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AND

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"Nec aranearum sane textus ideo melior quia ex se fila gignunt, nec noster vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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are led to look for the phænomena of mixed plates in minerals, such as *sulphate of lime* and *mica*, where a plate of two different thicknesses can be easily obtained. I have accordingly discovered the phænomena of mixed plates distinctly exhibited in sulphate of lime and mica.

A more splendid exhibition of these colours is seen when a stratum of cavities of extreme thinness occurs in sulphate of lime. I have observed such strata repeatedly in the gypsum from Mont-martre; but they are most beautiful when the stratum has a circular form. In this case the cavities are exceedingly thin at the circumference of the circle, and gradually increase in depth towards the centre, so that we have a series of edges increasing in thickness towards a centre; the very reverse of a mixed plate, such as a film of albumen pressed between two convex surfaces. The system of rings is therefore also reversed, the highest order of colours being in the centre, while the lowest are at the circumference of the circular stratum. In many strata of cavities, such as the one which I have engraven in my paper on the new fluids in minerals* the cavities are too deep to give the colours of mixed plates.

Another example of the colours of mixed plates in natural bodies occurs in specimens of mica, through which titanium is disseminated in beautiful flat dendritic crystals of various degrees of opacity and transparency. In these specimens the titanium is often disseminated in grains, forming an irregular surface. The edges of these grains, by retarding the light which they transmit, produce the direct and complementary colours of mixed plates in the most perfect manner, the tint passing through two orders of colours as the grains of titanium increase in size towards the interior of the irregular patch. I have observed another example of these colours in the deep cavities of topaz, from which the fluids have either escaped, leaving one or both of the surfaces covered with minute particles of transparent matter, or in which the fluids have suffered induration.

Allerly by Melrose, Oct. 18, 1837.

XXXVII. *Some Account of the Art of Photogenic Drawing.* By H. F. Talbot, *Esq.*, *F.R.S.*†

§ 1.

IN the spring of 1834 I began to put in practice a method which I had devised some time previously, for employing

* Edinburgh Transactions, vol. x. plate ii. fig. 33.

† Read before the Royal Society on the 31st of January, and communicated by the Author.

to purposes of utility the very curious property which has been long known to chemists to be possessed by the nitrate of silver; namely, its discoloration when exposed to the violet rays of light. This property appeared to me to be perhaps capable of useful application in the following manner.

I proposed to spread on a sheet of paper a sufficient quantity of the nitrate of silver, and then to set the paper in the sunshine, having first placed before it some object casting a well-defined shadow. The light, acting on the rest of the paper, would naturally blacken it, while the parts in shadow would retain their whiteness. Thus I expected that a kind of image or picture would be produced, resembling to a certain degree the object from which it was derived. I expected, however, also, that it would be necessary to preserve such images in a portfolio, and to view them only by candle-light; because if by daylight, the same natural process which formed the images would destroy them, by blackening the rest of the paper.

Such was my leading idea before it was enlarged and corrected by experience. It was not until some time after, and when I was in possession of several novel and curious results, that I thought of inquiring whether this process had been ever proposed or attempted before? I found that in fact it had; but apparently not followed up to any extent, or with much perseverance. The few notices that I have been able to meet with are vague and unsatisfactory; merely stating that such a method exists of obtaining the outline of an object, but going into no details respecting the best and most advantageous manner of proceeding.

The only definite account of the matter which I have been able to meet with, is contained in the first volume of the Journal of the Royal Institution, page 170, from which it appears that the idea was originally started by Mr. Wedgwood, and a numerous series of experiments made both by him and Sir Humphry Davy, which however ended in failure. I will take the liberty of quoting a few passages from this memoir.

"The copy of a painting, immediately after being taken, must be kept in an obscure place. It may indeed be examined in the shade, but in this case the exposure should be only for a few minutes. No attempts that have been made to prevent the uncoloured parts from being acted upon by light, have as yet been successful. They have been covered with a thin coating of fine varnish; but this has not destroyed their susceptibility of becoming coloured. When the solar rays are passed through a print and thrown upon prepared paper,

the unshaded parts are slowly copied; but the lights transmitted by the shaded parts are seldom so definite as to form a distinct resemblance of them by producing different intensities of colour.

"The images formed by means of a *camera obscura* have been found to be too faint to produce, in any moderate time, an effect upon the nitrate of silver. To copy these images was the first object of Mr. Wedgwood, but all his numerous experiments proved unsuccessful."

These are the observations of Sir Humphry Davy. I have been informed by a scientific friend that this unfavourable result of Mr. Wedgwood's and Sir Humphry Davy's experiments, was the chief cause which discouraged him from following up with perseverance the idea which he had also entertained of fixing the beautiful images of the *camera obscura*. And no doubt, when so distinguished an experimenter as Sir Humphry Davy announced "that all experiments had proved unsuccessful," such a statement was calculated materially to discourage further inquiry. The circumstance also, announced by Davy, that the paper on which these images were depicted was liable to become entirely dark, and that nothing hitherto tried would prevent it, would perhaps have induced me to consider the attempt as hopeless, if I had not (fortunately) before I read it, already discovered a method of overcoming this difficulty, and of *fixing* the image in such a manner that it is no more liable to injury or destruction.

In the course of my experiments directed to that end, I have been astonished at the variety of effects which I have found produced by a very limited number of different processes when combined in various ways; and also at the length of time which sometimes elapses before the full effect of these manifests itself with certainty. For I have found that images formed in this manner, which have appeared in good preservation at the end of twelve months from the time of their formation, have nevertheless somewhat altered during the second year. This circumstance, added to the fact that the first attempts which I made became indistinct in process of time (the paper growing wholly dark), induced me to watch the progress of the change during some considerable time, as I thought that perhaps *all* these images would *ultimately* be found to fade away. I found, however, to my satisfaction, that this was not the case; and having now kept a number of these drawings during nearly five years without their suffering any deterioration, I think myself authorized to draw conclusions from my experiments with more certainty.

§ 2. *Effect and Appearance of these Images.*

The images obtained in this manner are themselves white, but the ground upon which they display themselves is variously and pleasingly coloured.

Such is the variety of which the process is capable, that by merely varying the proportions and some trifling details of manipulation, any of the following colours are readily attainable:

Sky-blue,	Brown, of various shades,
Yellow,	Black.
Rose-colour,	

Green alone is absent from the list, with the exception of a dark shade of it, approaching to black. The blue-coloured variety has a very pleasing effect, somewhat like that produced by the Wedgwood-ware, which has white figures on a blue ground. This variety also retains its colours perfectly if preserved in a portfolio, and not being subject to any spontaneous change, requires no preserving process.

These different shades of colour are of course so many different chemical compounds, or mixtures of such, which chemists have not hitherto distinctly noticed.

§ 3. *First Applications of this Process.*

The first kind of objects which I attempted to copy by this process were flowers and leaves, either fresh or selected from my herbarium. These it renders with the utmost truth and fidelity, exhibiting even the venation of the leaves, the minute hairs that clothe the plant, &c.

It is so natural to associate the idea of *labour* with great complexity and elaborate detail of execution, that one is more struck at seeing the thousand florets of an *Agrostis* depicted with all its capillary branchlets (and so accurately, that none of all this multitude shall want its little bivalve calyx, requiring to be examined through a lens), than one is by the picture of the large and simple leaf of an oak or a chestnut. But in truth the difficulty is in both cases the same. The one of these takes no more time to execute than the other; for the object which would take the most skilful artist days or weeks of labour to trace or to copy, is effected by the boundless powers of natural chemistry in the space of a few seconds.

To give an idea of the degree of accuracy with which some objects can be imitated by this process, I need only mention one instance. Upon one occasion, having made an image of a piece of lace of an elaborate pattern, I showed it to some persons at the distance of a few feet, with the inquiry, whether it

was a good representation? when the reply was, "That they were not to be so easily deceived, for that it was evidently no picture, but the piece of lace itself."

At the very commencement of my experiments upon this subject, when I saw how beautiful were the images which were thus produced by the action of light, I regretted the more that they were destined to have such a brief existence, and I resolved to attempt to find out, if possible, some method of preventing this, or retarding it as much as possible. The following considerations led me to conceive the possibility of discovering a preservative process.

The nitrate of silver, which has become black by the action of light, is no longer the same chemical substance that it was before. Consequently, if a picture produced by solar light is subjected afterwards to any chemical process, the white and dark parts of it will be differently acted upon; and there is no evidence that after this action has taken place, these white and dark parts will any longer be subject to a spontaneous change; or, if they are so, still it does not follow that that change will *now* tend to assimilate them to each other. In case of their remaining *dissimilar*, the picture will remain visible, and therefore our object will be accomplished.

If it should be asserted that exposure to sunshine would *necessarily* reduce the whole to one uniform tint, and destroy the picture, the *onus probandi* evidently lies on those who make the assertion. If we designate by the letter A the exposure to the solar light, and by B some indeterminate chemical process, my argument was this: Since it cannot be shown, *à priori*, that the final result of the series of processes A B A will be the same with that denoted by B A, it will therefore be worth while to put the matter to the test of experiment, viz. by varying the process B until the right one be discovered, or until so many trials have been made as to preclude all reasonable hope of its existence.

My first trials were unsuccessful, as indeed I expected; but after some time I discovered a method which answers perfectly, and shortly afterwards another. On one of these more especially I have made numerous experiments; the other I have comparatively little used, because it appears to require more nicety in the management. It is, however, equal, if not superior, to the first in brilliancy of effect.

This chemical change, which I call the *preserving process*, is far more effectual than could have been anticipated. The paper, which had previously been so sensitive to light, becomes completely insensible to it, insomuch that I am able to show the Society specimens which have been exposed for an hour

to the full summer sun, and from which exposure the image has suffered nothing, but retains its perfect whiteness.

§ 4. *On the Art of fixing a Shadow.*

The phænomenon which I have now briefly mentioned appears to me to partake of the character of the *marvellous*, almost as much as any fact which physical investigation has yet brought to our knowledge. The most transitory of things, a shadow, the proverbial emblem of all that is fleeting and momentary, may be fettered by the spells of our "*natural magic*," and may be fixed for ever in the position which it seemed only destined for a single instant to occupy.

This remarkable phænomenon, of whatever value it may turn out in its application to the arts, will at least be accepted as a new proof of the value of the inductive methods of modern science, which by noticing the occurrence of unusual circumstances (which accident perhaps first manifests in some small degree), and by following them up with experiments, and varying the conditions of these until the true law of nature which they express is apprehended, conducts us at length to consequences altogether unexpected, remote from usual experience, and contrary to almost universal belief. Such is the fact, that we may receive on paper the fleeting shadow, arrest it there, and in the space of a single minute fix it there so firmly as to be no more capable of change, even if thrown back into the sunbeam from which it derived its origin.

§ 5.

Before going further, I may however add, that it is not always necessary to use a preserving process. This I did not discover until after I had acquired considerable practice in this art, having supposed at first that all these pictures would ultimately become indistinct if not preserved in some way from the change. But experience has shown to me that there are at least two or three different ways in which the process may be conducted, so that the images shall possess a character of durability, provided they are kept from the action of direct sunshine. These ways have presented themselves to notice rather accidentally than otherwise; in some instances without any particular memoranda having been made at the time, so that I am not yet prepared to state accurately on what particular thing this sort of semi-durability depends, or what course is best to be followed in order to obtain it. But as I have found that certain of the images which have been subjected to no preserving process remain quite white and perfect after the lapse of a year or two, and indeed show no symptom whatever

of changing, while others differently prepared (and left unpr served) have grown quite dark in one tenth of that time, think this singularity requires to be pointed out. Whethe it will be of much value I do not know; perhaps it will be thought better to incur at first the small additional trouble of employing the preserving process, especially as the drawings thus prepared will stand the sunshine; while the unpreserved ones, however well they last in a portfolio or in common daylight, should not be risked in a very strong light, as they would be liable to change thereby, even years after their original formation. This very quality, however, admits of useful application. For this semi-durable paper, which retains its whiteness for years in the shade, and yet suffers a change whenever exposed to the solar light, is evidently well suited to the use of a naturalist travelling in a distant country, who may wish to keep some memorial of the plants he finds, without having the trouble of drying them and carrying them about with him. He would only have to take a sheet of this paper, throw the image upon it, and replace it in his portfolio. The defect of this particular paper is, that in general the *ground* is not even; but this is of no consequence where utility alone, and not beauty of effect is consulted.

§ 6. *Portraits.*

Another purpose for which I think my method will be found very convenient, is the making of outline portraits, or *silhouettes*. These are now often traced by the hand from shadows projected by a candle. But the hand is liable to er from the true outline, and a very small deviation causes a no table diminution in the resemblance. I believe this manua process cannot be compared with the truth and fidelity with which the portrait is given by means of solar light.

§ 7. *Paintings on Glass.*

The shadow-pictures which are formed by exposing pain ings on glass to solar light are very pleasing. The glass itse around the painting, should be blackened; such, for instanc as are often employed for the magic lantern. The painting on the glass should have no bright yellows or reds, for thes stop the violet rays of light, which are the only effective one The pictures thus formed resemble the productions of the artist's pencil more, perhaps, than any of the others. Persons to whom I have shown them have generally mistaken them for such, at the same time observing, that the *style* was new to them, and must be one rather difficult to acquire. It is in these pic-

tures only that, as yet, I have observed indications of *colour*. I have not had time to pursue this branch of the inquiry further. It would be a great thing if by any means we could accomplish the delineation of objects in their natural colours. I am not very sanguine respecting the possibility of this; yet, as I have just now remarked, it appears possible to obtain at least *some indication* of variety of tint.

§ 8. *Application to the Microscope.*

I now come to a branch of the subject which appears to me very important and likely to prove extensively useful, the application of my method of delineating objects to the solar microscope.

The objects which the microscope unfolds to our view, curious and wonderful as they are, are often singularly complicated. The eye, indeed, may comprehend the whole which is presented to it in the field of view; but the powers of the pencil fail to express these minutiæ of nature in their innumerable details. What artist could have skill or patience enough to copy them? or granting that he could do so, must it not be at the expense of much most valuable time, which might be more usefully employed?

Contemplating the beautiful picture which the solar microscope produces, the thought struck me, whether it might not be possible to cause that image to impress itself upon the paper, and thus to let Nature substitute her own inimitable pencil, for the imperfect, tedious, and almost hopeless attempt of copying a subject so intricate.

My first attempt had no success. Although I chose a bright day, and formed a good image of my object upon prepared paper, on returning at the expiration of an hour I found that no effect had taken place. I was therefore half inclined to abandon this experiment, when it occurred to me, that there was no reason to suppose that either the nitrate or muriate of silver, as commonly obtained, was the most sensitive substance that exists to the action of the chemical rays*; and though such should eventually prove to be the fact, at any rate it was not to be assumed without proof. I therefore began a course of experiments in order to ascertain the influence of various modes of preparation, and I found these to be signally different in their results. I considered this matter chiefly in a practical point of view; for as to the theory, I confess that I cannot as yet understand the reason why the paper prepared in one way should be so much more sensitive than in another.

* Sir H. Davy somewhere says that the iodide is more sensitive, which I have hardly found to be the case in my experiments.

The result of these experiments was the discovery of a mode of preparation greatly superior in sensibility to what I had originally employed: and by means of this, all those effects which I had before only anticipated as theoretically possible were found to be capable of realization.

When a sheet of this, which I shall call "*Sensitive Paper*," is placed in a dark chamber, and the magnified image of some object thrown on it by the solar microscope, after the lapse of perhaps a quarter of an hour, the picture is found to be completed. I have not as yet used high magnifying powers, on account of the consequent enfeeblement of the light. Of course, with a more sensitive paper, greater magnifying power will become desirable.

On examining one of these pictures, which I made about three years and a half ago, I find, by actual measurement of the picture and the object, that the latter is magnified seventeen times in linear diameter, and in surface consequently 289 times. I have others which I believe are considerably more magnified; but I have lost the corresponding objects, so that I cannot here state the exact numbers.

Not only does this process save our time and trouble, but there are many objects, especially microscopic crystallizations, which alter so greatly in the course of three or four days (and it could hardly take any artist less to delineate them in all their details), that they could never be drawn in the usual way.

I will now describe the *degree of sensitiveness* which this paper possesses, premising that I am far from supposing that I have reached the limit of which this quality is capable. On the contrary, considering the few experiments which I have made, (few, that is, in comparison with the number which it would be easy to imagine and propose) I think it most likely that other methods may be found, by which substances may be prepared, perhaps as much transcending in sensitiveness the one which I have employed, as that does the nitrate of silver which I used in my first experiments.

But to confine myself to what I have actually accomplished in the preparation of a very sensitive paper. When a sheet of this paper is brought towards a window, not one through which the sun shines, but looking in the opposite direction, it immediately begins to discolour. For this reason, if the paper is prepared by daylight, it must by no means be left uncovered, but as soon as finished be shut up in a drawer or cupboard and there left to dry, or else dried at night by the warmth of a fire. Before using this paper for the delineation of any object, I generally approach it for a little time towards the light, thus intentionally giving it a slight shade of colour, for the

purpose of seeing that the *ground* is *even*. If it appears so when thus tried to a small extent, it will generally be found to prove so in the final result. But if there are some places or spots in it which do not acquire the same tint as the rest, such a sheet of paper should be rejected: for there is a risk that, when employed, instead of presenting a *ground* uniformly dark, which is essential to the beauty of the drawing, it will have large white spots, places altogether insensible to the effect of light. This singular circumstance I shall revert to elsewhere: it is sufficient to mention it here.

The paper then, which is thus readily sensitive to the light of a common window, is of course much more so to the direct sunshine. Indeed, such is the velocity of the effect then produced, that the picture may be said to be ended almost as soon as it is begun.

To give some more definite idea of the rapidity of the process, I will state, that after various trials the nearest evaluation which I could make of the time necessary for obtaining the picture of an object, so as to have pretty distinct outlines, when I employed the full sunshine, was *half a second*.

§ 9. *Architecture, Landscape, and external Nature.*

But perhaps the most curious application of this art is the one I am now about to relate. At least it is that which has appeared the most surprising to those who have examined my collection of pictures formed by solar light.

Every one is acquainted with the beautiful effects which are produced by a camera obscura and has admired the vivid picture of external nature which it displays. It had often occurred to me, that if it were possible to retain upon the paper the lovely scene which thus illuminates it for a moment, or if we could but fix the outline of it, the lights and shadows, divested of all *colour*, such a result could not fail to be most interesting. And however much I might be disposed at first to treat this notion as a scientific dream, yet when I had succeeded in fixing the images of the solar microscope by means of a peculiarly sensitive paper, there appeared no longer any doubt that an analogous process would succeed in copying the objects of external nature, although indeed they are much less illuminated.

Not having with me in the country a *camera obscura* of any considerable size, I constructed one out of a large box, the image being thrown upon one end of it by a good object glass fixed in the opposite end. This apparatus being armed with a sensitive paper, was taken out in a summer afternoon and placed about one hundred yards from a building favourably

illuminated by the sun. An hour or two afterwards I opened the box, and I found depicted upon the paper a very distinct representation of the building, with the exception of those parts of it which lay in the shade. A little experience in this branch of the art showed me that with smaller *cameræ obscuræ* the effect would be produced in a smaller time. Accordingly I had several small boxes made, in which I fixed lenses of shorter focus, and with these I obtained very perfect but extremely small pictures: such as without great stretch of imagination might be supposed to be the work of some Lilliputian artist. They require indeed examination with a lens to discover all their minutiæ.

In the summer of 1835 I made in this way a great number of representations of my house in the country, which is well suited to the purpose, from its ancient and remarkable architecture. And this building I believe to be the first that was ever yet known *to have drawn its own picture.*

The method of proceeding was this: having first adjusted the paper to the proper focus in each of these little *cameræ*, I then took a number of them with me out of doors and placed them in different situations around the building. After the lapse of half an hour I gathered them all up, and brought them within doors to open them. When opened, there was found in each a miniature picture of the objects before which it had been placed.

To the traveller in distant lands, who is ignorant, as too many unfortunately are, of the art of drawing, this little invention may prove of real service; and even to the artist himself, however skilful he may be. For although this natural process does not produce an effect much resembling the productions of his pencil, and therefore cannot be considered as capable of replacing them, yet it is to be recollected that he may often be so situated as to be able to devote only a single hour to the delineation of some very interesting locality. Now, since nothing prevents him from simultaneously disposing, in different positions, any number of these little *cameræ*, it is evident that their collective results, when examined afterwards, may furnish him with a large body of interesting memorials, and with numerous details which he had not had himself time either to note down or to delineate.

§ 10. *Delineations of Sculpture.*

Another use which I propose to make of my invention is for the copying of statues and bas-reliefs. I place these in strong sunshine, and put before them at a proper distance, and in the requisite position, a small camera obscura contain-

ing the prepared paper. In this way I have obtained images of various statues, &c. I have not pursued this branch of the subject to any extent; but I expect interesting results from it, and that it may be usefully employed under many circumstances.

§ 11. *Copying of Engravings.*

The invention may be employed with great facility for obtaining copies of drawings or engravings, or facsimiles of MSS. For this purpose the engraving is pressed upon the prepared paper, with its engraved side in contact with the latter. The pressure must be as uniform as possible, that the contact may be perfect; for the least interval sensibly injures the result, by producing a kind of cloudiness in lieu of the sharp strokes of the original.

When placed in the sun, the solar light gradually traverses the paper, except in those places where it is prevented from doing so by the opake lines of the engraving. It therefore of course makes an exact image or print of the design. This is one of the experiments which Davy and Wedgwood state that they tried, but failed, from want of sufficient sensibility in their paper.

The length of time requisite for effecting the copy depends on the thickness of the paper on which the engraving has been printed. At first I thought that it would not be possible to succeed with thick papers; but I found on trial that the success of the method was by no means so limited. It is enough for the purpose, if the paper allows any of the solar light to pass. When the paper is thick, I allow half an hour for the formation of a good copy. In this way I have copied very minute, complicated, and delicate engravings, crowded with figures of small size, which were rendered with great distinctness.

The effect of the copy, though of course unlike the original, (substituting as it does lights for shadows, and *vice versâ*,) yet is often very pleasing, and would, I think, suggest to artists useful ideas respecting light and shade.

It may be supposed that the engraving would be soiled or injured by being thus pressed against the prepared paper. There is not much danger of this, provided both are perfectly dry. It may be well to mention, however, that in case any stain should be perceived on the engraving, it may be readily removed by a chemical application which does no injury whatever to the paper.

In copying engravings, &c. by this method, the lights and shadows are reversed, consequently the effect is wholly altered. But if the picture so obtained is first *preserved* so as

to bear sunshine, it may be afterwards itself employed as a object to be copied; and by means of this second proces the lights and shadows are brought back to their origina disposition. In this way we have indeed to contend with th imperfections arising from two processes instead of one; but believe this will be found merely a difficulty of manipulatio I propose to employ this for the purpose more particularly multiplying at small expense copies of such rare or unique en gravings as it would not be worth while to re-engrave, fro the limited demand for them.

I will now add a few remarks concerning the very singula circumstance, which I have before briefly mentioned, viz. that the paper sometimes, although intended to be prepared of th most sensitive quality, turns out on trial to be wholly insensibl to light, and incapable of change. The most singular part of this is the very small difference in the mode of preparation which causes so wide a discrepancy in the result. For instance, a sheet of paper is all prepared at the same time, and with the intention of giving it as much uniformity as possible: and yet, when exposed to sunshine, this paper will exhibit large white spots of very definite outline, where the preparing process has failed; the rest of the paper, where it has succeeded, turning black as rapidly as possible. Sometimes the spots are of a pale tint of cœrulean blue, and are surrounded by exceedingly definite outlines of perfect whiteness, contrasting very much with the blackness of the part immediately succeeding. With regard to the theory of this, I am only prepared to state as my opinion at present, that it is a case of what is called "unstable equilibrium." The process followed is such as to produce one of two definite chemical compounds; and when we happen to come near the limit which separates the two cases, it depends upon exceedingly small and often imperceptible circumstances, which of the two compounds shall be formed. That they are both definite compounds, is of course at present merely my conjecture; that they are signally different, is evident from their dissimilar properties.

I have thus endeavoured to give a brief outline of some of the peculiarities attending this new process, which I offer to the lovers of science and nature. That it is susceptible of great improvements, I have no manner of doubt; but even in its present state I believe it will be found capable of many useful and important applications besides those of which I have given a short account in the preceding pages.

An Account of the Processes employed in Photogenic Drawing, in a Letter to Samuel H. Christie, Esq., Sec. R.S., *from* H. Talbot, Esq., F.R.S.*

Dear Sir,—In compliance with the request of several scientific friends, who have been much interested with the account of the art of Photogenic Drawing, which I had the honour of presenting to the Royal Society on the 31st of last month, I will endeavour to explain, as briefly as I can, but at the same time without omitting any thing essential, the methods which I have hitherto employed for the production of these pictures.

If this explanation, on my part, should have the effect of drawing new inquirers into the field, and if any new discoveries of importance should be the result, as I anticipate, and especially if any means should be discovered by which the sensitiveness of the paper can be materially increased, I shall be the first to rejoice at the success; and in the meanwhile I shall endeavour, as far as I may be able, to prosecute the inquiry myself.

The subject naturally divides itself into two heads; viz. the preparation of the paper, and the means of *fixing* the design.

(1.) *Preparation of the paper.*—In order to make what may be called ordinary photogenic paper, I select, in the first place, paper of a good firm quality and smooth surface. I do not know that any answers better than superfine writing paper. I dip it into a weak solution of common salt, and wipe it dry, by which the salt is uniformly distributed throughout its substance. I then spread a solution of nitrate of silver on one surface only, and dry it at the fire. The solution should not be saturated, but six or eight times diluted with water. When dry, the paper is fit for use.

I have found by experiment, that there is a certain proportion between the quantity of salt and that of the solution of silver, which answers best and gives the maximum effect. If the strength of the salt is augmented beyond this point, the effect diminishes, and, in certain cases, becomes exceedingly small.

This paper, if properly made, is very useful for all ordinary photogenic purposes. For example, nothing can be more perfect than the images it gives of leaves and flowers, especially with a summer sun: the light passing through the leaves delineates every ramification of their nerves.

Now, suppose we take a sheet of paper thus prepared, and wash it with a *saturated* solution of salt, and then dry it. We shall find (especially if the paper has been kept some weeks

* Read before the Royal Society, Feb. 21, 1839.

before the trial is made) that its sensibility is greatly diminished, and, in some cases, seems quite extinct. But if it is again washed with a liberal quantity of the solution of silver, it becomes again sensible to light, and even more so than it was at first. In this way, by alternately washing the paper with salt and silver, and drying it between times, I have succeeded in increasing its sensibility to the degree that is requisite for receiving the images of the camera obscura.

In conducting this operation it will be found that the results are sometimes more and sometimes less satisfactory in consequence of small and accidental variations in the proportions employed. It happens sometimes that the chloride of silver is disposed to darken of itself, without any exposure to light: this shows that the attempt to give it sensibility has been carried too far. The object is, to *approach* to this condition as near as possible without *reaching* it; so that the substance may be in a state ready to yield to the slightest extraneous force, such as the feeble impact of the violet rays when much attenuated. Having therefore prepared a number of sheets of paper with chemical proportions slightly different from one another, let a piece be cut from each, and, having been duly marked or numbered, let them be placed side by side in a very weak diffused light for about a quarter of an hour. Then, if any one of them, as frequently happens, exhibits a marked advantage over its competitors, I select the paper which bears the corresponding number to be placed in the camera obscura.

(2.) *Method of fixing the images.*—After having tried ammonia, and several other reagents, with very imperfect success, the first thing which gave me a successful result was the *iodide of potassium*, much diluted with water. If a photogenic picture is washed over with this liquid, an *iodide of silver* is formed which is absolutely unalterable by sunshines. This process requires precaution; for if the solution is too strong, it attacks the dark parts of the picture. It is requisite, therefore, to find by trial the proper proportions. The fixation of the pictures in this way, with proper management, is very beautiful and lasting. The specimen of *lace* which I exhibited to the Society, and which was made five years ago, was preserved in this manner.

But my usual method of fixing is different from this, and somewhat simpler, or at least requiring less nicety. It consists in immersing the picture in a *strong* solution of common salt, and then wiping off the superfluous moisture, and drying it. It is sufficiently singular that the same substance which is so useful in *giving* sensibility to the paper, should also be capable, under other circumstances, of *destroying* it; but such is, nevertheless, the fact.

Now, if the picture which has been thus washed and dried is placed in the sun, the white parts colour themselves of a pale lilac tint, after which they become insensible. Numerous experiments have shown to me that the depth of this lilac tint varies according to the quantity of salt used, relatively to the quantity of silver. But, by properly adjusting these, the images may, if desired, be retained of an absolute whiteness. I find I have omitted to mention that those preserved by *iodine* are always of a very pale primrose yellow; which has the extraordinary and very remarkable property of turning to a full gaudy yellow whenever it is exposed to the heat of a fire, and recovering its former colour again when it is cold.

I am, &c.

H. Fox Talbot.

XXXVIII. *Proceedings of Learned Societies.*

ROYAL SOCIETY.

[Continued from p. 141.]

Dec. 6, 1838.—A paper was in part read, entitled, "Experimental Researches in Electricity." *Fifteenth Series.*—"Note of the Character and Direction of the Electric Force of the Gymnotus." By Michael Faraday, Esq., D.C.L., F.R.S., &c.

Dec. 13, 1838.—The reading of a paper, entitled, "Experimental Researches in Electricity." *Fifteenth Series.**—"Note of the Character and Direction of the Electric Force of the Gymnotus." By Michael Faraday, Esq., D.C.L., F.R.S., &c., was resumed and concluded.

The author first briefly refers to what has been done by others in establishing the identity of the peculiar power in the Gymnotus and Torpedo with ordinary electricity, and then in reference to the intended conveyance to this country of Gymnoti from abroad, gives the instructions which he himself had received from Baron Humboldt for that purpose. A living Gymnotus, now in the possession of the Proprietors of the Gallery of Science in Adelaide Street, was placed for a time at the disposal of the author for the purpose of research, upon which he proceeded, with suitable apparatus, to compare its power with ordinary and voltaic electricity, and to obtain the direction of the force. Without removing it from the water he was able to obtain not only the results procured by others, but the other electrical phenomena required so as to leave no gap or deficiency in the evidence of identity. The shock, in very varied circumstances of position, was procured: the galvanometer affected; magnets were made; a wire was heated; polar chemical decomposition was effected, and the spark obtained. By comparative experiments made with the

* Prof. Faraday's preceding series of Exp. Res. in Electricity have been given, either entire or in abstract, in various volumes of Lond. and Edinb. Phil. Mag.—Edit.