DYEING, BLEACHING, PRINTING, FINISHING,
ETC.*

THE BLEACHING OF WOOL WITHOUT SULPHUR.

ORDINARILY wool is deprived of its yellow or grayish tinge by the application of sulphur in different ways, but mostly in the form of sulphurous anhydride, the pungent gas given rise to by the combustion of sulphur in air; this bleaches the wool, but not entirely, and to obtain the desired whiteness it is necessary to drown the remaining yellowing shade by the application of bluing, either with indigo carmine, indigo purple, aniline blue, aniline violet, ultramarine, Prussian blue, or similar substances. This, as a rule, gives satisfactory results as far as the appearance of the cloth goes, but the substances used undergo, more or less, a change through the action of the sun and soap when the cloth has been made up.

A German dyer, named Kallab, has recently invented a proceeding by which wool and silk, as well as other animal fibers, can be bleached and blued in such a manner that the shade withstands milling, washing, and the action of sunlight. Under this patent the wool is first well washed, and then brought, still damp, into a bath of pure water of ordinary temperature, to which has been added a very small quantity of finely powdered purple indigo, say 40 to 90 grains to 100 gallons of water; the addition must be so small that the water, when placed into a white earthenware vessel, has only a faint bluish tinge. The cloth is left a short time in this bath, during which the finely divided indigo deposits upon it; it is then wrung and brought into the bleaching bath.

The bleaching liquor is contained in a wooden well-closed vessel, and consists of a solution of freshly prepared subsulphate of soda (NaHSO_3) of 1.0069 to 1.0283 specific gravity, according as there is a necessity for more or less strength. To each gallon of the liquid are then added from three to six cubic inches of acetic acid of 50 per cent., and free from any mineral acid. The whole is then well stirred, and the yarn or cloth to be bleached introduced, after which the vessel is closed to prevent the atmospheric air entering. In this way the indigo, mechanically attached to the cloth, is converted into indigo-white, which latter is absorbed by the fiber, while the sulphurous acid, formed from the hyposulphite, performs the bleaching action. It takes from a few to twelve and twenty-four hours for this operation; when completed the cloth, taken out of the bath, must show a clear white, with a bluish tinge, after having been rinsed in water. As soon as this is attained the cloth is all taken out, drained, and exposed to the action of the air, by which means the indigo is again brought back to a blue color, and gives the cloth a bluish shade. Where the bath has been a strong one, it is advisable to treat the cloth afterward in a solution of crystals of soda of one half to one per cent. Finally the cloth or yarn is washed in clear running water, wrung and dried in the air, or a stove at a temperature of 100° to 110° . The foregoing proceeding may be varied by adding the acetic acid after the bleaching bath, but this deprives the acid of one of its chief functions; for it not only has to retain the indigo-white in process of formation on the fiber, but also to prevent that the blue indigo, which at the beginning adheres only mechanically to the cloth, does not detach itself, and float into the bath. The action of the acid can be easily tested; when indigo, ground damp, is put into a vessel containing water, the latter will for days appear blue; as soon, however, as a little acid is added, all indigo is precipitated.

When bleaching loose wool it is best to add the indigo to the hyposulphite bath, to place the wool in after a quarter of an hour, and half an hour later to add slowly the necessary quantity of acetic acid (one part acid to ten parts water) without taking the wool out. The remainder of the operation is as above.

If after the drying the cloth does not show sufficient whiteness, it is advisable to submit it to a second bleaching without any further addition of indigo, for which an old bath can be used. It is in that case necessary to first test the bath with nitric acid, to find out if it separates sulphur. If this action occur, it is a proof that the old bath still contains subsulphuric acid; in the contrary case it is necessary to add 1-10th or $\frac{1}{4}$ of the previously added hyposulphite, and to leave the cloth in the bath until the hyposulphite has changed to sulphite of soda; the cloth is then taken out, and so much nitric acid added until the presence of sulphurous acid is easily detected by the smell, and the cloth then reintroduced until it is completely bleached. The first submersion accomplishes the fixation of the indigo on the cloth; the second corresponds with the old method of bleaching with watery sulphurous acid. When loose wool has to be bleached a second time, the bath can be made of a specific gravity of 1.035 to 1.043, and without addition of acetic acid. Such a bath can be regenerated by the addition of nitric acid until it smells of sulphurous acid, and then the addition of metallic zinc.

Where a wool is remarkably yellow, it is advisable to take subsulphate of lime in place of the salts of potash or soda. The former are obtained by adding metallic zinc to a solution of bisulphite of potash; the vessel is then closed, and occasionally shaken; after an hour the clear liquid is poured off (and which contains a little zinc in the form of a double salt of zinc and sulphide of potash), and used for the bleaching bath. To be able to bleach with hyposulphite of calcium, it is requisite to add milk of lime to the fore-mentioned liquid, until it reacts slightly alkaline. After this a bath of hyposulphate of calcium is prepared without any further addition, the same being of a specific gravity of 1 to 1.028, and the wool added without being previously blued with indigo. The wool is then washed, treated with weak acetic acid, and washed a second time.

When it is desirable to have a white with a greenish tinge, the cloth is passed through a water-bath slightly acidulated with nitric or sulphuric acid. Where a reddish or violet shade of the white is desirable, the cloth is passed through a bath slightly colored to the required tinge.

The strength of the baths mentioned depends upon the degree of color to be removed, and as a rule is taken weaker for silk or other fibers than for wool. The process is, in fact, applicable to all animal fibers, and is said not to be dearer than the usual method, while it is said to furnish a thoroughly fast bluing.

ON AN ANILINE BLACK WHICH DOES NOT TURN GREEN.

I WISH to call the attention of the Society to a particular fact in the history of aniline black. Without entering into details, I will say that my dyeing processes consist essentially in causing salts or metallic oxidizing acids to act upon aniline in an acid solution in presence of the goods to be dyed. These become green, darker and darker, and finally

turn black when the oxidation reaches a sufficient point, and the flut remains perfectly limpid.

Besides the novelty of this kind of dyeing, I wish to point out especially the exact part which the metal plays in the constitution of these blacks, and which is quite different from its mode of action in Lightfoot's process. In this latter process the metal has no other effect than simply decomposing the chloric acid, which does not produce a black, into lower oxides of chlorine, which produce a black.

The experiments of M. Rosenstiehl are decisive on this point, and explain perfectly how it is that infinitely small doses of copper, and especially of vanadium, suffice to produce the color.

In my blacks, on the contrary, it is remarked that in spite of the acidity of the solutions, the metallic oxides derived from the salts or the acids employed fix themselves upon the fiber in a true combination with the black—a combination much more intimate than that of ordinary lake colors, and very probably in a state of true substitution.

The blacks that I produce will be blacks of metal-anile. One or more equivalents of hydrogen are replaced by one or more equivalents of metal, which gives to the products of ulterior oxidation a special stability because of the stability of the metallic oxides, and of their affinity for oxygen. This is what I said textually in my patents of November 3d, 1874, and in the claim of my English patent of October 21st of the same year I insisted upon the fact that this metallizing action of the metallic salts may either precede or succeed the oxidizing action.

[N. B.—Metallic oxides in contact with or anic matter are not necessarily stable.]

I claimed at the same time the application of these metal-anile blacks in printing, but I was stopped by the difficulty of reserving the whites or the other colors associated with the black.

The receipts which have since been given are merely a particular application of my theory, a special determination of the reagents pointed out by me, with the object of not soiling the whites and not destroying colors other than black.

The authors of these receipts, to whom I have imparted my theories and my results, have asserted that the black did not turn green in consequence of a more complete oxidation.

Two very simple experiments enable me to prove that this theory is erroneous, and that mine alone is exact.

Let us take a piece with black and white stripes, printed by Lightfoot's process and subject to greening.

We fix the black by taking it through a boiling beck of acidified persulphate of iron. When the transformation is complete, and the black no longer turns green, we remark that the beck no longer contains any ferric salt, and that all the oxide of iron which came from it may be found upon the black parts of the cloth, while the white is not at all soiled if the proportion of acid was sufficient.

Thus, therefore, aniline black, in fixing itself, attracts iron in a beck so acid as not to deposit a trace upon the white portions of the cloth.

The following example is still more decisive, permitting us to distinguish two phases in the action of the reagent in the former, of which it plays an oxidizing, and in the second a metallizing part. We may fix the black with chromic acid, acidified with sulphuric acid. As soon as a piece printed with aniline black, capable of turning green, has been worked for some minutes in a boiling beck containing a certain proportion of this reagent, the chromic acid is very rapidly reduced, and the liquid, which was yellow, becomes green. At this moment, though the reagent has exhausted all its oxidizing power, the black will still turn green if exposed to sulphuric acid. We may double, triple, quadruple the proportion of the reagent, and may turn the black grayish, and finally destroy it, but still without hindering it from turning green.

If, on the contrary, we work the goods in the beck with the original lot of the reagent for thirty to forty-five minutes, the liquor turns from green to a violet red. At this moment the black is fixed, and has become incapable of greening. It has attracted the total of the chromic oxide derived from the reduction of the chromic acid, and of which there no longer exists a trace in the bath, but which may now be found upon the black parts of the tissue. [If not a trace of chrome remains in the bath, asks the *Chemical Review*, to what is the violet red color due? It is well known that certain modifications of the salts of chrome in solution display this color.]

To sum up, aniline black is capable of forming with certain metallic oxides true combinations which give it a peculiar stability. This metallization of aniline may either precede or follow the oxidizing action which transforms it into black. The combination of aniline and of the metal is a true substitution. Aniline black incapable of greening is very probably a black of metal-anile.—M. S. GRAWITZ, in *Bulletin de la Soc. Chimique*.

ON CERIUM ANILINE BLACKS.

THE application of cerium in the development of aniline black has only been transitory, but having used it in printing, I take the liberty of communicating my observations.

This application has more than a merely historical interest, since cerium is a metal which, by its analytical properties, belongs to the aluminum group, not widely remote from the iron group. All the other metals in use for aniline blacks, such as copper, vanadium, tungsten, are precipitable by sulphureted hydrogen or by sulphureted ammonium as sulphurets, while cerium is only precipitated as a hydrated oxide.

The use of cerium for aniline blacks, like that of the other metals employed, is based upon its property of becoming easily reduced and again oxidized. It forms two series of salts corresponding with its two stages of oxidation—salts of the suboxide, and salts of the oxide. The former are easily oxidized in presence of oxidizing agents, such, for instance, as the chlorates or chloric acid, forming the hydrated oxide of cerium of a red color. The salts of oxide of cerium, on the other hand, are reduced by deoxidizing agents, such as alcohol with muriatic acid, to salts of the suboxide.

It is in virtue of these properties that the chlorate employed in mixtures for aniline blacks is decomposed, and the aniline forms black. The action continues till all the chlorate has been decomposed.

The chlorides and sulphates of cerium are soluble in water; and in my first experiments I made use of the bisulphate of cerium—a salt of a yellow color, soluble in six parts of water. I took 75 grains of bisulphate to $\frac{1}{4}$ pint of color, weighing 2 lbs. $6\frac{1}{2}$ ozs., and containing $2\frac{3}{4}$ ozs. muriate of aniline. The color printed very well, and did not attack the doctors. After printing it appeared of a very light green, and then become of a deep green, after aging for 24 hours at a temperature of 77° Fahr. by the dry

bulb thermometer, and 68° Fahr. by the wet bulb. After soaping and passing through an alkaline bath the color finally takes a rich velvety black.

But the bisulphate of cerium, as well as the chloride, is not to be found in the market, though the oxalate of cerium can be procured, a salt of a reddish white color almost soluble in water. It is in a sufficiently fine powder to be mixed with the colors.

On taking, however, 75 grains to 1.75 pint of color an ageing of 24 hours is insufficient, and more than a week must be taken. I supposed that the insoluble condition was the cause of this inconvenience, and I, therefore, treated the oxalate with dilute sulphuric acid in presence of alcohol. On taking 120 to 150 grains of oxalate per 1.75 pint, the color becomes slightly acid, and it is necessary to protect the doctors from its action during printing.

I have used this color for chrome orange styles, on an aniline black ground. When the black is oxidized I fixed the lead with a bath of sulphuric acid at 5° B., and after washing developed the orange by a single passage through bichromate of potash mixed with chalk.

I have not tried if it is possible to succeed better by completely dissolving the cerium in muriatic acid, then neutralizing with the quantity of aniline needful. It is possible that by this means a color easier to apply might be obtained.

In conclusion, I would remark that cerium interesting as its use may seem, presents little advantage over the sulphuret of copper. It is true that one-fourth part the weight of a salt of cerium gives a good result, but this reduction is counterbalanced by the high price of the salts of cerium. Consequently these salts have not found any particular practical application, vanadium having appeared at the same time and filled up their place.

Nevertheless, gratitude is due to M. K uis for having pointed out the properties of cerium, and thus increased the number of elementary bodies applicable in the formation of aniline black.—M. Ch. WEIDINGER, presented to the *Industrial Society of Rouen*, in *Moniteur de la Teinture*.

PAINTING UPON WOOD AND CANVAS—THE
DETERIORATION OF OIL PAINTINGS.*

By R. LIEBREICH, M.D., M.R.C.S., M.R.I.

OIL paintings are subject to various kinds of changes, which may be considered as diseases, requiring different treatment according to their different nature. A science needs to be formed—a pathology and therapeutics of oil paintings. The pathology would have to describe and explain those diseases and their progress, and to develop the methods by which a correct diagnosis could be arrived at in each individual case. The therapeutics would teach the remedies which might be applied either to cure or to alleviate the disease, or at least to stop its progress. A hygiene would follow, which would have to teach how to avoid pernicious influences, and which, besides, while giving precepts for the technical process of painting, would have to forestall those constitutional diseases which, even in cases where no noxious influences can be traced, are the causes of decay, after a comparatively short period of existence. As medical science is above all things based on anatomy and physiology, so the exact knowledge of the structure of a picture would have to be acquired previously to any study of its disease. Unfortunately, direct investigation alone can procure no such exact knowledge; on the contrary, we are obliged to enter upon a minute historical investigation of the material as well as of the technical methods adopted by artists of different schools and different periods.

The excellent works of Cennino Cennini, Mérimée, Sir Charles Eastlake, Mrs. Merrifield and others, have already furnished most valuable material; but still the field for investigation remains unlimited; for, in order to enable us to secure the conservation of each valuable painting, we ought to know exactly how it was made. The artists of the present time would spare infinite trouble to the investigators of future times if, along with their works, they would leave the account of their practice in the case of each picture. A treatment without exact knowledge of the normal condition, as well as of the nature of the disease, is, as we shall see, as dangerous for the picture as it would be in the case of living beings.

Professional restorers of pictures admit this danger in a general way; each of them, however, is convinced that he himself, by his personal knowledge, skill and care, knows how to avoid it. The public pays too little attention to the subject, and therefore it occurred to me that it might be useful to give a short account of what we know about this question, of the changes to which oil paintings are exposed, as well as of the means either to avoid or to cure them.

We have to consider, first, the material on which the artist has painted, that is, as far as oil painting is concerned, principally wood and canvas.

Secondly, the priming, that is, the substance with which the surface was prepared in order to be made fit for painting.

Thirdly, the painting itself, that is, the pigments and vehicles used for it, and the liquids that were added during the painting, the mediums, megilp, siccative, varnish, essential oils, etc.

Fourthly, the coat or coats of varnish spread over the picture.

The wood on which a picture has been painted may either warp, or get chinks in it, or become worm-eaten, or even altogether rotten. Against warping, the remedy usually applied is moisture. If the panel is very thick it is first made somewhat thinner; then the back is moistened, and the picture is left to lie on its back for twelve to twenty-four hours, after which time it will be found to have bent straight. Of course this must not be continued longer than necessary, otherwise the convex surface, instead of becoming plane, would become concave. When straight, the picture is kept so by beads which have to be adapted in a particular way, a certain degree of shifting being allowed for the expansion and contraction of the wood.

Cracks in the wood are drawn together by inserting pieces of wood of a special shape.

Sublimate solutions are employed to destroy worms.

Trifling losses of substance are replaced by cement. Small portions of rotten wood, not extending too near the painting, are cut out and replaced by wedge-shaped pieces. If, however, the greater part, or the whole substance of the panel, is rotten, the picture must be separated from it and transferred to new wood, or rather to canvas.

This was first tried by Hacquin in Paris, and was performed successfully upon many pictures, and, among others,

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* Lecture delivered at the Royal Institute of Great Britain, 1878.

upon one of Raphael's Madonnas, in the Gallery du Louvre, and upon Sebastian del Piombo's "Resurrection of Lazarus," now in the National Gallery. The process no longer appears so very marvelous; it is generally executed in the following way:

First of all the surface of the picture is pasted over with gauze and paper; after that the wood is made straight by moistening, or, if necessary, by making incisions with the saw, into which cuneiform pieces of wood are driven. By means of a tenon saw the panel is to be sawn into little squares, which must be removed by a chisel, and in this way the thickness of the wood is reduced to half an inch; it is then planed until it becomes no thicker than paper, and the rest is removed by means of a knife and with the fingers. The painting being thus severed from its basis, it can be fixed on canvas, if the priming is sufficiently preserved. In the opposite case, a mixture made of chalk and glue, or something of the kind, must be put on first, and very evenly smoothed after being dry. This done, the new canvas has to be fixed upon it by means of a mixture of glue, varnish and turpentine, and the substance of the picture pressed tightly and evenly against it by means of warm irons.

In order to avoid deterioration, the most minute precepts have been given for preparing the panel. It has to be taken from the best oak, or nut trees, or cedars. The wood is to be cut into boards during the winter-time, and kept till autumn before being dried; it can then be prepared only in the following spring, etc. It would certainly be preferable to give up wood panels altogether for large pictures, and only to think of means to make the canvas stronger. For small pictures, panels offer certain advantages, and can be more easily preserved from decay.

In the canvas we meet with the results of injuries or spontaneous decay. A rent may be mended by rags of linen stuck at the back of the picture. Even a hole may be filled up by pieces taken from other decayed paintings. If the picture is considerably damaged, it will be best to line it. But if the whole canvas is rotten and tattered, it will be preferable to sacrifice it by pulling off the threads one by one, after having secured the painting itself by pasting paper on the front of it. This done, the painting is transferred to another canvas in the same way as those removed from wood.

There are different modes of priming, which may be brought under two principal heads: the distemper and the oil priming.

1. The canvas is distempered by a mixture of chalk or plaster and paste, or glue, which may be laid on raw, unbleached canvas, or this latter may be beforehand prepared with glue or paste. Several coats of this mixture must be put on in succession, one being perfectly dry before the next can be applied. Many of the older oil paintings are painted on such ground. It has the advantage of being quicker prepared, of absorbing the excess of oil, of permitting the color to enter into the priming, and to dry quicker, and, moreover, of containing a white absolutely innocuous to other colors.

The inconveniences, on the other hand, are: that it more easily breaks, and under the influence of humidity separates from the canvas.

2. The oil priming consists of several coats of oil colors. As each of these must be perfectly dry before the next is laid on, and as, moreover, time must be given to the whole to dry completely before painting upon, in order to avoid the sinking in of the colors, the whole preparation is much slower than the distemper. Nevertheless it is now generally adopted.

Rey, in France, has pointed out a process which is a compromise between the two methods; he begins by distempering, and after several coats of distemper, having dried one after the other, he puts a coat of oil, which, as it were, changes the distempered ground into an oil color ground.

With oil priming it is of importance that the principal color be white lead, to which are added comparatively small quantities of yellow, black, or other colors. For a whole century a school, that of Bologna, predominated in Italy, which abandoned this principle. During the second half of the seventeenth and the first half of the eighteenth century most of the Italian masters of other schools followed its example. Probably for the purpose of obtaining more easily the desired effect of the chiaroscuro they painted on a brownish red priming, which consisted of bolus mixed with umber. Not one of those pictures has kept its original coloring. Not only has the priming caused all the dark parts to grow much darker, but it has destroyed, or nearly so, all the glazing, so that only those colors can be recognized which either contain white or are glazed on white. I can show you numerous instances of this, for, on account of the extreme fertility of this school, there is little difficulty in procuring pictures of masters of that time or of their pupils.

Wood priming does not require the same elasticity as that of the canvas, which ought to be capable of being rolled. Therefore the priming of the wood shows less variations. It is generally composed of chalk or plaster, tempered with starch, paste, size or glue, and more or less thickly laid on. In some pictures of different centuries we find, either between the wood and the priming, or between the priming and the painting, canvas, and exceptionally even paper.

The diseases of the priming are not of a very complicated nature. They manifest themselves principally in three different ways: 1, by cracks in the priming itself; 2, by the severance of the priming from the painting; 3, by the severance of the priming from the wood or the canvas. The third disease is by far the most frequent, especially among pictures on canvas distempered with paste. If small pieces only are scaling off or blistering, they are fixed again to the ground by letting a solution of size pass between the detached part and the canvas, and pressing both gently together. If the deterioration extends over a considerable surface, the picture has to be lined. While this is being done, and while the gluing substance penetrates into the picture, the detached parts are pressed on again with slightly heated irons. If the whole priming threatens to come off, it will be better to take the picture entirely from the panel or canvas, and to transfer it to a new canvas.

I shall show you examples illustrating the before mentioned points, and among them two pictures, one in oil, taken off from canvas, the other in tempera, taken off from wood. Both of them, strange to say, have escaped destruction without having been transferred to a new canvas, and without being covered with paper, as is usually done, before taking them off. They show you the painting by itself from both sides. I have, of course, used every precaution in bringing them safely over from Florence, where I happened to discover them carefully stowed away among heaps of old pictures.

We come now to the most important part of the picture, the painting itself. We meet very often with the idea that

the old masters had been in possession of colors, that is pigments, the knowledge of which has been lost, and that this accounts principally for the difference between the oil painting of the fifteenth and sixteenth centuries, on the one hand, and that of the eighteenth and nineteenth on the other. But this is a great mistake. We know perfectly well the pigments used by the old masters; we possess the same, and a considerable number of new ones, good as well as bad, in addition. In using the expression of good and bad, I am principally thinking of their durability. From this point of view the pigments can be placed under three headings:

1. Those that are durable in themselves, and also agree well with the other pigments with which they have to be mixed.

2. Such as when sufficiently isolated remain unaltered; but when in contact with certain other pigments change color, or alter the others, or produce a reciprocal modification.

3. Those which are so little durable that, even when isolated from other pigments, the mere contact of the vehicle, the air, or the light, makes them in time fade, darken, or disappear altogether.

The old masters used, without reserve, only those belonging to the first of these three categories. For those belonging to the second they imposed on themselves certain limits and precautions. Those belonging to the third they did not use at all.

That some of the modern masters have not followed these principles is not owing to a lost secret, but to the fact that they disregarded those well known principles, and even consciously acted against them. In Sir Joshua Reynolds' diary, for instance, we read that in order to produce certain tints of flesh, he mixed orpiment, carmine-lake and blue-black together. Now, orpiment is one of the colors of the second category, carmine-lake one of the third. That is to say: orpiment, as long as it remains isolated, keeps its brilliant yellow or reddish-orange color; but when mixed with white lead it decomposes, because it consists of sulphur and arsenic, and it, moreover, blackens the white lead, because the sulphur combines with it. Carmine-lake, even if left isolated, does not stand as an oil color, and therefore has been superseded by madder-lake.

Unfortunately some of the most brilliant colors are perishable to such a degree that they ought never to be used; yet, it seems to me, that just in one branch of art in which of late remarkable progress has been made, I mean landscape painting, the artists, in order to obtain certain effects of color not easily to be realized, do not always resist the temptation to make use of a number of pigments, the non-durability of which is proved beyond doubt. However that may be, I think it pretty certain that the pigments in themselves play only a subordinate part in the deterioration of oil paintings, and that the principal part belongs to the vehicle with which the colors are ground, and to the liquids which are added during the painting. I hope, therefore, you will excuse my making some elementary explanations about these liquids.

PHOTOGRAPH ENLARGEMENTS.

THIS invention, by Messrs. Warlich & Cadett, of England, has for its object the production of enlarged photographs direct from negative or positive pictures.

A condenser is placed at the proper distance from the light to condense the rays thereof, the said condenser being

Fig. 1.

hollow, so as to allow of being kept filled with water or other liquid, and by means of an arrangement of pipes water or other liquid or solution of any substance that may be considered fit for the purpose is made constantly or at intervals to flow through the said condenser for the purpose of keeping it cool.

The apparatus which holds the said condenser has also a similar arrangement, by which liquid can be made to flow through it for the purpose of keeping it cool.

FIG. 3.

Glass condensers, in place of the hollow condensers just described, can be used for the purpose of this invention, but in such case it would be desirable to interpose between the light and glass condenser a glass trough or transparent receptacle for water or transparent liquid, having arrangements for changing or flowing the water or liquid through the same. Such receptacle for flowing the water or other liquid can be formed by making one face of the lens a side for such receptacle, a plate of glass forming the other side

of the trough; or the space between the condensers, when two or more are used, may be used as a water or liquid compartment.

In cases where the heat would be excessive a trough or transparent receptacle might be used, in which the picture to be taken is immersed in water or other fluid, which is kept circulating through the trough or receptacle, or is changed by means such as described. On the side of the condenser, from which emanate the condensed rays of light, and at a proper distance from the said condenser, is placed the positive or negative picture to be enlarged, and at a still greater and proper distance in the same line a lens is placed parallel and concentric with the said condenser. The condensed rays of light, on leaving the said condenser, pass through the negative or positive picture to be enlarged, according to the several densities of its different parts, and are then taken up by the above lens, the result being that an image of the above positive or negative picture is projected at a proper focus, and the said image is made to project upon any suitable surface sensitive to light.

When the electric light is used an arrangement is, or may be, employed for keeping the light central with the said condenser and lens, which it does by means of clockwork or

FIG. 2.

otherwise, and utilizing part of the heat evolved from the light.

In using sunlight the box or lantern used with artificial light is not necessary, and the rays of light are projected into the said condenser by the usual means.

Fig. 1 shows in outline the arrangements for producing enlarged photographs.

Fig. 2 is a view in outline of arrangements for keeping the light central with the condenser or lens.

Fig. 3 shows a form of hollow lens.

Fig. 4 shows an arrangement of two lenses or condensers, with chambers at back and front.

Fig. 5 is a front view of Fig. 4.

Fig. 6 is an arrangement with a separate trough or receptacle placed in front of the lenses.

A is the point where the light is placed; B, the condensers; C, position of negative or positive picture; D, lens or lenses placed parallel with the condensers, B; E, position for enlarged negative.

It is to be understood that the drawing is simply for the purpose of exemplifying the method adopted, as the positions of the negative or positive picture, the lens, and the enlarged image depend entirely upon the operator and the subject to be treated.

The condenser or condensers, B, receive the rays of light from A, and such rays are condensed and pass through the negative or positive picture, C, to be enlarged, and are then taken up by the lens or lenses, D, and projected at the proper focus to produce the enlarged image at E from the said negative or positive picture, C. The condensers, B, are, as before described, hollow, to allow a continuous flow of water or liquid through the same, the water or liquid issuing in at a, passing upwards through one condenser, and thence by the pipe or other means conveyed down and into the second condenser at b. It thence flows upwards and out by a pipe or other means from the upper part. By this continuous flow of water or liquid through the condensers the same are kept cool and insure the efficient working of the arrangements.

The arrangements shown in Fig. 2 are placed so that they do not interfere with the rays from the condensers to the lenses, and such arrangements are for keeping the light central.

In any part within the path of the rays is placed a lens, b', in front of which and at the focal point on either side thereof are springs or means, s, s', which by the effect of the heat from the focus of the lens make contact with the electrical communication, the result being that by such contact the magnets, m, m', act upon detents which free clockwork or other means inclosed in chambers, c, c', and thus the lamp is raised or lowered to keep the light central with the condensers and lenses, as before described.

The action is as follows: Suppose the light falls too low, the result would be that the focal point between the springs

FIG. 4.

or means would rise and fall upon s', and contact would be made by expansion of s' through heat, and communication would be made by electro-magnet, m', in chamber, c'. The detent would thus be released, and the lamp raised until the light assumed its normal position between s and s', as shown. If the light be too high the focal point would fall and act upon s, and, by the electrical communication, the magnet, m, would act upon the detent and lower the lamp.

In Fig. 3 the water or other fluid which circulates between,