ART. IV.—*Image Transference*; by M. CAREY LEA, Philadelphia.

BY the term, *Image Transference*, I propose to denote certain effects produced on sensitive films, effects curious in themselves, and of interest in connection with the subjects of papers which have appeared in the May and June numbers of this Journal.

In those investigations it was shown to be possible to take a film of a silver haloid—chloride, bromide or iodide, and after making marks upon it with sodium hypophosphite to obtain a development of these marks, precisely as if they had been impressed by light, but quite independently of any exposure to light. I now propose to show that it is possible to develop on a film of silver haloid a complete image—a print from a negative for example, without either exposing the silver haloid to light, or to the action of hypophosphite, or subjecting it to any treatment whatever, between the moment of its formation and that of its development. The film of silver haloid comes into existence with the image already impressed upon it.

For this purpose almost any silver salt is selected; citrate, benzoate, tartrate, pyrophosphate, etc., answer perfectly. (Some silver salts, the phosphate especially, undergo a slight reduction spontaneously in the dark; these are less suitable.) A film of the silver salt selected is formed on paper by the ordinary methods, and this is exposed under the negative to a few seconds of sunshine.

The next step is to convert this film into one of silver chloride or bromide, by plunging it for a few minutes into dilute acid. Ordinary hydrochloric acid may be diluted with six times, commercial hydrobromic with two or three times, its bulk of water; the exact strength is unimportant. After a short immersion, the acid is to be washed out, and it only remains to put the film, now consisting of silver haloid, into a ferro-oxalate developer, when the image appears at once. The chloride or bromide of silver into which the salts above mentioned are rapidly converted by the halogen acid, comes into existence with the image already impressed on it at the instant of its formation.

So that although the substance which received the image is completely broken up and destroyed, the image is not, but is transferred in all its details to the new film of silver haloid.

It is therefore evident that the action of light on all silver salts that can thus transfer an image, must be similar in all its essentials to the action of light on the silver haloids. An important conclusion follows, that all such silver salts must be

capable of forming subsalts, else the image could not be transferred. In the case of most silver salts the existence of such subsalts has not before been recognized or even suspected; indeed, if I am not mistaken, the existence of such a subsalt of silver phosphate has been expressly denied. But the image formed by light on silver phosphate can be transferred, therefore subphosphate must exist.

These results have also a very direct bearing on the subject of one of my papers in the last number of this Journal. I there endeavored to show that the photo-salts of silver as obtained by purely chemical means are identical with the products of the action of light on the silver haloids, both with the material of the latent image, and with the visible product of the continued action of light, or rather with the most characteristic constituent of that product. As respects this latter identity, I showed that although the brightly colored photo-chloride could not be obtained by the direct action of light on silver chloride, it could readily be formed indirectly by acting with light on other salts of silver, and treating the product with HCl.

It might be argued that in this proof one link was wanting, viz: proof that the photo-chloride obtained by the action of HCl on silver salts, other than chloride, exposed to light, was of the same nature as that obtained by the action of light directly on silver chloride. The results above described supply that link, if it was needed, and show that the photo-chloride obtained by the action of HCl on silver salts, other than the chloride, exposed to light, has the same capacity for development as has the material of the latent image obtained on ordinary silver chloride.

But this proof itself may be thought liable to an objection. It may be said that as an image was certainly impressed upon the original film, it is not completely proved that the halogen acid had anything to do with the ultimate production of a developed image. The objection would not be well taken, and the experiment may be varied to two ways, either of which eliminates it.

Most silver salts are soluble in nitric acid. After applying the halogen acid, it may be washed off, and the paper may be placed in nitric acid until every trace of the original salt (supposing that any escaped the action of the HCl or HBr) is removed, and until it is absolutely certain that nothing is left in the film but the silver haloid. When this is done, the development, so far from being impeded, is rendered only the stronger and brighter. Certainly therefore the silver haloid is the essential base of the development.

Another very decisive experiment may be made in this way. Paper prepared with tartrate, oxalate or almost any other salt of silver, is to be exposed for a minute or thereabouts to a strong light; (not under a negative). It is then taken into a dark room, and marks are made upon it either with a glass rod or a camel's hair pencil dipped in dilute hydrochloric or hydrobromic acid. After letting the acid act for five or ten minutes, it is to be washed off, the paper plunged into nitric acid, and after again washing, it can be placed in a developing solution when the marks made will appear black on a white ground. This mode of operating gives a very convincing result. The nitric acid treatment may be omitted, but when this is done, the number of salts that can be used is more limited. The four salts first above mentioned give good results, even without the nitric treatment, but some silver salts undergo a spontaneous change in the dark by keeping a short time, such that when they are placed in a developing solution (without exposure to light) they may blacken instantly all over. Silver tartrate is one of the best salts to operate with, though pyrophosphate, citrate, oxalate and some others do almost equally well. Sulphate, antimonio-tartrate, phosphate, nitrite and arsenite do not give good results, except with the nitric acid treatment.

With a salt like tartrate or oxalate the experiment is very striking. The paper imbued with it is exposed to light over its whole surface, it is then taken to the dark room, and simply marked with dilute HCl or HBr and washed. Thrown into a developer, all the marks of the halogen acid quickly blacken, proving, first, that the effect of light is transferred from the one salt to the other; second, that the effect as transferred to the chloride or bromide is far more susceptible of development than it was in the original salt. It seems a not unreasonable explanation of this last-mentioned fact that the greater sensitiveness of the haloid compounds may depend on their power to combine with their own subsalts, so that the reduction may commence with the subsalt, and quickly extend from it to the portion of normal salt with which it is combined; that on the other hand, other silver salts may not share this power of uniting with their subsalts, and are consequently more slowly and imperfectly attacked by the developing solution. This explanation may or may not be correct, but seems not improbable.

A curious fact incidentally presented itself in the course of this investigation: that when paper prepared with silver salts, other than the haloids, was exposed to light, and then marked with HCl, the effect of a short exposure, so far as development was concerned, was as great as that of a long one. A piece of paper was prepared with a given salt by non-actinic light. It

was then placed between the leaves of a closed book with one end projecting. The book was then placed in the light (very faint sunshine), and the prepared paper was gradually drawn out so that different portions received progressive exposures from 400 seconds down to 3 seconds. A number of marks were made with HCl diluted, parallel to the end of the paper, so that to each mark corresponded a different exposure from 3'' to 400''. The papers were then placed in nitric acid, washed and developed. These pieces are before me as I write, and it is impossible to say by the appearances which portion received the 3 seconds, which the 400. The marks are equal in strength on each paper from one end to the other. The salts used were: silver benzoate, tungstate, phosphate, pyrophosphate and tartrate. The short exposure gave a sufficient basis for development, the longer effected nothing more.

The object of this series of papers has been to offer a new explanation of the nature of the latent photographic image, and to show that it consists neither of the normal silver haloid physically modified, nor of a subsalt, but of a combination of normal salt and subsalt. That the subsalt loses in this way its weak resistance to reagents, and acquires stability, thus corresponding to the great stability of the latent image, which, though a reduction product, shows considerable resistance to even so powerful an oxidizer as nitric acid.

Further, that this combination of normal salt and subsalt, which constitutes the material of the latent image, can be obtained by chemical means, and wholly without the aid of light. That the forms of these photosalts, as I have ventured to name them, which correspond to the material of the latent image are either colorless or nearly so, but that other forms, possessing beautiful and often intense coloration, also exist. With the chloride some of these brightly colored forms show a ready tendency to reproduce color, in some cases with well marked and beautiful tints. So that we have here an approach to the solution of the problem of obtaining images of objects in their natural colors from a quite new direction, and probably with better hopes of an eventual complete success than by any of the older methods.

Philadelphia, May 17, 1887.