his memory was to recall to the minds of the men, by the energy and intelligence of whom chemistry has undergone its modern astonishing development, what important treasures of knowledge lie still hidden in the works of that wonderful genius. I am not sufficiently acquainted with chemistry to be confident that I have given the right interpretation, that interpretation which Faraday himself would have given perhaps, if he had known the law of chemical quantivalence, if he had had the experimental means of ascertaining how large the extent, how unexceptional the accuracy of his law really is; and if he had known the precise formulation of the law of energy applied to chemical work, and of the laws which determine the distribution of electric forces in space as well as in ponderable bodies transmitting electric current or forming condensers. I shall consider my work of to-day well rewarded if I have succeeded in kindling anew the interest of chemists for the electro-chemical part of their science.

RECENT ADVANCES IN PHOTOGRAPHY, NEGATIVE AND POSITIVE.

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Among the numerous civilizing and educational agencies of the nineteenth century that have been and are now benefitting mankind stand pre-eminent the Steam Engine, Electricity and Photography. Upon the two former I need not dwell before an audience of the Franklin Institute.

It may, however, be interesting, and perhaps to some instructive, to briefly trace the history of photography, before proceeding to the description and illustration of modern photography, negative and positive, this being the main object for which I have the honor to appear before you this evening.

Photography means literally writing by means of light, and is of much older origin than many suppose. The eminent Swedish chemist, Scheele, was the first to notice the decomposing action of light on compounds containing silver, and in 1777 obtained the first photograph of the solar spectrum.

The first attempt to render the action of light available in the repro-

duction of drawings was made about 1802 by Wedgwood and Davy, who, while they succeeded in obtaining images by aid of the sun's rays, were unable to fix or render unalterable those parts of the sensitive surface not acted upon by the light.

It was not, however, until the discovery by Sir John Herschel of the power of hyposulphite of soda to dissolve the salts of silver that are insoluble in water, that any real progress was made in this art. The discoveries of Daguerre, of France, and Talbot, of England, were made known to the world in 1839; for some years previous both had been experimenting to produce photogenic drawings by the aid of light and the camera obscura (the invention of Baptista Porto in the sixteenth century), Daguerre on metal and Talbot on paper.

Daguerre took a polished silver plate, made sensitive to light by exposing it to the vapor of iodine, and after exposure in the camera developed the image by the vapor of mercury.

Talbot used paper, coating the surface with a solution of iodide of potassium in water, and when dry again coating with an aqueous solution of nitrate of silver, drying and exposing in the camera, developing the image with gallo-nitrate of silver.

The Daguerreotype process, as given to the world, was but in a crude form, the sensitiveness being of a low degree, requiring 15 to 20 minutes' exposure in sunlight to obtain an impression, and the image not permanent; nevertheless, the results at that time were considered marvelous. On the process becoming known, men of science took up the study of Daguerreotyping, and speedily improved upon the results obtained by Daguerre. To M. Godard, of London, is due the credit of increasing the sensitiveness of the plates by using the vapor of bromine in addition to iodine, as employed by Daguerre, and to M. Fizeau, of Paris, the rendering of the impression permanent by giving the plate a slight gilding of gold. The Daguerreotype, while one of the most beautiful pictures ever produced by photography, owing to its reversed image and want of duplicating power, received its death-blow on the advent of Archer's collodion process in 1851, and was practiced for only a few years after that time.

The Calotype process of Fox Talbot, or Talbotype as it is generally named, was never a favorite, on account of the difficulty of getting rid of the effect of the grain or fibre of the paper on which the negative was made; but Le Gray, of Paris, removed this objection in a great measure by his improvement of waxing the paper negative.

This process was succeeded by the albumen process of Niepce de Saint Victor, albumen being used as the vehicle to hold the sensitive salts of silver on glass plates, as suggested by Sir John Herschel; although a slow process, it yielded negatives of fine quality, also positives, and is still extensively used in France in the production of transparencies for the lantern. Messrs. Langenheim Bros. and Francis Schreiber, of Philadelphia, as well as others in America, were successful workers of this process.

In 1851 F. Scott Archer, of London, as previously stated, gave to the world his collodion process, which, with slight modifications, has been used as he gave it for nearly thirty years, and is called by the profession the *wet process*. Its use is confined chiefly to the building or gallery of the photographer, the great difficulties involved in transporting the chemicals and "dark room" apparatus in a serviceable condition for out-door photographing restricting its use mainly to professionals. Since the advent of collodion constant effort has been made to prepare the sensitive plates in a dry state, with collodion or collodion and albumen combined, and with considerable success by both professional and amateur photographers; yet the most successful in preparing these plates felt seriously at times that a most essential quality—rapidity or sensitiveness—was lacking, as they required an exposure of from four to ten times as long as wet collodion plates. It was not until another vehicle for holding the sensitive salts of silver was found, that a rapidity of action equal to and exceeding the most sensitive wet collodion plate was attained, and dry-plate photography became practicable to the professional photographer.

In the new method gelatine is the material with which the sensitive salts of silver are combined, and plates are prepared of the most exalted sensitiveness. This process is not yet ten years old. To Dr. R. L. Maddox, of London, is due the credit of first publishing a formula for their preparation. For six or seven years very little notice was taken of it, but for the past two years the photographic world, or that part of it on the other side of the Atlantic, has become enthusiastic over it, and now the fever has reached American photographers, both amateur and professional.

This gelatino-bromide process, as it is generally called, is certainly a wonderful advance in the art science of photography, enabling impressions in the camera to be obtained in from one-sixth to one-tenth the time of the most rapid collodion plate hitherto employed. The pre-

paration of these "gelatino-bromide" plates is in brief as follows: To a solution of fine gelatine in water is added bromide of potassium or ammonium; in another portion of water is dissolved nitrate of silver; in a room lighted through dark ruby glass, the solution of silver is added by degrees to the bromide and gelatine, and well stirred. It must be kept in a fluid condition for some hours, at a moderate temperature, and, where great sensitiveness is required, for one to four days, or the time may be confined to an hour or two by using a higher degree of heat. It now remains only to free it from the nitrates of potassium or ammonium, formed during the making of the emulsion, which is done by pouring the emulsion into a porcelain dish and allowing it to set to a stiff jelly, after which it is broken up, washed in several changes of cold water, drained and remelted for use, and the plates are coated and dried, and are then ready for use, and may be kept any length of time. These plates are being rapidly adopted by the profession, not only for viewing, but for the regular practice of photography in the studio, as they require no preparation, but are ready at any and all times when the operator is prepared to make the exposure. For scientific explorations they are of great value. I have secured a few prints from negatives taken by the photographer on the Howgate Expedition to the Arctic regions, as well as some by professional and amateur photographers, on gelatine plates made in this city, and known as the "Keystone" brand. To convey to you some idea of the progress made in shortening the time of exposure in the camera, one of the pictures to be shown on the screen was said to have been taken in the 150th part of a second. Compare this with the fifteen minutes exposure given to the Daguerreotype spoken of, and you will find it to be one 270,000th part of that time. It would not be fair to claim for gelatine dry plates all the credit of securing these wonderful results; the perfection to which our optical instruments have been brought has much to do with it, and I have here to show you the most recent improvements in dry-plate apparatus, made by the Scovill Manufacturing Co., New York.

I will now exhibit to you a few slides made on gelatine plates from gelatine negatives, and then proceed with the remainder of my subject—positive photography and its improvements.

Reproducing the image of the negative on paper was first confined to Talbot's Calotype process. Plain chloride of silver paper was then used both for direct printing and gallic acid development and some

of the latter prints have stood the test of time better than any since made with the silver salts. Albumen paper was introduced about 1854—that is, paper coated with a layer of albumen containing a certain amount of chloride of ammonium or sodium and dried. It is sensitized by floating it on a solution of nitrate of silver. After drying it is printed under the negative, toned by passing it through a weak solution of chloride of gold, then into a solution of hyposulphite of soda, technically called the fixing-bath. After a thorough washing the picture is finished, so far as any chemical treatment is needed. This has been, and is yet, the staple process by which the greater bulk of positive impressions is produced. It was early discovered that the permanence of the prints was not assured, and various attempts have been made to replace the albumen print by one of a more durable nature. The process that at one time seemed destined to supplant it was the carbon process, which was adopted by some few photographers, to the exclusion of silver printing; but, after a thorough trial, it had to be abandoned for the old process. The carbon process finds but limited application in America, while in England it is made use of to a large extent in the reproduction of works of art.

The next process to attract public attention was the platinum process of W. Willis, Jr., of London, but now of New York. In this process it was aimed to replace the silver salt by the less oxidizable metal platinum. At first, while the process gave very beautiful results, it required chemical knowledge on the part of the operator, and so much care that it was practically valueless. About two years ago Mr. Willis discovered a method by which all these objectionable features were removed—the process much simplified—and reliable results obtained with ordinary care. This process, in its improved form, I shall now describe, and develop some prints before you.

Only four chemicals are made use of; they are ferric oxalate, potassic oxalate, potassic chloro-platinate and hydrochloric acid. One ounce of the ferric oxalate solution is taken, and from 40 to 60 grains of the potassic chloro-platinate is dissolved therein. This is the sensitizing solution, which is applied to the surface of the paper to be used, by means of a pad of flannel. The paper is allowed to become surface dry, and is then perfectly dried by the aid of heat. The exposure to light is made in the usual manner, either under the negative, or when an enlargement is desired, by the use of the solar camera or electric light. The exposed print is developed in or on a hot solu-

tion of potassic oxalate, and is then immersed in a weak bath of hydrochloric acid to dissolve out the iron salt left in the paper, and finally washed in three or four baths of plain water.

I will now conclude by developing some prints sent to me by Mr. Willis. You will observe a faint image on this sheet of paper, produced by the action of light; it is a picture in ferrous oxalate, the iron salt only being reduced from ferric oxalate to ferrous oxalate, the platinum salt being in intimate mixture only. Now if to a solution of ferrous oxalate in oxalate of potassa, a solution of platinum chloride be added, you will instantly see a decomposition of the platinum salt in the shape of a fine black powder; and this is what will take place as I now pass the print through this hot solution of oxalate of potash. You see, where the action of the light has been strongest, the greatest quantity of platinum is precipitated; this is caused by the dissolving of the ferrous oxalate by the potassic oxalate solution, when the two combined instantly reduce the platinum salt in situ, forming an image in platinum black, known as spongy platinum. Prints by this process have been subjected to the severest chemical tests without having their permanence affected in the least. I now pass the print into this water, acidified with hydrochloric acid, which will dissolve out the iron salt not acted on by the light—two or three changes in fresh water completing the process.

Another improvement in photographic printing is now being developed. It is the application of gelatino-bromide of silver to paper for enlargements and contact printing, the image being developed with ferrous oxalate. Gelatino-chloride of silver has also been used for contact printing in place of albumen paper. As yet these improvements have not been brought into use in America, but I am safe in saying there is no doubt they soon will be, as American photographers are too enterprising to let any improvement having merit lie idle.

Prophets without Honor.—The old proverb is illustrated by the inventors of thermometers. In England they use Fahrenheit's thermometer, the invention of a German. In Germany the thermometer of Reaumur, a Frenchman, is still the most common. In France and in many other countries the Centigrade thermometer, which was invented by the Swede Celsius, is universally adopted.—*Verkehrszeitung.* C.