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I hope this etext inspires a wider interest in the origins of photography and in the modern practice of the Daguerreian Art.

THE HISTORY AND PRACTICE OF THE ART OF PHOTOGRAPHY;

OR THE PRODUCTION OF PICTURES

THROUGH THE AGENCY OF LIGHT.

CONTAINING ALL THE INSTRUCTIONS NECESSARY FOR THE COMPLETE PRACTICE OF THE DAGUERREAN AND PHOTOGENIC ART, BOTH ON METALLIC PLATES AND ON PAPER.

By HENRY H. SNELLING.

ILLUSTRATED WITH WOOD CUTS.

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TO EDWARD ANTHONY, ESQ., AN ESTEEMED FRIEND.

Whose gentlemanly deportment, liberal feelings, and strict integrity have secured him a large circle of friends, this work is Respectfully Dedicated By the AUTHOR.

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PREFACE.

The object of this little work is to fill a void much complained of by Daguerreotypists--particularly young beginners.

The author has waited a long time in hopes that some more able pen would be devoted to the subject, but the wants of the numerous, and constantly increasing, class, just mentioned, induces him to wait no longer.

All the English works on the subject--particularly on the practical application, of Photogenic drawing--are deficient in many minute details, which are essential to a complete understanding of the art. Many of their methods of operating are entirely different from, and much inferior to, those practised in the United States: their apparatus, also, cannot compare with ours for completeness, utility or simplicity.

I shall, therefore, confine myself principally--so far as Photogenic drawing upon metalic plates is concerned--to the methods practised by the most celebrated and experienced operators, drawing upon French and English authority only in cases where I find it essential to the purpose for which I design my work, namely: furnishing a complete system of Photography; such an one as will enable any gentleman, or lady, who may wish to practise the art, for profit or amusement, to do so without the trouble and expense of seeking instruction from professors, which in many cases within my own knowledge has prevented persons from embracing the profession.

To English authors I am principally indebted for that portion of my work relating to Photogenic drawing on paper. To them we owe nearly all the most important improvements in that branch of the art. Besides, it has been but seldom attempted in the United States, and then without any decided success. Of these attempts I shall speak further in the Historical portion of this volume.

Every thing essential, therefore, to a complete knowledge of the whole art, comprising all the most recent discoveries and improvements down to the day of publication will be found herein laid down.

INTRODUCTION

New York, January 27, 1849. E. ANTHONY, ESQ.

Dear Sir,--In submitting the accompanying "History and Practice of Photography" to your perusal, and for your approbation, I do so with the utmost confidence in your ability as a practical man, long engaged in the science of which it treats, as well as your knowledge of the sciences generally; as well as your regard for candor. To you, therefore, I leave the decision whether or no I have accomplished my purpose, and produced a work which may not only be of practical benefit to the Daguerrean artist, but of general interest to the reading public, and your decision will influence me in offering it for, or withholding it from, publication.

If it meets your approbation, I would most respectfully ask permission to dedicate it to you, subscribing myself,

With esteem,
Ever truly yours,
HENRY H. SNELLING

New York, February 1st, 1849.
Mr. H. H. SNELLING.

Dear Sir--Your note of January 27th, requesting permission to dedicate to me your "History and Practice of Photography," I esteem a high compliment, particularly since I have read the manuscript of your work.

Such a treatise has long been needed, and the manner in which you have handled the subject will make the book as interesting to the reading public as it is valuable to the Daguerrean artist, or the amateur dabbler in Photography. I have read nearly all of the many works upon this art that have emanated from the London and Paris presses, and I think the reader will find in yours the pith of them all, with much practical and useful information that I do not remember to have seen communicated elsewhere.

There is much in it to arouse the reflective and inventive faculties of our Daguerreotypists. They have heretofore stumbled along with very little knowledge of the true theory of their art, and yet the quality of their productions is far in advance of those of the French and English artists, most of whose establishments I have had the pleasure of visiting I feel therefore, that when a sufficient amount of theoretic knowledge shall have been added to this practical skill on the part of our operators, and when they shall have been made fully acquainted with what has been attained or attempted by others, a still greater advance in the art will be manifested.

A GOOD Daguerreotypist is by no means a mere machine following a certain set of fixed rules. Success in this art requires personal skill and artistic taste to a much greater degree than the unthinking public generally imagine; in fact more than is imagined by nine-tenths of the Daguerreotypists themselves. And we see as a natural result, that while the business numbers its thousands of votaries, but few rise to any degree of eminence. It is because they look upon their business as a mere mechanical operation, and having no aim or pride beyond the earning of their daily bread, they calculate what will be a fair per centage on the cost of their plate, case, and chemicals, leaving MIND, which is as much CAPITAL as anything else (where it is exercised,) entirely out of the question.

The art of taking photographs on PAPER, of which your work treats at considerable length, has as yet attracted but little attention in this country, though destined, as I fully believe, to attain an importance far superior to that to which the Daguerreotype has risen.

The American mind needs a waking up upon the subject, and I think your book will give a powerful impulse in this direction. In Germany a high degree of perfection has been reached, and I hope your countrymen will not be slow to follow.

Your interesting account of the experiments of Mr. Wattles was entirely new to me, and is another among the many evidences that when the age is fully ripe for any great discovery, it is rare that it does not occur to more than a single mind.

Trusting that your work will meet with the encouragement which your trouble in preparing it deserves, and with gratitude for the undeserved compliment paid to me in its dedication,

I remain, very sincerely,
Your friend and well wisher,
E. ANTHONY.

PHOTOGRAPHY.

CHAP. I.

A BRIEF HISTORY OF THE ART.

As in all cases of great and valuable inventions in science and art the English lay claim to the honor of having first discovered that of Photogenic drawing. But we shall see in the progress of this history, that like many other assumptions of their authors, priority in this is no more due them, then the invention of steamboats, or the cotton gin.

This claim is founded upon the fact that in 1802 Mr. Wedgwood recorded an experiment in the Journal of the Royal Institution of the following nature.

"A piece of paper, or other convenient material, was placed upon a frame and sponged over with a solution of nitrate of silver; it was then placed behind a painting on glass and the light traversing the painting produced a kind of copy upon the prepared paper, those parts in which the rays were least intercepted being of the darkest hues. Here, however, terminated the experiment; for although both Mr. Wedgwood and Sir Humphry Davey experimented carefully, for the purpose of endeavoring to fix the drawings thus obtained, yet the object could not be accomplished, and the whole ended in failure."

This, by their own showing, was the earliest attempt of the English savans. But this much of the principle was known to the Alchemists at an early date--although practically produced in another way--as the following experiment, to be found in old books, amply proves.

"Dissolve chalk in aquafortis to the consistence of milk, and add to it a strong solution of silver; keep this liquor in a glass bottle well stopped; then cutting out from a piece of paper the letters you would have appear, paste it on the decanter, and lay it in the sun's rays in such a manner that the rays may pass through the spaces cut out of the paper and fall on the surface of the liquor the part of the glass through which the rays pass will be turned black, while that under the paper remains white; but particular care must be observed that the bottle be not moved during the operation."

Had not the alchemists been so intent upon the desire to discover the far famed philosopher's stone, as to make them unmindful of the accidental dawnings of more valuable discoveries, this little experiment in chemistry might have induced them to prosecute a more thorough search into the principle, and Photogenic art would not now, as it is, be a new one.

It is even asserted that the Jugglers of India were for many ages in possession of a secret by which they were enabled, in a brief space, to copy the likeness of any individual by the action of light. This fact, if fact it be, may account for the celebrated magic mirrors said to be possessed by these jugglers, and probable cause of their power over the people.

However, as early as 1556 the fact was established that a combination of chloride and silver, called, from its appearance, horn silver, was blackened by the sun's rays; and in the latter part of the last century Mrs. Fulhame published an experiment by which a change of color was effected in the chloride of gold by the agency of light; and gave it as her opinion that words might be written in this way. These incidents are considered as the first steps towards the discovery of the Photogenic art.

Mr. Wedgwood's experiments can scarcely be said to be any improvement on them since he failed to bring them to practical usefulness, and his countrymen will have to be satisfied with awarding the honor of its complete adaptation to practical purposes, to MM. Niepce and Daguerre of France, and to Professors Draper, and Morse of New-York.

These gentlemen--MM. Niepce and Daguerre--pursued the subject simultaneously, without either, however being aware of the experiments of his colleague in science. For several years, each pursued his researches individually until chance made them acquainted, when they entered into co-partnership, and conjointly brought the art almost to perfection.

M. Niepce presented his first paper on the subject to the Royal Society in 1827, naming his discovery Heliography. What led him to the study of the principles of the art I have no means, at present, of knowing, but it was probably owing to the facts recorded by the Alchemists, Mrs. Fulhame and others, already mentioned. But M. Daguerre, who is a celebrated dioramic painter, being desirous of employing some of the singularly changeable salts of silver to produce a peculiar class of effects in his paintings, was led to pursue an investigation which resulted in the discovery of the Daguerreotype, or Photogenic drawing on plates of copper coated with silver.

To this gentleman--to his liberality--are we Americans indebted for the free use of his invention; and the large and increasing class of Daguerrean artists of this country should hold him in the most profound respect for it. He was not willing that it should be confined to a few individuals who might monopolise the benefits to be derived from its practice, and shut out all chance of improvement. Like a true, noble hearted French gentleman he desired that his invention should spread freely throughout the whole world. With these views he opened negociations with the French government which were concluded most favorably to both the inventors, and France has the "glory of endowing the whole world of science and art with one of the most surprising discoveries that honor the land."

Notwithstanding this, it has been patented in England and the result is what might have been expected: English pictures are far below the standard of excellence of those taken by American artists. I have seen some medium portraits, for which a guinea each had been paid, and taken too, by a celebrated artist, that our poorest Daguerreotypists would be ashamed to show to a second person, much less suffer to leave their rooms.

CALOTYPE, the name given to one of the methods of Photogenic drawing on paper, discovered, and perfected by Mr. Fox Talbot of England, is precisely in the same predicament, not only in that country but in the United States, Mr. Talbot being patentee in both. He is a man of some wealth, I believe, but he demands so high a price for a single right in this country, that none can be found who have the temerity to purchase.

The execution of his pictures is also inferior to those taken by the German artists, and I would remark en passant, that the Messrs. Mead exhibited at the last fair of the American Institute, (of 1848,) four Calotypes, which one of the firm brought from Germany last Spring, that for beauty, depth of tone and excellence of execution surpass the finest steel engraving.

When Mr. Talbot's patent for the United States expires and our ingenious Yankee boys have the opportunity, I have not the slightest doubt of the Calotype, in their hands, entirely superceding the Daguerreotype.

Let them, therefore, study the principles of the art as laid down in this little work, experiment, practice and perfect themselves in it, and when that time does arrive be prepared to produce that degree of excellence in Calotype they have already obtained in Daguerreotype.

It is to Professor Samuel F. B. Morse, the distinguished inventor of the Magnetic Telegraph, of New York, that we are indebted for the application of Photography, to portrait taking. He was in Paris, for the purpose of presenting to the scientific world his Electro-Magnetic Telegraph, at the time, (1838,) M. Daguerre announced his splendid discovery, and its astounding results having an important bearing on the arts of design arrested his attention. In his letter to me on the subject, the Professor gives the following interesting facts.

"The process was a secret, and negociations were then in progress, for the disclosure of it to the public between the French government and the distinguished discoverer. M. Daguerre had shown his results to the king, and to a few only of the distinguished savans, and by the advice of M. Arago, had determined to wait the action of the French Chambers, before showing them to any other persons. I was exceedingly desirous of seeing them, but knew not how to approach M. Daguerre who was a stranger to me. On mentioning my desire to Robert Walsh, Esq., our worthy Consul, he said to me; 'state that you are an American, the inventor of the Telegraph, request to see them, and invite him in turn to see the Telegraph, and I know enough of the urbanity and liberal feelings of the French, to insure you an invitation.' I was successfull in my application, and with a young friend, since deceased, the promising son of Edward Delevan, Esq., I passed a most delightful hour with M. Daguerre, and his enchanting sun-pictures. My letter containing an account of this visit, and these pictures, was the first announcement in this country of this splendid discovery."

"I may here add the singular sequel to this visit. On the succeeding day M. Daguerre paid me a visit to see the Telegraph and witness its operations. He seemed much gratified and remained with me perhaps two hours; two melancholy hours to him, as they afterwards proved; or while he was with me, his buildings, including his diorama, his studio, his laboratory, with all the beautiful pictures I had seen the day before, were consumed by fire. Fortunately for mankind, matter only was consumed, the soul and mind of the genius, and the process were still in existence."

On his return home, Professor Morse waited with impatience for the revelation of M. Daguerre's process, and no sooner was it published than he procured a copy of the work containing it, and at once commenced taking Daguerreotype pictures. At first his object was solely to furnish his studio with studies from nature; but his experiments led him into a belief of the practicability of procuring portraits by the process, and he was undoubtedly the first whose attempts were attended with success. Thinking, at that time, that it was necessary to place the sitters in a very strong light, they were all taken with their eyes closed.

Others were experimenting at the same time, among them Mr. Wolcott and Prof. Draper, and Mr. Morse, with his accustomed modesty, thinks that it would be difficult to say to whom is due the credit of the first Daguerreotype portrait. At all events, so far as my knowledge serves me, Professor Morse deserves the laurel wreath, as from him originated the first of our inumerable class of Daguerreotypists; and many of his pupils have carried the manipulation to very great perfection. In connection with this matter I will give the concluding paragraph of a private letter from the Professor to me; He says.

"If mine were the first, other experimenters soon made better results, and if there are any who dispute that I was first, I shall have no argument with them; for I was not so anxious to be the first to produce the result, as to produce it in any way. I esteem it but the natural carrying out of the wonderful discovery, and that the credit was after all due to Daguerre. I lay no claim to any improvements."

Since I commenced the compilation of this work, I have had the pleasure of making the acquaintance of an American gentleman--James M. Wattles Esq.--who as early as 1828--and it will be seen, by what I have already stated, that this is about the same date of M. Niepce's discovery--had his attention attracted to the subject of Photography, or as he termed it "Solar picture drawing," while taking landscape views by means of the camera-obscura. When we reflect upon all the circumstances connected with his experiments, the great disadvantages under which he labored, and his extreme youthfullness, we cannot but feel a national pride--yet wonder--that a mere yankee boy, surrounded by the deepest forests, hundred of miles from the populous portion of our country, without the necessary materials, or resources for procuring them, should by the force of his natural genius make a discovery, and put it in practical use, to accomplish which, the most learned philosophers of Europe, with every requisite apparatus, and a profound knowledge of chemistry--spent years of toil to accomplish. How much more latent talent may now be slumbering from the very same cause which kept Mr. Wattles from publicly revealing his discoveries, viz; want of encouragement--ridicule!

At the time when the idea of taking pictures permanently on paper by means of the camera-obscura first occurred to him, he was but sixteen years of age, and under the instructions of Mr. Charles Le Seuer, (a talented artist from Paris) at the New Harmony school, Indiana. Drawing and painting being the natural bent of his mind, he was frequently employed by the professors to make landscape sketches in the manner mentioned. The beauty of the image of these landscapes produced on the paper in the camera-obscura, caused him to pause and admire them with all the ardor of a young artist, and wish that by some means, he could fix them there in all their beauty. From wishing he brought himself to think that it was not only possible but actually capable of accomplishment and from thinking it could, he resolved it should be done.

He was, however, wholly ignorant of even the first principles of chemistry, and natural philosophy, and all the knowledge he was enabled to obtain from his teachers was of very little service to him. To add to this, whenever he mentioned his hopes to his parents, they laughed at him, and bade him attend to his studies and let such moonshine thoughts alone--still he persevered, though secretly, and he met with the success his perseverance deserved.

For the truth of his statement, Mr. Wattles refers to some of our most respectable citizens residing at the west, and I am in hopes that I shall be enabled to receive in time for this publication, a confirmation from one or more of these gentlemen. Be that as it may, I feel confident in the integrity of Mr. Wattles, and can give his statement to the world without a doubt of its truth.

The following sketch of his experiments and their results will, undoubtedly, be interesting to every American reader and although some of the profound philosophers of Europe may smile at his method of proceeding, it will in some measure show the innate genius of American minds, and prove that we are not far behind our trans-atlantic brethren in the arts and sciences.

Mr. Wattles says: "In my first efforts to effect the desired object, they were feeble indeed, and owing to my limited knowledge of chemistry--wholly acquired by questioning my teachers--I met with repeated failures but following them up with a determined spirit, I at last produced, what I thought very fair samples--but to proceed to my experiments."

"I first dipped a quarter sheet of thin white writing paper in a weak solution of caustic (as I then called it) and dried it in an empty box, to keep it in the dark; when dry, I placed it in the camera and watched it with great patience for nearly half an hour, without producing any visible result; evidently from the solution being to weak. I then soaked the same piece of paper in a solution of common potash, and then again in caustic water a little stronger than the first, and when dry placed it in the camera. In about forty-five minutes I plainly percieved the effect, in the gradual darkening of various parts of the view, which was the old stone fort in the rear of the school garden, with the trees, fence, &c. I then became convinced of the practicability of producing beautiful solar pictures in this way; but, alas! my picture vanished and with it, all--no not all--my hopes. With renewed determination I began again by studying the nature of the preparation, and came to the conclusion, that if I could destroy the part not acted upon by the light without injuring that which was so acted upon, I could save my pictures. I then made a strong solution of sal. soda I had in the house, and soaked my paper in it, and then washed it off in hot water, which perfectly fixed the view upon the paper. This paper was very poor with thick spots, more absorbent than other parts, and consequently made dark shades in the picture where they should not have been; but it was enough to convince me that I had succeeded, and that at some future time, when I had the means and a more extensive knowledge of chemistry, I could apply myself to it again. I have done so since, at various times, with perfect success; but in every instance laboring under adverse circumstances."

I have very recently learned, that, under the present patent laws of the United States, every foreign patentee is required to put his invention, or discovery, into practical use within eighteen months after taking out his papers, or otherwise forfeit his patent. With regard to Mr. Talbot's Calotype patent, this time has nearly, if not quite expired, and my countrymen are now at perfect liberty to appropriate the art if they feel disposed. From the statement of Mr. Wattles, it will be perceived that this can be done without dishonor, as in the first instance Mr. Talbot had no positive right to his patent.

Photography; or sun-painting is divided, according to the methods adopted for producing pictures, into

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DAGUERREOTYPE, CHROMATYPE,
CALOTYPE,      ENERGIATYPE,
CHRYSOTYPE,    ANTHOTYPE and
CYANOTYPE,     AMPHITYPE.
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CHAP. II.

THE THEORY ON LIGHT.--THE PHOTOGRAPHIC PRINCIPLE

Some philosophers contend that to the existence of light alone we owe the beautiful effects produced by the Photogenic art, while others give sufficient reasons for doubting the correctness of the assumption. That the results are effected by a principle associated with light and not by the luminous principle itself, is the most probable conclusion. The importance of a knowledge of this fact becomes most essential in practice, as will presently be seen. To this principle Mr. Hunt gives the name of ENERGIA.

THE NATURE of Light is not wholly known, but it is generally believed to be matter, as in its motions it obeys the laws regulating matter. So closely is it connected with heat and electricity that there can be little doubt of their all being but different modifications of the same substance. I will not, however, enter into a statement of the various theories of Philosophers on this head, but content myself with that of Sir Isaac Newton; who supposed rays of light to consist of minute particles of matter, which are constantly emanating from luminous bodies and cause vision, as odoriferous particles, proceeding from certain bodies, cause smelling.

The effects of light upon other bodies, and how light is effected by them, involve some of the most important principles, which if properly understood by Daguerreotypists would enable them to improve and correct many of the practical operations in their art. These effects we shall exhibit in this and the following chapters. Before we enter on this subject it will be necessary to become familiar with the

DEFINITIONS of some of the terms used in the science of optics.

Luminous bodies are of two kinds; those which shine by their own light, and those which shine by reflected light.

Transparent bodies are such as permit rays of light to pass through them.

Translucent bodies permit light to pass faintly, but without representing the figure of objects seen through them.

Opaque bodies permit no light to pass through them, but reflect light.

A ray is a line of light.

A beam is a collection of parallel rays.

A pencil is a collection of converging, or diverging rays.

A medium is any space through which light passes.

Incident rays are those which fall upon the surface of a body.

Reflected rays are those which are thrown off from a body.

Parallel rays are such as proceed equally distant from each other through their whole course.

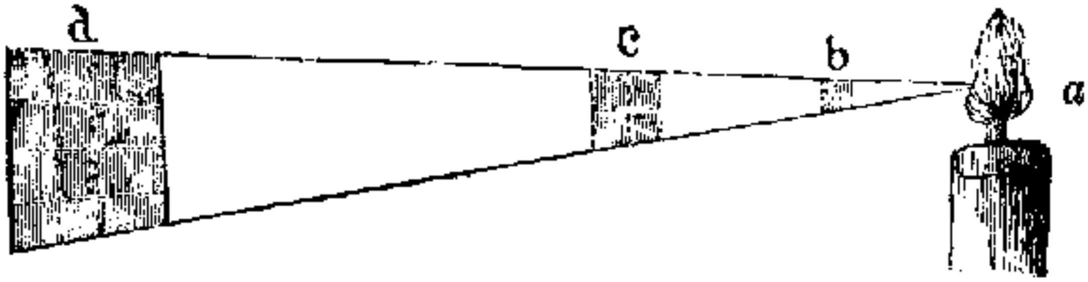
Converging rays are such as approach and tend to unite at any one point, as at b. Fig. 3.

Diverging rays are those which continue to recede from each other, as at e. Fig. 3.

A Focus is that point at which converging rays meet.

MOTION OF LIGHT--Rays of light are thrown off from luminous bodies in every direction, but always in straight lines, which cross each other at every point; but the particles of which each ray consists are so minute that the rays do not appear to be impeded by each other. A ray of light passing through an aperture into a dark room, proceeds in a straight line; a fact of which any one may be convinced by going into a darkened room and admitting light only through a small aperture.

FIG. 1.

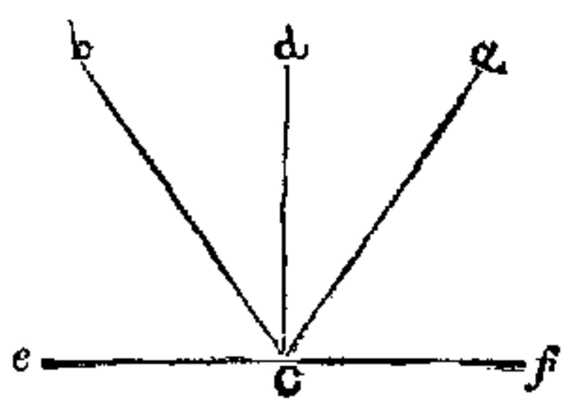


Light also moves with great velocity, but becomes fainter as it recedes from the source from which it eminates; in other words, diverging rays of light diminish in intensity as the square of the distance increases. For instance let a fig. 1, represent the luminous body from which light proceeds, and suppose three square boards, b. c. d. severally one, four and sixteen square inches in size be placed; b one foot, c two feet, and d four feet from a, it will be perceived that the smallest board b will throw c into shadow; that is, obstruct all rays of light that would otherwise fall on c, and if b were removed c would in like manner hide the light from d--Now, if b recieve as much light as would fall on c whose surface is four times as large, the light must be four times as powerful and sixteen times as powerful as that which would fall on the second and third boards, because the same quantity of light is diffused over a space four and sixteen times greater. These same rays may be collected and their intensity again increased.

Rays of light are reflected from one surface to another; Refracted, or bent, as they pass from the surface of one transparent medium to another; and Inflected, or turned from their course, by the attraction of opaque bodies. From the first we derive the principles on which mirrors are constructed; to the second we are indebted for the power of the lenses, and the blessings of sight,--for the light acts upon the retina of the eye in the same manner as on the lens of a camera. The latter has no important bearing upon our subject.

When a ray of light falls perpendicularly upon an opaque body, it is reflected bark in the same line in which it proceeds; in this case the reflected ray returns in the same path the incident ray traversed; but when a ray falls obliquely, it is reflected obliquely, that is, it is thrown off in opposite direction, and as far from the perpendicular as was the incident ray, as shown at Fig. 2; a representing the incident ray and b the reflected. The point, or angle c made by the incident ray, at the surface of the reflector e f, with a line c d, perpendicular to that surface, is called the angle of incidence, while the angle formed by the reflected ray b and the perpendicular line d is called the angle of reflection, and these angles are always equal.

FIG. 2.



It is by this reflection of light that objects are made visible; but unless light falls directly upon the eye they are invisible, and are not sensibly felt until after a certain series of operations upon the various coverings and humors of the eye. Smooth and polished surfaces reflect light most powerfully, and send to the eye the images of the objects from which the light proceeded before reflection. Glass, which is transparent--transmitting light--would be of no use to us as a mirror, were it not first coated on one side with a metalic amalgam, which interrupts the rays in their passage from the glass into the air, and throws them either directly in the incident line, or in an oblique direction. The reason why trees, rocks and animals are not all mirrors, reflecting other forms instead of their own, is, that their surfaces are uneven, and rays of light reflected from an uneven surface are diffused in all directions.

Parallel rays falling obliquely upon a plane mirror are reflected parallel; converging rays, with the same degree of convergence; and diverging rays equally divergent.

Stand before a mirror and your image is formed therein, and appears to be as far behind the glass as you are before it, making the angle of reflection equal to that of incidence, as before stated. The incident ray and the reflected ray form, together, what is called the passage of reflection, and this will therefore make the actual distance of an image to appear as far again from the eye as it really is. Any object which reflects light is called a radiant. The point behind a reflecting surface, from which they appear to diverge, is called the virtual focus.

Rays of light being reflected at the same angle at which they fall upon a mirror, two persons can stand in such a position that each can see the image of the other without seeing his own. Again; you may see your whole figure in a mirror half your length, but if you stand before one a few inches shorter the whole cannot be reflected, as the incident ray which passes from your feet into the mirror in the former case, will in the latter fall under it. Images are always reversed in mirrors.

Convex mirrors reflect light from a rounded surface and disperse the rays in every direction, causing parallel rays to diverge, diverging rays to diverge more, and converging rays to converge less--they represent objects smaller than they really are--because the angle formed by the reflected ray is rendered more acute by a convex than by a plane surface, and it is the diminishing of the visual angle, by causing rays of light to be farther extended before they meet in a point, which produces the image of convex mirrors. The greater the convexity of a mirror, the more will the images of the objects be diminished, and the nearer will they appear to the surface. These mirrors furnish science with many curious and pleasing facts.

Concave mirrors are the reverse of convex; the latter being rounded outwards, the former hollowed inwards--they render rays of light more converging--collect rays instead of dispersing them, and magnify objects while the convex diminishes them.

Rays of light may be collected in the focus of a mirror to such intensity as to melt metals. The ordinary burning glass is an illustration of this fact; although the rays of light are refracted, or passed through the glass and concentrated into a focus beneath.

When incident rays are parallel, the reflected rays converge to a focus, but when the incident rays proceed from a focus, or are divergent, they are reflected parallel. It is only when an object is nearer to a concave mirror than its centre of concavity, that its image is magnified; for when the object is farther from the mirror, this centre will appear less than the object, and in an inverted position.

The centre of concavity in a concave mirror, is an imaginary point placed in the centre of a circle formed by continuing the boundary of the concavity of the mirror from any one point of the edge to another parallel to and beneath it.

REFRACTION OF LIGHT:--I now pass to the consideration of the passage of light through bodies.

A ray of light failing perpendicularly through the air upon a surface of glass or water passes on in a straight line through the body; but if it, in passing from one medium to another of different density, fall obliquely, it is bent from its direct course and recedes from it, either towards the right or left, and this bending is called refraction; (see Fig. 3, b.) If a ray of light passes from a rarer into a denser medium it is refracted towards a perpendicular in that medium; but if it passes from a denser into rarer it is bent further from a perpendicular in that medium. Owing to this bending of the rays of light the angles of refraction and incidence are never equal.

Transparent bodies differ in their power of bending light--as a general rule, the refractive power is proportioned to the density--but the chemical constitution of bodies as well as their density, is found to effect their refracting power. Inflammable bodies possess this power to a great degree.

The sines of the angle of incidence and refraction (that is, the perpendicular drawn from the extremity of an arc to the diameter of a circle,) are always in the same ratio; viz: from air into water, the sine of the angle of refraction is nearly as four to three, whatever be the position of the ray with respect to the refracting surface. From air into sulphur, the sine of the angle of refraction is as two to one--therefore the rays of light cannot be refracted whenever the sine of the angle of refraction becomes equal to the radius* of a circle, and light falling very obliquely upon a transparent medium ceases to be refracted; this is termed total reflection.

* The RADIUS of a circle is a straight line passing from the centre to the circumference.

Since the brightness of a reflected image depends upon the quantity of light, it is quite evident that those images which arise from total reflection are by far the most vivid, as in ordinary cases of reflection a portion of light is absorbed.

I should be pleased to enter more fully into this branch of the science of optics, but the bounds to which I am necessarily limited in a work of this kind will not admit of it. In the next chapter, however, I shall give a synopsis of Mr. Hunt's treatise on the "Influence of the Solar Rays on Compound Bodies, with especial reference to their Photographic application"--a work which should be in the hands of every Daguerreotypist, and which I hope soon to see republished in this country. I will conclude this chapter with a brief statement of the principles upon which the Photographic art is founded.

SOLAR and Stellar light contains three kinds of rays, viz:

1. Colorific, or rays of color.

2. Calorific, or rays of heat.

3. Chemical rays, or those which produce chemical effects.

On the first and third the Photographic principle depends. In explaining this principle the accompanying wood cuts, (figs. 3 and 4) will render it more intelligible.

If a pencil of the sun's rays fall upon a prism, it is bent in passing through the transparent medium; and some rays being more refracted than others, we procure an elongated image of the luminous beam, exhibiting three distinct colors, red, yellow and blue, which are to be regarded as primitives--and from their interblending, seven, as recorded by Newton, and shown in the accompanying wood cut. These rays being absorbed, or reflected differently by various bodies, give to nature the charm of color. Thus to the eve is given the pleasure we derive in looking upon the green fields and forests, the enumerable varieties of flowers, the glowing ruby, jasper, topaz, amethist, and emerald, the brilliant diamond, and all the rich and varied hues of nature, both animate and inanimate.