

Section of Photography and Microscopy.

Stated Meeting, held Thursday, December 5, 1901.

ON THE REVERSAL OF THE PHOTOGRAPHIC IMAGE AND ITS SUBSEQUENT DEVELOPMENT IN ACTINIC LIGHT.

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Prof. Francis E. Nipher, during the past year, presented several communications to the Academy of Science of St. Louis that have renewed the general interest in the subject of sensitive silver salts and their characteristic behavior to the action of actinic light. The peculiar fact that these silver salts have the property of assuming a certain physical condition that makes them particularly susceptible to the action of reducing agents, and also that an extended exposure to actinic light brings about a reversal of this peculiar physical condition, were facts that had been observed long before Professor Nipher made his interesting communications. The feature of his experiments that was original, and that was all that Professor Nipher claimed to be original, is the possibility of developing these reversed photographic images in actinic light.

The statement of this fact, when first made, appeared to be so different to what we were accustomed, in ordinary photography, that it created widespread attention, and caused numerous experiments to be made along the same lines.

Following up a suggestion that was made before the Photographic Section of the Franklin Institute some two months ago, I made several experiments along these same lines. These experiments appeared to me to be interesting, and to some extent also instructive. Professor Nipher, in one of his early communications, states that a photographic plate, even after it had been exposed for weeks to diffused daylight, would still give an image if exposed to the direct

spark discharge of an induction coil or a static machine, and subsequently developed, either in the dark room or in bright daylight,

To test this statement I allowed several pieces of damaged photographic plates to lay exposed to bright light for ten days or two weeks, and then subjected them to a spark discharge; the resulting electrographs were then developed in bright light, and, in each case, the resulting picture showed the action of the electric spark clearly. In one case, shown here, a coin was placed in the center of photographic plate and connected with one terminal of the induction coil. In the resulting picture we see plainly the radiations of the spark in all directions. The most interesting part of this particular experiment, however, is the fact that the area immediately under the coin and a very narrow zone around it has been completely reversed, while the spark radiations, with few exceptions, show dark against the fogged background of the plate itself.

Following up Professor Nipher's own experiments, I exposed a very sensitive photographic plate under a positive, in this case a dense lantern slide, for five minutes and then developed the same at a window with northern exposure, using an old metol-hydroquinone developer without any further restrainer. The resulting picture makes a presentable lantern slide, and represents fairly the condition of the original positive.

To get an idea of the length of time necessary to obtain the best results under similar conditions, I interposed between the plate and positive a piece of heavy black paper. By withdrawing this paper gradually, I was able to make on the same plate exposures of one, two, four and eight minutes. As will be seen by an inspection of this picture the portion of the plate that has not had any exposure under the positive is entirely opaque; that portion that was exposed for one minute is very dense, but the portions of the picture representing the deepest shadows in the original picture are not entirely reversed. The portion of the plate exposed for two minutes is next in density, and here we have complete reversal of all portions of the picture. The parts that were

exposed four and eight minutes respectively, are not nearly as dense and differ but little in their general appearance. This is a feature that should especially be noted, as it appears to me to be evidence of a protective influence of the upper layers of changed silver salts, similar to what we would naturally expect to have had in the plates that had been exposed to diffused daylight for weeks. This experiment was gone over on several occasions, with uniform results. Even in cases where the highest exposures were as long as an hour, or the equivalent of many hours' exposure in a camera, the high lights came out quite clear, barring the general vagueness that we see in all reversed pictures.

A series of exposures made with a camera were, however, of even greater interest to me showing, as they do, the very great range of exposure that is possible with rapid photographic plates under practically the same conditions of illumination and development.

The subject was Girard College in bright sunlight at or near mid-day. The first picture is a negative made with an exposure of approximately half a second, using a Beck wide angle lens having a 128 stop. The resulting picture developed with fresh normal metol-hydroquinone developer, came up to its present density in a little over four minutes after being placed in the developing solution and is, if anything, a little overexposed.

The next picture had exactly the same amount of exposure with a sixteen stop, giving it approximately eight times the amount of light of the first; the plate developed very much more rapidly, but is still a very fair negative.

The next one of the series was exposed for five seconds under exactly the same conditions as the previous one, using the sixteen stop, and the result is still a negative, though rather thin; but when we consider that it has had eighty times the light that the first negative had, we will appreciate that the possible range of exposure is really remarkable.

The next plate had an exposure of fifty seconds, and shows traces of general fog; you can see, however, that there are distinct traces of reversal; the high lights are

completely reversed and almost clear. This plate would probably come somewhere near the so-called zero condition, where the positive and negative conditions of the plate would nearly balance each other, and give as result of this a general fog.

Again increasing our exposure, this time to ten minutes, and developing the picture in the dark room, we obtained a completely reversed picture that is rather dense in the shadows on account of the activity of the developer; under these conditions, this plate did not require more than three minutes in the developing solution, and appeared to flash up very rapidly.

The next picture was given the same exposure, but developed at an unprotected window having a northern exposure—in fact, the same window from which the plate had been exposed in the camera. This required eight or nine minutes to develop, and the conditions of the development were quite different. When the plate was first taken from the camera there was plainly seen a distinct outline of the picture as a negative. On placing the plate in the developing solution this negative image gradually faded until the plate was perfectly blank, then the edges of the plate that had been protected by the holder began to darken, and following this the positive image gradually but slowly developed, the process requiring at least three times the time that was necessary in the dark room.

Some further experiments were made with a view of testing the action of various reducing agents; the exposure in these cases was twenty-five minutes, and more or less satisfactory results were obtained by using pyrogallie acid, amidol, eikonogen, metol, metol-hydroquinone, and hydroquinone as the reducing agents. The first four did not give very satisfactory results, as their action appears to be too rapid and rather irregular; the fifth was the developer used in the experiments alluded to above; while the sixth, hydroquinone, was used with and without an alkali, with interesting results. The first picture, which I show you, had the normal amount of alkali, as advised in the formula given by the manufacturer of the plates that were used. This plate shows up quite clearly and is quite black.

The next plate was developed with a developer having but half the amount of alkali, and, as you can see, it has a distinctly brown cast of color; it was also slower in development, although not markedly so.

The third plate was developed without the addition of any alkali, and presents a reddish-brown appearance in color, though sharp and distinct in all details of the picture. Speculation as to the principles involved in these processes are perhaps out of order, but it appears to me as though the action of light on sensitive silver salts was in the first stage a purely physical one, disarranging the equilibrium of the molecules of the silver salt and making them susceptible to chemical reducing agents; prolonged action brings about a chemical change that produces opaque metallic silver or a silver oxid, and this in turn protects the silver bromide molecules immediately below it from further action of light; the physical change is going on in other portions of the plate, and these in turn are susceptible of reducing by proper chemical agents, while the portion that has been acted on chemically is not. The change brought about by reducing agents is much more intense and opaque than is that produced by light, thus giving us a dark picture against a gray or hazy background. As evidence of this I would say that so far I have not seen any reversed pictures in which the highlights were represented by perfectly clear glass.

More evidence that the ultimate action of light is chemical is found in the fact that we may expose a plate under a negative for a sufficient length of time to produce the outlines of the picture distinctly, then fix the resulting plate in hyposulphite solution and still retain the faint outline of the positive, and this in turn may be intensified so as to be distinctly visible.

Under proper conditions we would no doubt be able to make photographic negatives in this way without the use of a dark room; that is, by first dissolving out the unchanged silver salts in a fixing bath and subsequently intensifying the very weak but distinct image remaining on the resulting plate.