emulsion with ice water, as the effect is better. The principle is explained in a later section. The precipitation of the emulsion by means of methylated spirits or alcohol is a method introduced by a well-known firm of plate makers, but is very little practised at the present day. For this purpose, ordinary methylated spirit may be used (preferably of low specific gravity), not containing gum. Some workers recommend an equal quantity of alcohol or spirit, whilst others prefer to use double the quantity. Of the two methods, the latter is perhaps the safer, as the great desideratum is to completely remove the soluble nitrates. Take, then, twice as much alcohol as of water used in the making of the emulsion. In the present case, 5 oz. should be used. The bottle, or other closed vessel, containing the emulsion, is then violently shaken, so as to completely impregnate the solution with the spirit. As this proceeds, the spirit having a strong affinity for water will extract it from the gelatinous matter, with the result that it subsides to the bottom of the vessel (on allowing the solution to stand), in the form of a thick pasty mud. In removing the water the soluble nitrates are removed also which remain dissolved in it. When working on a large scale, the spirit may be saved, so as to be re-distilled for use again. It has been said, however, that this method, although offering as it does many advantages in the way of simplicity, is not so applicable to the preparation of rapid emulsions on a small scale. The soluble nitrates do not appear to be so effectively removed as may be done by washing. Supposing, therefore, that washing the emulsion is the method adopted; after allowing it to set in the dish as already described, it is redissolved and cooled down to a temperature of about 70° to 80° F. This may be done by allowing a stream of cold water to run down one side of the vessel containing it. The 240 grs. of gelatine are now rapidly rinsed in a few changes of distilled water to free it from dust or any adherent matter, and then covered with 2 oz. of distilled water and placed in a water bath, the temperature of which should only be sufficient to dissolve it properly. Something about 100° F., probably. Do not be in too great a hurry for the gelatine to dissolve. The less heat used in dissolving this the better, as it is liable to lose its power of setting properly. When thoroughly dissolved it is added to the emulsion and shaken violently. It is now ready for filtering.

Filtering and Filters.

For this operation a water jacket will be necessary. Such an arrangement is shown in use in Fig. 135. It consists of a copper vessel, of funnel shape, supported on three legs, out of the side of which comes a tube by means of which the water may be kept warm. The temperature of the water may be taken through the hole shown at the top near the edge of the rim. For the experi-

menter of slender means, a satisfactory home-made arrangement is shown in Fig. 136. A fairly stout can, such as is used for packing canned meat in, is taken, and a hole about the size of a halfpenny punched in the bottom. In this is tightly fixed a good cork, through the centre of which has been pierced a hole of sufficient size to tightly fit the tube of the funnel. A second hole, sufficient to accommodate another similar cork, may be punched; and through this, after boring the hole to a proper size, is put a small glass tube with tap, such as is used in a burette. This, however, is not absolutely necessary. The arrangement will answer very well without it, but if one is at hand by all means use it, for it is a convenience. If desired, a rim of tin may be placed over the top to cover in the hot water. The water jacket is now ready. If a Bunsen or a small lamp flame is available to place beneath the jacket, all that is necessary is to fit the funnel through the opening in the cork, and through the cap or sheet of metal, filling it nearly with cold water through the opening at the top by means of a second funnel. When the water is sufficiently warm, the filtering medium and the emulsion may be poured in. Another plan is to pour hot water into the jacket, and proceed at once with the filtering. If this is done, the tap fitted to it will be found an advantage, since the water as it cools may be run off and a fresh supply poured in without upsetting the filtering arrangements.

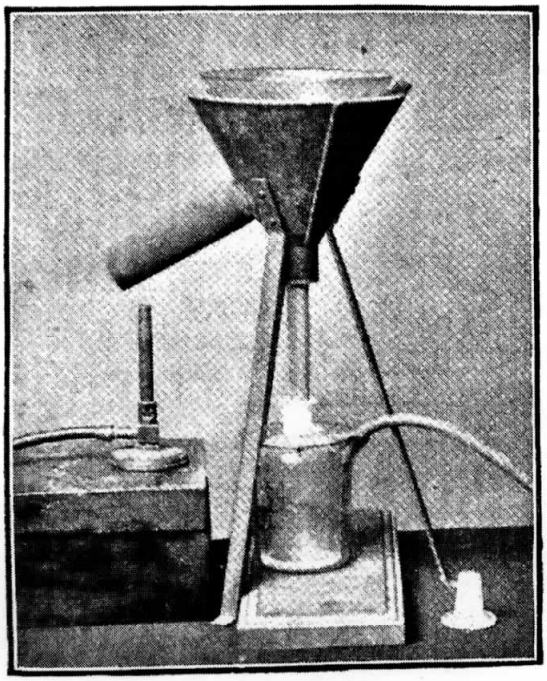

Fig. 135.—Water Jacket.

Apparatus for Keeping Temperature Constant.

Another method of keeping constant the temperature of solutions is by means of the apparatus shown in Fig. 137. This consists of a glass funnel around which is coiled india-rubber tubing, fastened by means of thin wire, so that one end may be attached to the hot water supply, while the other, allowed to remain free, runs off into the sink. An efficient and permanent heating arrangement may be made by coiling compo pipe around a tin plate funnel and using an inner glass funnel for filtering. Steam or hot water is passed through the coil of pipe. The apparatus might be made with glass tubing, if preferred, by anyone accustomed to bending this. A block of the same shape would be necessary, around which the tubing could be allowed to fall as it

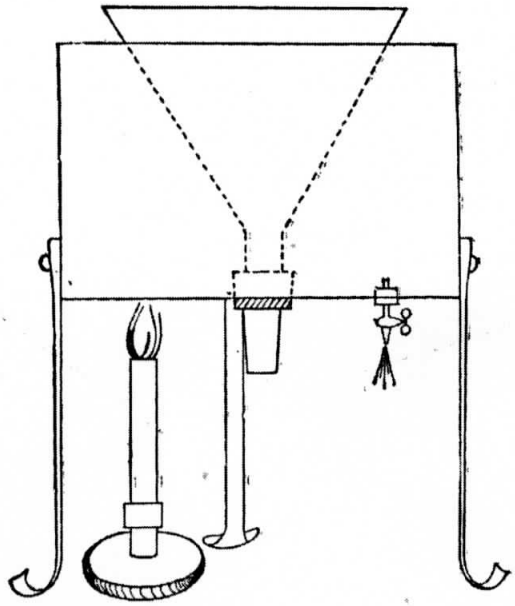

Fig. 136.—Home-made Water Jacket.

warmed. There are several operations in photography where this method might be useful. The next consideration is the filtering medium; some workers recommending one, and some another. For this purpose, washed wool and chamois leather are equally good. It is essential that filtration should be thorough, and although the emulsion may be made to run more quickly through wool, it is possible the operation may have to be repeated, so that there is no advantage in the end. A good practice is to use swansdown calico, washed in soda water, rinsed, and dried. Various methods have been suggested for forcing the emulsion more rapidly through the filtering medium, by means of some pneumatic arrangement or by sucking it through by means of a filter pump (see Fig. 138), but filtering is a tedious process. At Fig. 135 it will be noted that the emulsion filters into a yellow glass bottle, which is standing in a beaker of hot water. When the tubing arrangement is used, or the small tap as shown in Fig. 136, this is supplied easily from the vessel above. Filtering completed, the emulsion may at once be placed on the plates, regardless of the fact that it still contains the soluble nitrate, and is in an unwashed condition.

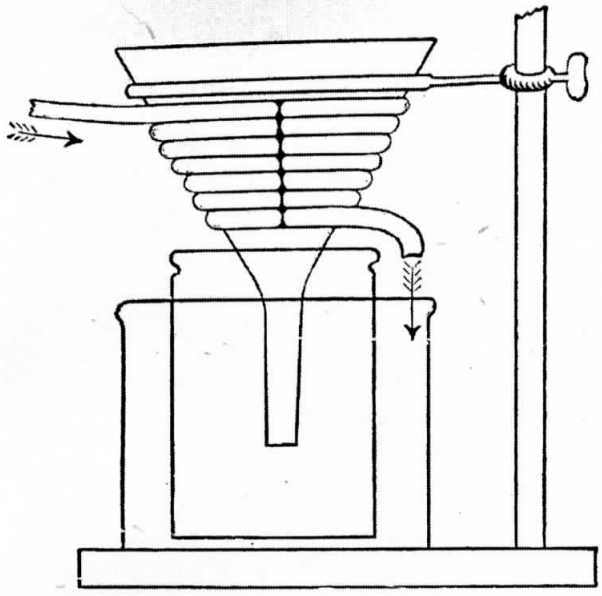

Fig. 137.—Rubber Arrangement for Hot Filtration.

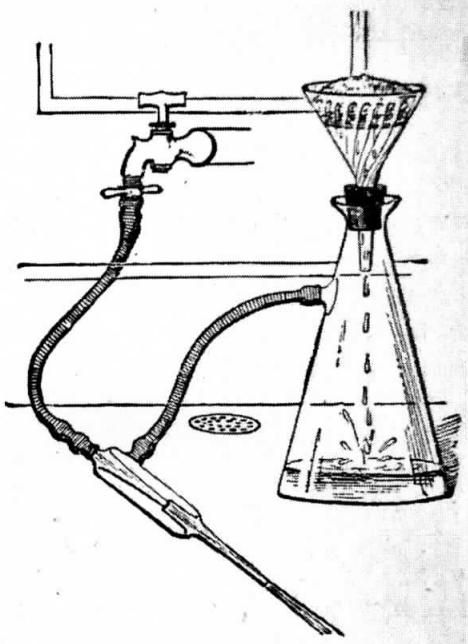

Fig. 138.—Filter Pump.

Cleaning the Plates.

Whilst the emulsion has been filtering, the plates are cleaned and prepared ready for coating. For this purpose, it is possible to use old negative glasses; that is, those from which the film has been removed; but it is far better to procure some sheets of new glass, as besides the fact that the waste of time in cleaning the plates almost or quite equals the cost of new stuff, there is always the danger of chemicals still remaining on the glass, despite the fact that it may have been most scrupulously cleaned. There may also be scratches on the old plates. These would give rise to unaccountable spots and even more curious appearances on photographic plates. One photographer, who had exposed a plate on an open landscape in Switzerland, was alarmed to find, on development, a superimposed image of a lady in evening dress, whose costume and features were entirely unknown to him. The explanation was, no doubt, quite simple. The plates were coated upon old negative glasses, and still preserved some reducing power from their former image. This is, of course, a thing which is hardly likely to occur in any large factory. In choosing glass for coat-

ing great care must be taken, first, that it is of correct thickness; secondly, that this thickness is uniform; and thirdly, that it is entirely free from striæ, bubbles, etc., as these usually come on some important part of the negative, and seriously affect the definition. The size of the plates is not important, so long as they

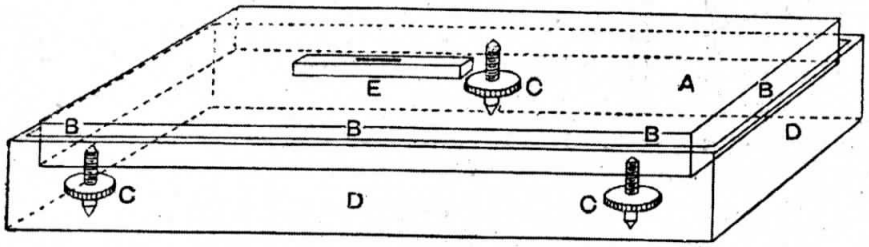

Fig. 139.—Levelling Slab for Coating Plates.

are not too large to handle conveniently. They may be cut up to suitable sizes afterwards. The size most useful may be multiplied by a number leaving a slight margin to trim off, as the emulsion is sometimes not coated nicely at the edges. Odd sizes are inconvenient, as the amount of emulsion poured on the plate is in direct proportion to its area.

Preparations for Coating.

In coating the plate, the first requirement is a levelling slab. The best form consists of a glass slab of patent plate A (Fig. 139), resting on a frame B, supported by three levelling screws C. This can be adjusted to a nicety, and may if desired be home-made. The details will be gathered from an examination of Fig. 139. This may with advantage be allowed to stand in a wooden dish D of sufficient size to allow of the screw C being easily manipulated, according to the indications of the spirit level E. All that is necessary is to place the glass on the screws with a spirit level in the centre, and adjust one or other of the screws until quite level. To clean the glass, first wash it in a weak solution of caustic soda, rinse, and immerse in a weak solution, say 1 per cent., of nitric acid, again washing thoroughly. The final washing is best done in hot water, the plates being then stood in a rack to dry spontaneously. The plates should not be rubbed dry, as friction seems to prevent the proper adhesion of the emulsion. When dry, the next operation is to edge them with india-rubber solution to prevent

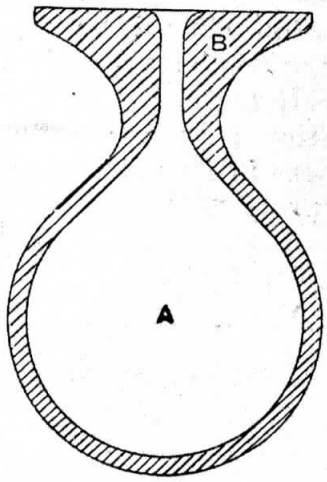

Fig. 140.—Pneumatic Holder.

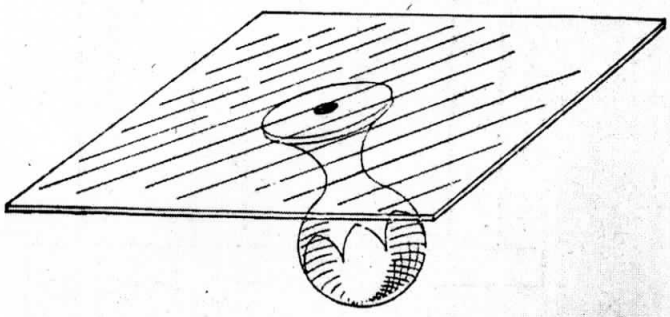

Fig. 141.—Pneumatic Holder and Glass Plate.

frilling. Frilling is probably one of the most serious troubles the experimental plate maker will have to contend with. It consists of an irregular expansion of the gelatine around the edges of the plate, causing it to pucker up and leave the glass. Once started, unless immediate pains are taken to harden the film and arrest its progress, the latter is liable to completely leave its support and float off into the solution. The most likely time for such frilling to occur is in the hypo. bath, particularly if the weather is very hot or very cold, or the solutions of uneven temperature. In bad cases of frilling it will even start in the developer. To ensure a proper adhesion of the film to the glass is, therefore, most important.

Coating the Plates.

Plate coating in factories is done by machinery, but in experimental work hand coating will answer quite well. It is possible to coat 60 plates in an hour by hand, and, in fact, until about fifteen years ago, the majority of the work was done in this way. A pneumatic holder, similar to that shown in Fig. 140, will be useful. This consists of a collapsible rubber bulb A with a flat top B. The bulb is pressed, the plate laid on the top, and the bulb released, when it holds firm by suction (see Fig. 141). In use, the holder should be placed in warm water until ready, as otherwise the chill is liable to cause a slight unevenness in the coating. A pool of emulsion, about equal to one-third the area of the plate, which should be warmed, is then poured in the centre of the plate, and by tilting it very gently the emulsion is caused to flow first to the top right hand corner, next to the top left hand corner, then to the bottom left hand corner—taking extreme care to do this slowly, as otherwise the emulsion will run over on to the arm—then finally to the bottom right-hand corner, pouring the excess into the coating pot. Figs. 142 to 145 will make this clear. If a certain quantity of emulsion be taken in a warm measure, and poured from it, the amount used being noted, it will be found that about 80 minims are required to each half-plate or its equivalent. Coating pots resembling a teapot were at one time obtainable, consisting of an inner and outer vessel, the latter being filled with warm water and the former with emulsion. The latter may be poured from such a contrivance without fear of bubbles forming. The plate can now be put in the washing-tank, which should be filled preferably with distilled water, and allowed to remain for half an hour, giving one or two changes during that time. It may then be removed,

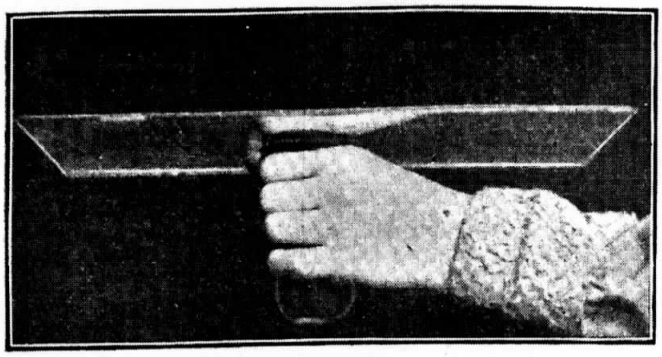

Fig. 142.—Coating Plate, First Position.

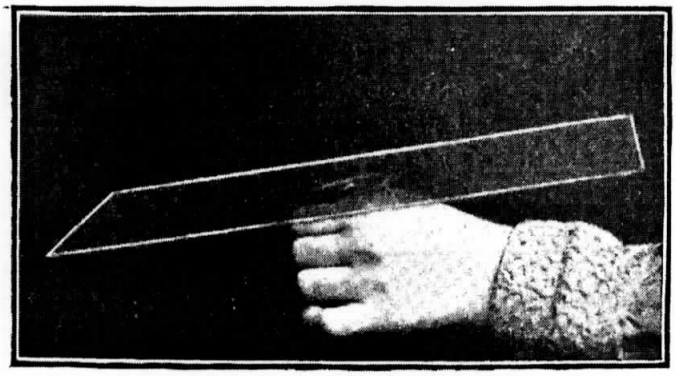

Fig. 143.—Coating Plate, Second Position.

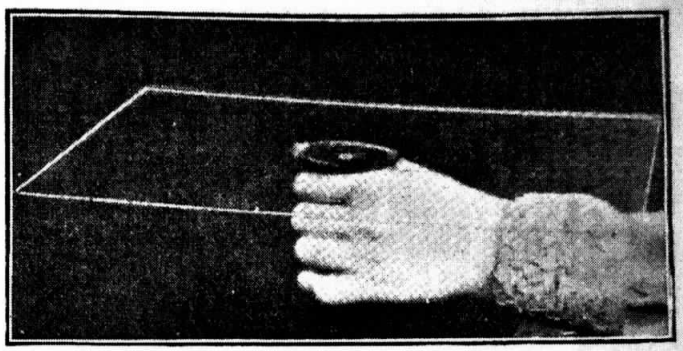

Fig. 144.—Coating Plate, Third Position.

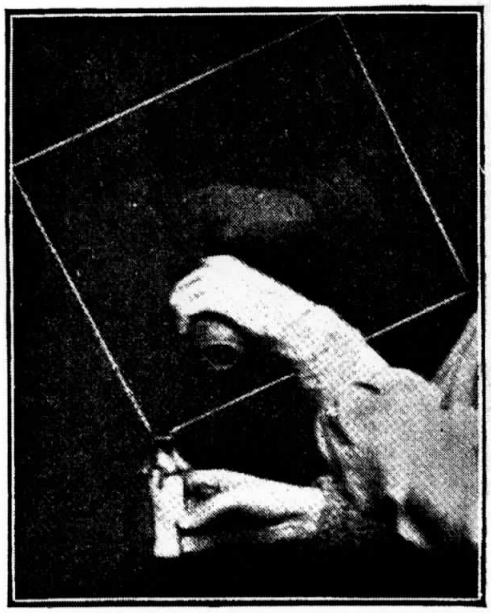

Fig. 145.—Pouring Off the Surplus Emulsion.

and if the operator is possessed of a drying cupboard it should be placed in it until thoroughly dry.

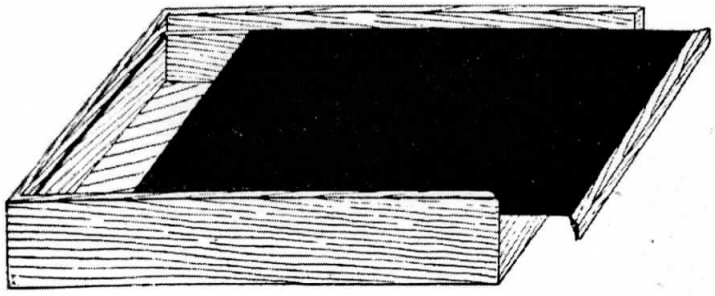

Fig. 146.—Dish with Sliding Board.

Rapid Drying with Spirit.

When working experimentally, the plate may be dried by the aid of methylated spirit. Have at hand a perfectly clean dish, into which pour sufficient spirit to well cover the plate. If a half-plate is used with a half-plate dish, about 6 oz. will be required; while larger dishes will require a proportionate amount. Entire absence of dust is essential, so that the spirit should be carefully filtered before use. It is a good plan to pour the spirit each time after use back to the jar through a funnel, in the neck of which has been loosely placed a small tuft of cotton wool. Where several plates have to be dried in this way, the best plan is to take a 20 in. by 16 in. dish (preferably a wooden one with a glass bottom, as these are flatter and economise the solution), which will accommodate ten half-plates side by side, requiring about 80 oz. of spirit. The plates are laid gently on scrupulously clean blotting paper for an instant, and the backs are then well wiped before placing them in the solution. When dry, the plate is ready for exposure. Drying usually occupies about fifteen minutes. The dish should be provided with a sliding board, to prevent evaporation and exclude light, as shown in Fig. 146.

Machine for Coating Plates.

In coating plates by machinery, the apparatus invented by B. J. Edwards, and patented June 5th, 1884, is still used, with only slight modifications. This apparatus is shown in Fig. 147. It consists of a trough

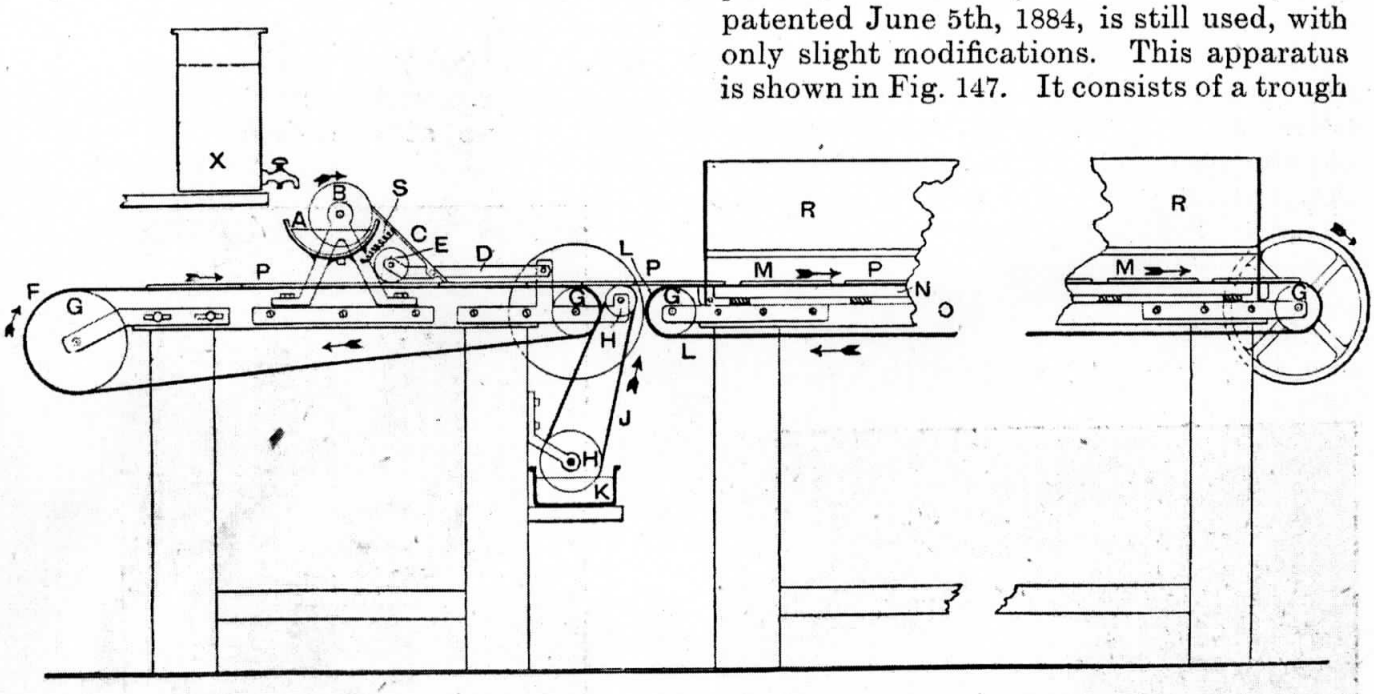

Fig. 147.—Plate Coating Machinery.

A for holding the emulsion The trough is silver-plated, and is supported between two uprights, as shown, and in it revolves a roller B carrying around with it a coating of the emulsion, which flows into the trough from the tap in the reservoir X fitted above. At C is fixed a movable scraper, which is so arranged as to take off a layer of emulsion from the roller. This scraper is carried by the pivoted frame D. It is made to press against the roller by means of two springs S, and can be placed

at any desired angle. Its width must be the same as that of the plates to be coated. The emulsion thus scraped off the roller flows down it on to the glass plate P, the thickness of the coating being controlled by the speed at which the plates travel past. The scraper may be placed at different heights to accommodate glasses of different thickness, and this is effected automatically by two side rollers. A guiding roller E brings the plate into exact position below the scraper. The plates are moved along below the scraper by means of an endless travelling band F, which is carried by the rollers G. Another endless band L passes around the two rollers G and carries the plates through a cooling chamber M, a tunnel-shaped compartment, open only at each end, which may be supplied with cold air. These bands are so arranged that in travelling from band F to band L the plates are separated slightly as shown. This is effected by the band L being made to travel at a slightly greater speed than the band F. Beneath L, or immediately under the plates, is a cold slab N; O is a metal tray in which the slab rests, which may be filled with ice-water. By a similar ice-tank R, just above the plates, the air in the chamber M is kept perfectly cool. An ingenious arrangement is shown in the centre of the illustration for

Cleaning the Plates.

Two rollers H carry an endless band J, which travels through a vessel of water K and effectually removes any emulsion that may find its way on to the back of the plate. This band also touches the band F, for the same purpose. The bands F and J are made of rubber, but the band L is made of woven wire, in order that the plates may be cooled at maximum speed. The tunnel chamber M is about 15 ft. long, so that the setting or stiffening of the plate may be assured before it is removed from the endless band. This is the kind of machine in use in many large factories, and with it an enormous amount of coating may be done in a surprisingly short space of time, with absolute uniformity and precision.

Melting Down Stock Emulsion.

From the description given, it will be seen that the operation goes on almost automatically, little or no attention being necessary beyond seeing that the emulsion trough is kept filled from the reservoir above, and that the plates are removed for drying when they reach the end of the ice-chamber. In working on so large a

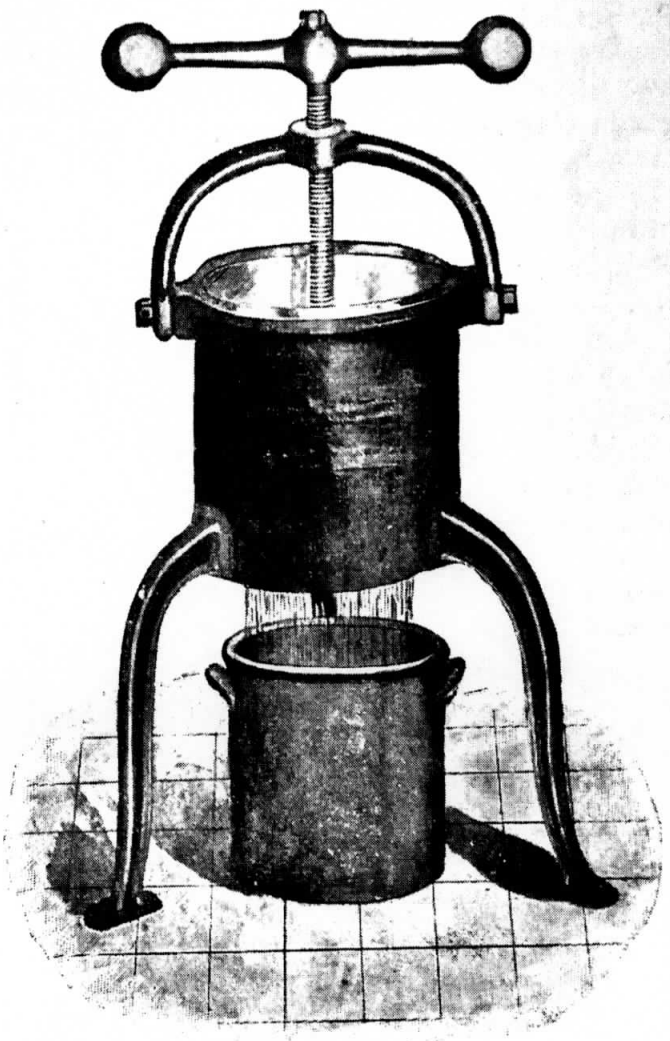

Fig. 148.—Emulsion Press.

scale, it is usual to make a stock emulsion and to melt it down as required. A press to break up the emulsion is shown at Fig. 148. The emulsion is placed in this, and is squeezed through holes in the bottom by means of the plunger. The body of the press and the plunger are made of an aluminium alloy, which does not affect the emulsion — an important consideration which ought not to be overlooked.

Emulsions Ripened with Ammonia.

Fairly rapid plates may be made without employing the boiling process at all, by treating them with ammonia. Such plates, although not extremely sensitive, are considerably quicker than collodion plates. They may be prepared by treatment at a temperature of about 100° F., or the emulsification and subsequent treatment may take place at ordinary temperature. The former does not appear to possess any advantage over the usual method of boiling, but the latter certainly gains much as regards simplicity. The following solutions may be made up:—No 1. Silver nitrate, 175 grs.; water, 1 oz. No 2. Potassium bromide, 140 grs.; water, 1 oz. No. 3. Gelatine, 45 grs.; water, 1 oz. Add to No. 1 solution a little ammonia, and a precipitate of silver oxide is formed. Continue to drop in ammonia and shake the solution until the silver oxide, which is soluble in ammonia, is re-dissolved. It makes the operation a little simpler if the ammonia is diluted with a small quantity of water. This solution is added to No. 3, and shaken vigorously. When an intimate mixture is assured, the bromide solution, No. 2, may be added, a little at a time, with much shaking. Two hundred grains of gelatine are then dissolved in 2 oz. of water, and when cool added to the solution in the same manner. As in the preparation of other emulsions, the more complete the mixture the better. When this has been properly done, the emulsion should be set aside for twenty-four hours to ripen, Before doing so, it is best to pour it out into a flat glass dish, so that it may be in a convenient form for breaking up and washing. This is done as described on p. 64. The emulsion may be made with the whole of the gelatine at once, but in this case the temperature of the solution will have to be raised, or it will be too thick to allow of proper mixing.

Orthochromatic Plates.

These are plates specially prepared to give a truer rendering of the colour intensities, and to overcome the well-known defect of blue photographing too light and yellow too dark. The subject of orthochromatic photography will be dealt with later, so that nothing beyond practical points in the preparation of the plates need be given here.

Methods of Preparation.

The object being to prevent certain colours photographing too dark, the special qualities of such plates must be that they are more sensitive to the rays of these colours. This increased sensitiveness is brought about by the action of certain organic compounds — dyes — which are capable of entering into combination with the silver to form a new compound having the desired special sensitiveness. There are, however, other and different explanations of the precise action of these dyes, which will be dealt with in the portion of this book devoted to theory. The dyes are numerous, and have varying effects. Erythrosine is a favourite for increasing the sensitiveness to yellow light, and erythrosine with cyanine to increase its sensitiveness to red. The dye may be added to the emulsion, or the plate after coating may be immersed in the dye solution. The latter is the better method for work on a moderate scale, and may be done as follows: Take 200 parts of distilled water, 25 parts of a 1 in 1,000 solution of erythrosine, and add 6 parts of ammonia (specific gravity ·880). The plate, carefully dusted, is immersed in this solution for from one to one and a half minutes, then swilled under the tap, and dried in a proper drying cupboard or on a shelf in a well ventilated dark-room. The plate is then ready for exposure. In some cases the plate may be exposed straight away as soon as drained—that is, without waiting for it to dry.

Lantern and Process Plates.

These are plates which in the one case should have an extremely fine grain, and in the other should give a dense deposit exceedingly opaque, so that extreme contrast may be obtained when photographing drawings and similar subjects possessing only a short range of contrast. Both these

qualities are obtainable from the same emulsion. An extremely slow emulsion gives an extremely fine grain and a very dense deposit and contrast. Therefore, the sensitive coating is very similar, except that in the lantern plates the coating is very much thinner, and in the process plate the coating is heavier than in an ordinary dry plate. In development the plates are treated quite differently, as will be explained later.

Multiple-coated Plates.

With a view to obtaining extreme latitude in exposure, plates have been prepared, and are still sold, which are coated with several layers of emulsion, each being of a different rapidity. The least sensitive emulsion is laid next to the glass; on top of this comes a coating of medium rapidity; and over these is laid an exceedingly rapid emulsion. The principle of such plates is that where the light is feeble it is capable of penetrating the emulsion, and therefore acts only on the top coating. As the light is stronger or the exposure is prolonged, it penetrates to the second or third coatings, which are capable of giving proportionately greater density in a shorter space of time in the developer.

The Wet Collodion Process.

As explained in an earlier section, this process consists of forming silver iodide or bromide in the pores of a film of collodion on glass and exposing in the camera while still wet. For ordinary photography in the studio or in the field the process is obsolete; but it is still used for certain kinds of technical work, such as the making of enlarged negatives, the making of negatives for printing process blocks, and for microscopic work. In the first case it possesses the advantage of cheapness, in the second it is preferred on account of the great density of deposit obtainable, together with the extreme clearness of shadows, and in the last instance on account of the fineness of its grain, and therefore its advantage in rendering exceedingly fine detail. It is possible that extreme competition in plate-making, and the consequent cheapness of all kinds of plates, may result in discounting the first advantage, while the modern process plate certainly runs it very close as regards the second and third qualities. It is probable, therefore, that it will gradually fall out of practical use.

Nature of Collodion.

A brief explanation of the substance from which collodion is made—pyroxyline—is necessary to a proper understanding of the subject. Pyroxyline, or gun-cotton, to use its more familiar name, is formed by the action of nitric and sulphuric acids upon cotton, paper, and other substances. Generally speaking, cotton is employed. Now these acids have a strong affinity for water, and therefore are capable of combining with the hydrogen and oxygen in the cotton to form a new compound, leaving the cotton in a dry, crisp state, quite different from its condition before treatment, and highly inflammable. If the acids are allowed to act sufficiently long, the insoluble explosive gun-cotton is formed. The theoretical part of the subject will be dealt with later, so that the preparation of the pyroxyline may at once be described. If, however, the student has no knowledge of chemistry, he should defer his attempts at this class of work until he has carefully mastered the principles laid down in the theoretic section, since the preparation of pyroxyline is dangerous to the inexperienced, on account of its highly explosive nature.

Preparation of Pyroxyline.

Ordinary cotton is contaminated with certain impurities which must first be removed. Take 1 oz. of cotton-wool and place it in a beaker. Cover this with a strong solution of washing soda, and boil it gently in this for a few minutes. It should then be well washed, first with ordinary water and finally in distilled water. If thoroughly done, this will completely remove all the resinous matter contained in the cotton, which should now be made perfectly bone-dry by baking in an oven. The cotton is next immersed for from eight to ten minutes in a bath of nitric and sulphuric acid. This operation should be

performed in an upright vessel, preferably a beaker, as it has to be kept at a temperature of 140° F. on a water bath. An ordinary gallipot, if the glaze is good, will answer the purpose. The bath is made up of: Sulphuric acid, 18 oz.; nitric acid, 8 oz.; and water, 1 oz. As it is dangerous to add water to sulphuric acid, the water should first of all be placed in the vessel, then the nitric acid, and lastly the sulphuric acid.

Converting the Wool.

The operator should be provided with a stout apron and gloves, or finger-stalls

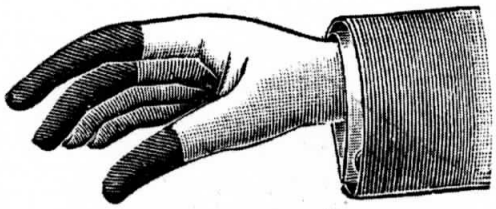

Fig. 149.—Finger Stalls.

(see Fig. 149), and the wool must be manipulated with a couple of glass spoons or spatulas—or strips of glass may be used. The wool should be rolled into little balls and plunged completely under the surface at once. When sufficiently soaked, the excess is squeezed out and the wool washed in running water for twenty-four hours, or until it ceases to show an acid reaction when tested with litmus paper. This will indicate when the excess of acid has been removed. It must now be again dried.

Qualities of Pyroxyline.

Pyroxyline properly prepared should show a gain in weight of about 25 per cent. over the original cotton. Fortunately, it is not necessary or advisable to prepare one's own pyroxyline, as it can be purchased at from 1s. to 2s. 6d. per oz. The proper consistency of the collodion is partly dependent upon the preparation of the pyroxyline. The greater the proportion of acids used, the heavier and more glutinous will be the collodion, and *vice versâ*. The disadvantage of the heavier sample is its tendency to curl up and leave the plate. It may, however, be used for enamelling.

Preparation of Collodion.

Collodion is formed by dissolving pyroxyline in equal quantities of alcohol and ether. For this take pyroxyline, 2 drams; alcohol (·820), 10 oz.; and ether (·725), 10 oz. The alcohol is poured over the pyroxyline in a vessel with a closed top, and the ether added to it. The proportions are not arbitrary, but form a good average. In cold weather the proportion of ether may be slightly increased (with a proportionate decrease of alcohol), with advantage. Further, the consistency for special work may be varied by altering the proportions of the solvents. It is sometimes recommended to refine the collodion by precipitating and re-dissolving; collodion so prepared having a finer texture. To do this, the collodion is poured in a thin stream into distilled water, and the precipitate collected and redissolved in the same proportions of ether and alcohol. If the precipitate is dried and weighed, as it should be, it will be found to be lighter, showing that all the pyroxyline was not precipitated. Hence the alteration in its condition.

Iodising the Collodion.

Collodion may be either iodised or bromised. The former gives density and the latter detail; that is to say, the iodide gives a heavier deposit of silver in the lightest portions, and the bromide a more even density. For such work as the process is now used for, iodised or bromo-iodised collodion answers best. Collodion may be purchased in a plain state or iodised, or with the iodiser done up separately. A simple plan is to dissolve some ammonium iodide in a little alcohol in the proportion of 4 grs. to each ounce of collodion, and then to add it to the collodion, when it may be used at once. Where the collodion is likely to be kept a considerable time, 5 grs. per ounce of cadmium iodide may be substituted. If, however, a bromo-iodised collodion is preferred, the following is a good formula: Cadmium iodide, 3 grs.; ammonium iodide, 18 grs.; ammonium bromide, 10 grs.; and collodion, 6 oz. If desired, the proportions of iodide and bromide may be varied according to the

density or detail required. Collodion so prepared is better for keeping a few days before use.

The Silver Bath.

The quantity of silver solution to be prepared will depend upon the size of negatives to be made, but about 20 oz. will be ample for ordinary purposes. A very small quantity of solution may be used if the sensitising is done in a flat dish, but the dangers of dust are so much greater that it cannot be recommended. The making up of the silver bath is a very simple matter, but there are certain points which must be borne in mind. For example, the bath may be either acid or neutral, its condition in this regard being governed by the sensitive compound used. If the iodide is used, so that the sensitive salt in the film consists wholly of silver iodide, the bath may be in a neutral state; if the iodide and bromide are used together, then the bath should be faintly acid; and if bromide alone is used, it must be more strongly acid. The safest plan, at any rate for a beginner, is to have the bath faintly acid even when using the iodide only. The action of the nitric acid is to prevent the spontaneous or independent reduction of the silver, thereby keeping the shadows clear and free from fog. The proper strength for the bath in ordinary circumstances is 40 grs. per ounce; therefore, to make up the bath, take 320 grs. of recrystallised silver nitrate and dissolve in 8 oz. of distilled water.

Importance of a Pure Bath.

The purity of the chemicals employed for the bath is very essential. Silver nitrate is usually tolerably pure, but may be distinctly acid; this may be neutralised by the addition of a little chalk, after which the bath should be filtered. This acidity, however, is not a serious drawback. Distilled water is sometimes contaminated with organic matter, which should be got rid of by dissolving the silver nitrate in it and then exposing to sunlight, when the organic matter will be destroyed and some of the silver precipitated. When distilled water is not at hand, ordinary water may be used, and the solution filtered. In either case, however, allowance must be made for the loss of silver, which may be ascertained by use of the argentometer, a kind of hydrometer specially made for testing the amount of silver in a given quantity of solution, as will be explained in a later section.

Saturating with Silver Iodide.

Now if a bath were made up as directed above, the first plate immersed in it would give only a thin, weak image, and would be practically useless. This is because silver iodide is soluble to a very slight extent in silver nitrate. Therefore, to avoid such an effect, it is necessary to form an extremely small quantity of silver iodide in the bath by the addition of a soluble iodide. If, say, a small quantity of cadmium iodide is added to the bath, the solution will at once turn milky; but on shaking it will become clear again, provided that only an extremely small quantity of the silver iodide is formed. One grain will be sufficient for the 8 oz. of silver bath given above. This operation is spoken of as saturating with silver iodide. In practice, it is usually best to dissolve the silver in half the water, then to add the iodide, shake, add the remainder of the water, and filter, when the acid may be put in. If the solution is more than saturated, the plate will come out with sparkling particles of metallic silver; this may be overcome by adding barium nitrate 1 part to 50 parts.

Apparatus Required for Wet Collodion Process.

For experimental work no special apparatus is necessary, but as the plate has to be used in a wet state some provision must be made in the dark-slide to catch the drainings and to avoid spoiling the appearance of the woodwork. A piece of blotting-paper folded up, on which to rest the bottom of the plate, and another piece behind the plate, will suffice; but in slides specially made for the purpose it is usual to have a silver-plated gutter along the bottom. The camera should preferably be one with flat sides, as it may be more

easily freed from dust, the great difficulty of the process. Bellows body cameras are great harbourers of dust. In other respects the form and fittings of the camera may be as usual, and must be chosen with a view to the work in hand rather than the process.

Silver Bath and Dipper.

An upright silver bath of the shape shown in Fig. 150 will be necessary, and a dipper of the form of either Fig. 151 or Fig. 152. The former is made of ebonite, and may be purchased very cheap, while the latter is a home-made substitute consisting of a strip of glass of the shape

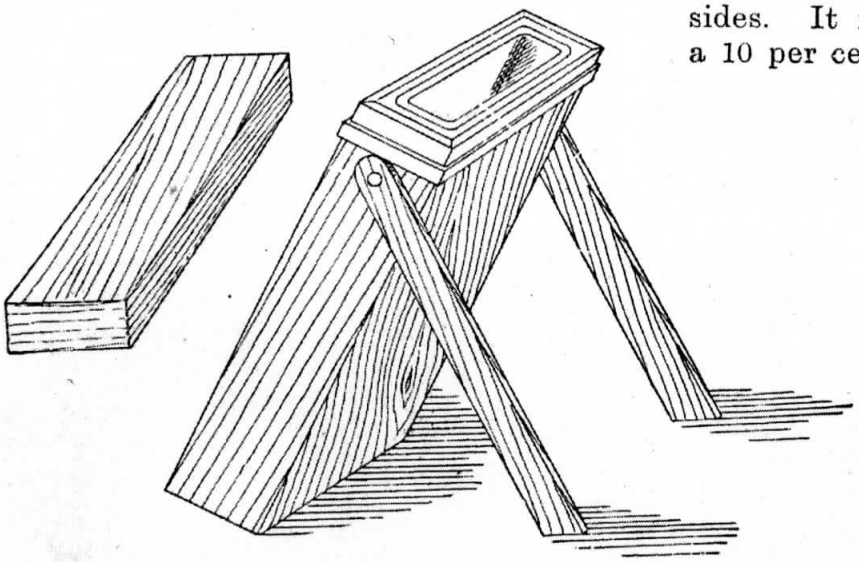

Fig. 150.—Upright Silver Bath and Cover.

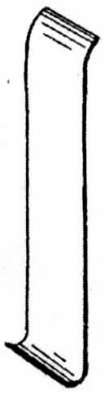

Fig. 151.—Ebonite Dipper.

shown, cemented to which is a narrow strip to form a rest for the plate. This may be attached with a little seccotine. Another kind of dipper, perhaps superior to the others, is shown by Fig. 153; this is made of silver wire. In dark-slides specially made, rests of silver wire are provided instead of the usual rebate.

Collodion Bottles.

These bottles are made in the form illustrated by Figs. 154 to 156, so as to present as little area as possible to the air when the stopper is removed, as well as for convenience in pouring. Fig. 155, known as the cometless pattern, is the better of the two, although slightly more expensive. Fig. 156 is a combined bottle and filter. In addition to the above, some suitable glass will be required. On the whole, good sheet glass carefully selected so as to be free from bubbles, scratches, and other defects will answer as well as anything for small sizes. For important work in large sizes, either flatted crown or patent plate should be used, the former for preference.

Cleaning the Plates.

The first operation is that of making the glass chemically clean. For this purpose, after cutting the desired size, the glass should be placed in a solution of caustic soda or potash for a few moments, and then well rinsed under the tap on both sides. It is then placed for an hour in a 10 per cent. solution of nitric acid and well washed. An upright porcelain trough as used for fixing is most convenient, and a number of glasses may be done together. The glass is then well rubbed with a creamy solution of Tripoli powder, and polished with a dry cloth on both sides. This treatment ensures a good basis to work upon, and if not absolutely necessary in all circumstances, may prevent many troubles.

Alternative Method of Cleaning.

Instead of the method just described, a cleaning solution made as follows may be employed: Potassium bichromate, 1 oz.; sulphuric acid, 1 dram; and water, 10 oz. This is a useful cleaning solution for general purposes. It may be used repeatedly,

and should be kept in a bottle ready for use. It is poured out and swilled around the vessel or plate to be cleaned, and then returned to the bottle. After treatment the plate should be well rinsed with clean water. As the plates are cleaned they should be stored in a grooved box, as shown in Fig. 157, ready for use.

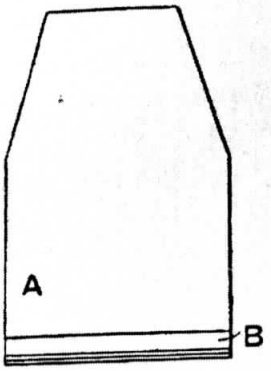

Fig. 152.—Home-made Dipper.

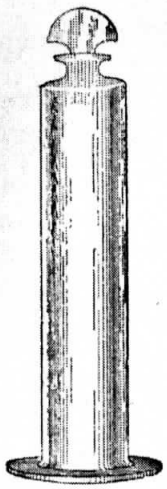

Fig. 154.—Plain Collodion Bottle.

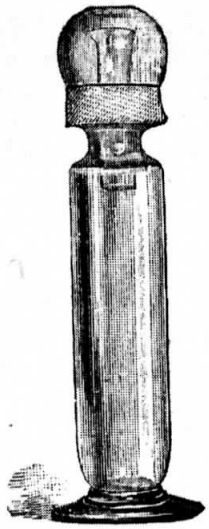

Fig. 155.—Cometless Collodion Bottle.

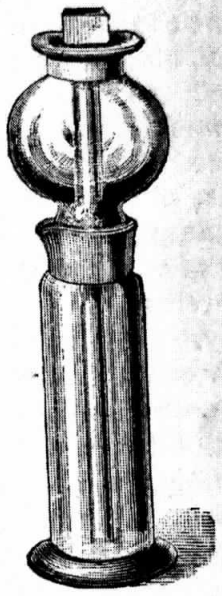

Fig. 156.—Combined Bottle and Filter.

Edging the Plate.

In order to prevent the collodion film "frilling" off or leaving the glass support, it is best first to edge the plate with rubber solution. For early experimental work the ordinary rubber solution as used for mending tyres may be used, but it is more satisfactory to use a 1 per cent. solution of pure rubber in benzole. This should be applied to the plate in the same way as the opaque varnish is applied in safe-edging a negative to be used for carbon printing. A small camel-hair brush, to the side of which a wooden match has been tied, is drawn quickly along each edge of the negative, keeping the match firmly against the side of the plate. This puts a narrow edging of rubber solution of an even width along the margin.

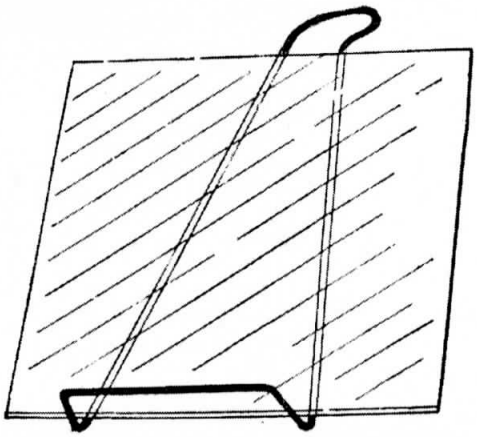

Fig. 153.—Silver Wire Dipper.

Exposing Wet Plates.

The next operation is that of covering the plate evenly with a film of collodion; but as from this point the manipulations must go on almost without a break up to the completion of the negative, the operator should see that he has everything ready for use which may be required for sensitising, developing, fixing, and wash-

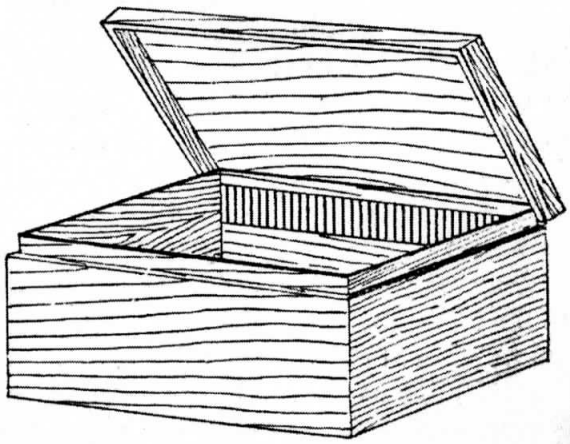

Fig. 157.—Light-tight Grooved Plate Box.

ing. He should also have fixed upon some subject for exposure. The most convenient way of exposing wet plates is through the camera, but as an introductory experiment the making of a "contact" transparency may be tried. Absolute contact is, of course, impossible, for as the one film is wet it would stick to and injure the other. By working, however, with a small light, say a candle-flame or acetylene bicycle lamp, a definite shadow is thrown which will give a fairly sharp image, even if the receiving surface is moved a little further away. Fasten a strip of stout paper across each corner of a negative with gum, and the collodion plate will then rest against these without doing harm. Prepared thus, the negative may be exposed in the printing-frame in the dark-room as described later for bromide printing.

Coating the Plate with Collodion.

These matters settled, the collodionising of the plate may be proceeded with. A pool is poured in the centre of the plate about one-third its area, and flowed first to the top right-hand corner, then to the top left, then to the bottom left, and finally to the bottom right, whence the excess should be poured gently into the bottle. Do not allow the edge of the plate to touch the bottle if it can be avoided. Give the plate a gentle motion from side to side as the collodion is poured off. If the edge is allowed to grind on the side of the bottle, it will merely fill the solution with fine particles of glass. Directly the plate ceases to drip, replace the stopper in the collodion bottle and stand it by to set. On no account allow the collodion to run back on itself, or streaks and marks in the negative will be the result. In other respects, the coating is carried out in the same way as described on p. 69. A little practice in accordance with these instructions is advisable before commencing to coat with collodion. In coating small sizes, the plate may be supported on the tips of the fingers of the left hand, and held in position by the ball of the thumb, as shown in Fig. 159 (p. 81). When coated, the plate should be stood aside for the film to set. Setting will take a little longer in cold weather than in the summer, and may usually be determined by a dulness spreading over the film. If in doubt, the corner from which the plate was drained may be touched very gently with the finger; if it shows no sign of tackiness, it may be taken to have set. It is then ready for immersion in the sensitising bath.

Immersing the Plate.

As soon as the collodion has set, the plate is placed on the dipper and gently lowered with one continuous sweep into the silver bath. Stoppages in immersing the plate, if of any appreciable duration, are liable to cause marks. The silver bath is supposed to have been poured into the upright bath already referred to. All the operations up to this point may be carried out in broad daylight without fear of damage, but after this a dull orange light only is permissible. Wet plates vary considerably in rapidity, and at the best they are much slower than an ordinary dry plate. It may be borne in mind that the silver iodide is not formed in the instant of immersion, and sensitising may therefore be commenced in white light without harm being done. When the plate has been immersed an instant, it is advisable to move it up and down in the bath until all greasiness has disappeared; in this way the ether is swilled off the surface, and an even sensitising action insured. If using a flat porcelain dish, the same result may be secured by rocking. The plate should remain in the bath for about three minutes. The exact time is governed by (*a*) the temperature and (*b*) the sensitive salt to be formed. The higher the temperature, the shorter the immersion. In summer, only two-thirds of that required in winter will be necessary. If the iodide only is to be formed, slightly over two minutes will suffice at ordinary temperature; but in winter a little over three minutes may have to be given, unless precautions are taken to keep the bath at an even temperature of 60° F. When the bromide has to be formed, the operation takes longer, six minutes being necessary in extreme cases; and greater care is required, as the plate will be more sensitive.

Exposure of the Plate.

The plate must now be very slowly withdrawn from the bath and stood up to drain on clean white blotting-paper. The excess is then taken from the back of the plate by wiping over with a piece of blotting-paper, and the plate may be laid on the silver wires in the carrier ready for exposure. When the exposure is to be a long one, or when the plate is likely to remain some time before exposure for a special effect, a sheet of wet blotting-paper should be laid at the back of the plate to keep the air moist. The duration of exposure may be found as described, first making a gradation test in order to compare the relative rapidity of the plate. Plates prepared with the simple iodide will possibly require fifteen to twenty times the exposure of an ordinary plate, but those prepared with bromo-iodide or bromide will be proportionately quicker. One advantage of the wet plate, as with all slow plates, is the great latitude of exposure allowable, considerable increase being possible without any serious result. An important warning may here be given to those accustomed to handle dry plates. On no account must the film be touched, as it is extremely tender; a strong flow of water even is sufficient to destroy it completely. The appearance of a wet plate after development and fixing is similar to that of a dry plate which has been bleached in mercury, being a brownish colour by transmitted light and a cream colour by reflected light.

Purifying the Bath.

In addition to the information already given on this subject, some instructions may be laid down on purifying the bath from special impurities, such as ether, alcohol, etc. If the bath is gently warmed, the ether, owing to its volatility, will be easily driven off. It is not necessary to heat the bath to any considerable extent for this purpose, but the alcohol will need a much higher temperature, so that it is usual to drive off both together by pouring the bath into a large beaker and boiling up for a time. This heating should continue until rather more than a half has been evaporated, when the strength of the solution is taken with the argentometer and sufficient distilled water added. Instead of using heat, the bath may be evaporated by exposure to the air; but the operation will, of course, take proportionately longer.

Wet-collodion Developers.

The developers employed in wet-plate photography are numerous, and, unlike those used in the modern dry-plate method, they do not require an accelerator, but work in an acid state. They consist merely of a reducer, a restrainer, and a medium for holding both, the water. To this, for convenience in making the solutions flow evenly, is added a small quantity of alcohol. As this subject will be dealt with in a later section, it is not necessary to pursue the subject further. The following is a typical formula: Reducer, ferrous sulphate, $\frac{1}{4}$ oz.; restrainer, glacial acetic acid, 1 dram; diffuser, alcohol, in sufficient quantity; medium, water, 5 oz. Pyrogallic acid and the double sulphate of iron and ammonia may also be employed as the reducing agent. Development may be carried out in a dish, but more frequently the plate is held in the hand. The iron developer may be used repeatedly, but it is not advisable. For fixing, either hypo. or potassium cyanide may be employed. The proper strength for the hypo. is 1 to 6; if the cyanide is used, it should be 1 to 16. In many instances wet plates are intensified, a favourite intensifier being pyro. and silver. The method of intensification, and the necessary formula are given in the section dealing with that subject.

Defects of the Wet Collodion Process.

Leaving out those defects which are common to all photographic processes, such as light fog, etc., there are still several which are of special interest. For instance, too much or too little iodide in the collodion is apt to cause insensitive spots or pin-holes. Dust, which may be in the air, the collodion, or the silver bath, is liable to cause black spots. Insoluble particles of gun-cotton in the collodion cause "comets," a sort of black spot with a tail

to it. Streaky marks may be caused by the collodion or silver solution flowing back over the plate, the collodion containing too much alcohol or an unsuitable sample of pyroxyline. Too much care cannot be taken to avoid dust and grit.

The Ferrotype Process.

The ferrotype process, in careful hands, is capable of producing results which, if not comparable with modern processes, are at least vastly superior to the results obtained generally with the process by itinerant photographers, for artistic skill in posing, lighting, and composition will make itself felt in either. Ferrotypes are collodion positives taken upon a dark enamelled iron plate by a wet or dry process, usually the former. The picture appears reversed as regards left and right. Those formerly made by a similar process upon glass plates, and viewed from the glass side, do not appear so reversed; they are called glass positives, and not ferrotypes, and are backed with black varnish. A ferrotype is a positive and not a negative process—that is to say, one in which white will be rendered as white in the first result. Being so, it is necessary, when many copies are required, to have the camera fitted at the front with a battery of lenses, so that the desired number may be taken with one exposure and exactly alike. Failing this, a repeating back may be used, but even this necessitates separate sittings.

Suitable Form of Camera.

An old wet-plate camera and portrait lens may be used for the process. These often may be had of a second-hand dealer for a very small sum. This form of camera has two advantages; if of box form, it can be more easily freed from dust, and the slide will be provided with silver wires for the plate to rest upon, and a gutter at the bottom to receive drippings from the plate. An ordinary camera may be used, but a wad of blotting-paper must be put in the slide for the plate to drain upon. If a box camera is used, it must be placed upon a substantial tripod.

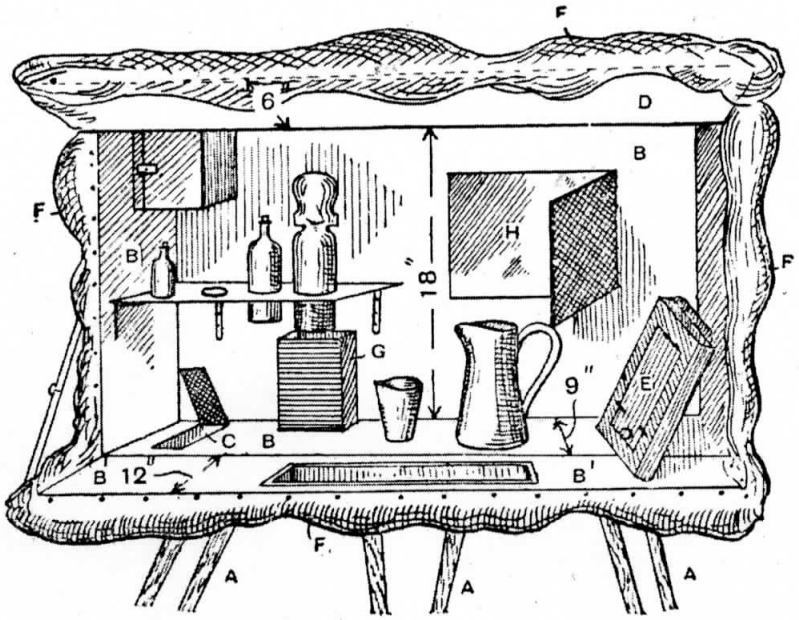

Fig. 158.—Dark Tent for Ferrotype Work.

The Dark Tent.

A dark tent is also required if the work is to be done out of doors and at various places, as is generally the case. The method of fitting up a dark tent is shown by Fig. 158, in which A is the tripod, B is the carrying case, with one side B folded down to form a table; C is the silver bath, D the remaining part of the case, folded up; E the dark slide, G the fixing bath, and F a bag glued (or otherwise fastened to make a light-tight join) around the extreme of the inside edges. This bag may

be made of two thicknesses of rubber-lined cloth. A window of ruby fabric is fitted at H. The bag is rolled back when not required, but, when in use, falls down around the operator, and may be reeved up round the waist.

Materials Required.

Other requisites are a 2-oz. bottle of Mawson's iodised collodion, 1 oz. of nitrate of silver, ¼ oz. of potassium iodide, 1 oz. each of nitric and acetic acids, one pennyworth of protosulphate of iron, 1 oz. of alcohol, specific gravity ·805, 1 oz. of caustic potash, 1 oz. of cyanide of potassium, a few dozen ferrotype plates, and two dippers, as shown by Fig. 151. Dippers are usually of ebonite, but may be made by cementing along the bottom of a long strip A (Fig. 152), a small strip of glass B. An upright glass bath for silver, a 4-oz. tumbler, and 5 oz. of crystal varnish also are required.

Making the Silver Bath.

The silver bath is first made up very carefully. In 16 oz. of distilled water dissolve 1 gr. of potassium iodide, and add 1 oz. of nitrate of silver. Thoroughly mix this solution by shaking, and allow to stand for some hours in sunlight. If a precipitate falls, decant the top. Then add one or two drops of nitric acid, sufficient to make the bath turn litmus paper faintly red. If the bath is too acid, marks on the film will be caused; if too little acid is used, the picture will be flat and of a dirty grey appearance. In the first case a little neutral silver solution must be mixed up and added. The remedy in the other case is obvious. The silver bath, being made up, is poured into the glass bath, and kept covered.

Suitable Developers.

The developer is next made up. Add 1 oz. of acetic acid (glacial) to 16 oz. of water, and dissolve in this 1 oz. of protosulphate of iron. Then add 1 oz. of alcohol to make the developer run easily. The fixing bath is easily made by dissolving 5 scruples of potassium cyanide in 4 oz. of water. This solution, being very poisonous, is best kept in an upright bath, like the silver. Another suitable developer is iron protosulphate 1½ oz., nitrate of baryta 1 oz., nitric acid 40 drops, water 20 fluid oz. To this, although not indispensable, about 1 fluid oz. of alcohol may be added to make the developer flow properly over the surface of the exposed plate.

Home-made Collodion.

Home-made collodion is preferred by many experienced workers, but it is not advisable for the beginner to make his own. However, a reliable formula for collodion is here given: Ether and alcohol 20 fluid oz. each, gun-cotton 200 grains, bromide of cadmium 100 grains, iodide of cadmium 80 grains, iodide of ammonium 120 grains. In making up, the alcohol is first added to the gun-cotton, and then the ether. When all the gun-cotton is dissolved the collodion should be filtered. The collodion is bromo-iodised by simply adding the cadmium bromide and the two iodides ground and mixed. The ether used should have a specific gravity of about ·72, while that of the alcohol should be about ·8.

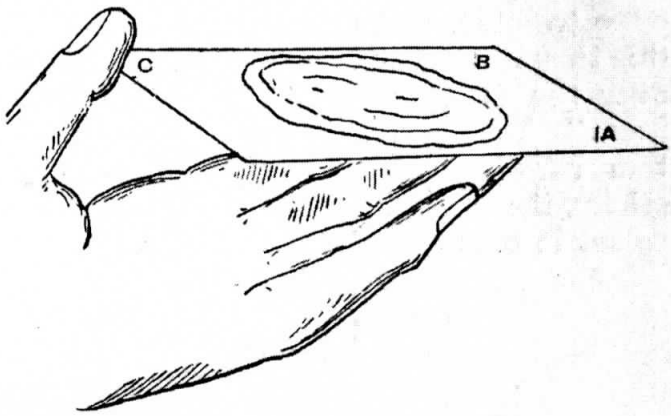

Fig. 159.—Pouring on Pool of Collodion.

Coating the Plate.

The actual work of preparing a wet collodion plate may now be begun. Take one of the enamelled iron plates, and, having cleaned it, rest it upon the tips of the fingers as shown in Fig. 159, and pour in the centre a pool of collodion about half the size of the plate. Now very slowly and slightly tilt the plate in the direction of the corner A, to which the collodion will run. Just before it reaches the edge, tilt

towards B (still very gently and smoothly). In the same way run the collodion to C, almost touching the thumb, and pour off into another bottle. When this bottle gets full the collodion may be filtered back into the first bottle again. After a time it may become thick by evaporation of the ether and alcohol, in which case 2 parts of the first to 1 of the second may be added until the desired consistency results. It may be mentioned that an excess of ether causes the collodion to set too rapidly, whilst too much alcohol makes it too glutinous. As soon as the collodion has nearly all run off, rock gently (to prevent streaks) from edge to edge, and not back to front. By this time a general dulness will have spread over the film, showing the collodion has "set." When undecided, touch the bottom corner, and if no longer tacky or sticky, it is ready. Collodion takes longer to set in cold than in hot weather.

Fig. 160.—Dark-slide Wires.

Sensitising the Film.

Place the film upon the dipper, and slide with a gentle and continuous motion down into the silver bath; a stop or hesitation will cause a line across the plate. Whilst the plate is being "excited," prepare the slide, wiping it out, if necessary, as dust is fatal. It is not necessary to coat the plates and dip in the silver bath in the dark, as the iodide of silver is not formed immediately upon immersion; but if these processes are carried on in the open, the bath must be covered with a light-tight cover the instant the plate is put in. When about a minute has elapsed, draw out gently in the dark and see if greasiness has gone (in cold weather about double this time); if it has not, markings may be expected. When the plate appears quite even, dip and withdraw a few times slowly. Any dust on the top of the bath should be skimmed off with a strip of perfectly clean blotting-paper. Then blot off the back and allow to drain for half a minute.

Exposure, Development, Fixing, etc.

Place the plate on the wires (Fig. 160) of the dark slide and insert the same very gently in the camera, drawing out the slide shutter with great care to avoid dust, and after exposure close in the same way; return to the tent and deposit it, still in an upright position. Take sufficient developing solution in the glass, lower the bag, hold the plate as in coating, and pour the solution over, giving a gentle rock to keep it flowing slowly to and fro on the plate. This requires a little practice. Do not pour on with a splash. Have underneath the plate a bottle with funnel containing a little cotton-wool. The developer running off the plate is thus filtered ready for use in cases of over-exposure. It is necessary that the exposure be very correct; this is a matter that can only be learnt by experience, as development cannot be controlled as in dry plate work. Directly the image is fully out (if it is stopped too soon it will be too black; if allowed to remain too long it will be weak, flat, and foggy), swill and transfer to fixing bath, using another dipper. When the shadows appear quite clear, the ferrotype should be well washed for a minute or longer. If this is done by pouring over it water out of a jug, do not pour too rapidly and heavily. An over-developed ferrotype, or one weak and flat, may be improved by adding a drop or two of iodine to the fixing bath. A little of the latter may be taken up in another measure to which this has been added and applied as in developing. After final washing the plate may be dried slowly, face upwards, over a small lamp and varnished, the varnish being applied by flowing over the plate as usual. Ferrotypes can be controlled but little in development, and it is usually better to take another if greatly in error. Transparent varnish for ferrotypes is best when bought ready-made; it is a solution of seed lac in methylated alcohol.

Dry-collodion Plates.

What are known as collodion plates are plates of either glass or metal coated with emulsion in which the vehicle used for the

sensitive salts is collodion instead of gelatine. Collodio-bromide emulsion can be purchased if desired, or it may be made as follows. The chemicals used are silver nitrate, zinc bromide, alcohol, ether, and pyroxyline, and the precautions already referred to must be taken as regards purity. The alcohol must be the pure spirit, not mineralised. The ether may be methylated, but should be of the purified kind, with a specific gravity of ·825.

Preparing the Emulsion.

All the apparatus required is a 7 in. by 5 in. glass, or porcelain dish, a few test tubes, a beaker, and a 20-oz. bottle. Weigh out 100 grs. of pyroxyline, and add 4 oz. of alcohol and 4 oz. of ether, and shake, when the cotton will be seen to be changed to a glutinous transparent mass. This solution should be stood aside for a time, and in the meanwhile 128 grs. of zinc bromide may be dissolved in ½ oz. of alcohol in a test tube. In a boiling tube dissolve 160 grs. of silver nitrate in 160 minims of distilled water, using sufficient heat, and add 300 minims of alcohol. This should be kept warm until mixed with collodion. Now take the plain collodion, and add the silver solution to it in parts, introducing about 30 minims at a time and shaking vigorously between each addition. The zinc bromide solution may now be added by one of the methods already suggested, and thoroughly mixed. The emulsion can then be poured out into the dish and washed as usual, or used without washing; it must be kept in an opaque or deep-ruby bottle.

Finishing the Plates.

The glass may be cleaned with alcohol, and after polishing with a clean chamois leather, is edged with a solution of rubber and coated as before described. When coated, the plates may be placed in a rack with divisions about 1 in. apart to dry. It is also possible to dry them in an oven—a hot-air or hot-water oven, as used for chemical experiments, is preferable (see Fig. 161); but the kitchen oven may be used, taking care that the plate is well protected from light the whole time. Plates so prepared may be used when dry, or kept for a time, although they lose sensitiveness by too long keeping. The method of developing is dealt with elsewhere. The plates are used for lantern-slide making, for which they are popular on account of their fine grain and ease of working; they are also used in ferrotype photography.

Albumen Plates.

The plate which gives the finest grain of any known process is one produced with albumen as the vehicle. The glass plate is coated with albumen containing iodide, and is then sensitised by immersion in the silver bath. Such plates are exceedingly slow. The process is now of more than historical interest, as it is the one used in the Lippman process of natural colour photography, the ordinary plate having a grain too coarse to give the necessary laminæ of silver.

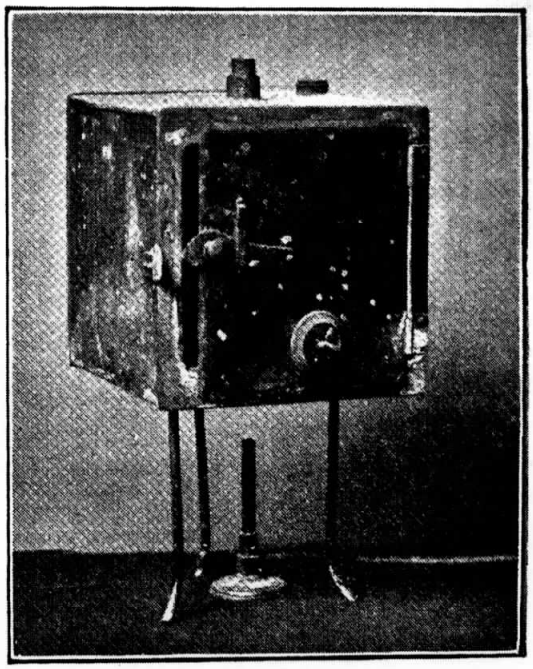

Fig. 161.—Drying Oven.

Negative Papers.

Since film photography has become so popular, and as it possesses such immense advantages in every way, except perhaps that of cheapness, negative papers have fallen out of use. A few years ago there

was an attempt to revive their use, but the results are never very satisfactory except for very large work. They consist of paper coated with emulsion of the usual rapidity for plates, the paper either before or after being parchmentised, waxed, or otherwise rendered translucent to get rid of the grain as far as possible. Even ordinary bromide paper may be used in this way for making enlarged negatives, except that the thinness of the coating seldom allows sufficient density of deposit in the high lights. After fixing, washing, and drying, the paper is rubbed over on the back with wax, and then ironed between sheets of blotting-paper until the effect is quite even. Oil may be used instead of wax for the same purpose.