ARAGO'S PLAN FOR PROVING THE TRUE THEORY OF LIGHT.

Among the papers published in the Smithsonian Report is a translation by Alfred M. Mayer, Professor of Physics, Pennsylvania College, Gettysburg, of a very clear essay on the velocity of light, by M. Delaunay, of the Institute of France. From this translation we extract the following account of the plan proposed by M. Arago for determining experimentally the long disputed question whether light is an emission or an undulation. Arago's eyesight being impaired, he was unabled to try the experiment himself, but in 1850 the trial was made by M. Faucault, also by MM. Fijeau and Bregnet, these *gentlemen* having first obtained the assent of Arago, before proceeding with an experiment suggested by him.

The first step in this direction was the most difficult to make, and it required all the daring of genius to attempt it. We find it in an experiment projected by Arago, and communicated to the Academy of Sciences of Paris during its meeting on the 3d of December, 1838. In the project it was not as yet proposed to measure the velocity of light, but simply to compare the velocities with which light moves in air, or in a liquid such as water, or bisulphide of carbon; it was proposed to find by experiment which of these two velocities was the greater, which would decide in an irrefutable manner between the two systems imagined by physicists to explain optical phenomena, viz:—the system of emission and that of vibration or undulation. We cannot do better than here allow Arago to speak for himself. The following is what he says in the notice printed in the proceedings of the meeting:—

"I propose to show in this communication how it is possible to decide, unequivocally, whether light be composed of little particles emanating from radiating bodies, as Newton supposes, and as the greater part of modern geometers admit; or whether it is simply the result of the undulations of a very rare and very elastic medium which physicists have agreed to call *ether*. The system of experiments which I am about to describe will no longer permit, it seems to me, to hesitate between these two rival theories. It will decide *mathematically*, (I use designedly this expression); it will decide mathematically one of the grandest and most debated questions of natural philosophy.

"Besides, my communication is the fulfilling of a sort of engagement to the Academy I accepted at one of its last secret sittings.

"I discussed the admirable method, by the aid of which Mr. Wheatstone attempted the solution of the problem of the velocity of electricity over metallic conductors. I had hardly terminated the enumeration of the important results obtained by that ingenious physicist, when several of our members, whose names are authority in such matters, stated that my report was far too approbative. 'In supposing it well determined, the inferior limit assigned by Mr. Wheatstone to the velocity of electricity will not have,' said one, 'any marked influence on the progress of the sciences; besides, limits of the same order, and even more extensive, can be deduced indirectly from various electric or magnetic phenomena. As to the method of the revolving mirrors, it does not seem to be susceptible of application, but to the simple questions already studied by the inventor.' I tried to refute this last opinion. I believe myself that the new instrument, suitably modified, would lead to results that Mr. Wheatstone was not aware of. I already foresaw that, even in supposing it inclosed in the narrow limits of a small room, it could serve to measure the comparative velocities of light moving through air and through a liqnid. I was not slow in learning, and without having hardly the right to be astonished or to complain that my assertions had been received with incredulity. Nevertheless, I intend to vindicate it today in all its parts.

"Principle of the method:—Let a ray of light fall upon a plane polished mirror; it will be reflected, as every one knows, in forming with the surface of the mirror an angle of reflection exactly equal to the angle of incidence.

"Let us now suppose that the mirror turns through an arc, a, around the point of its surface from which the reflection takes place. If this motion, for example, increases the quantity, a, *the original angle of incidence*, it will diminish as much *the original angle of reflection*. The latter will, therefore, after the displacement of the mirror, be smaller than the first by the quantity $2a$; thus it must be increased $2a$ to render it equal to *the new angle of incidence;* hence that angle increased $2a$ will give the direction of the reflected ray in the second position of the mirror; and thus the incident ray remaining the same, an angular motion, a, of the mirror occasions a *double* angular motion in the reflected ray.

"This mode of reasoning applies as well to the case where the motion of the mirror, acting in a contrary direction, would *diminish* the first angle of incidence. The principle is, therefore, general; and it is also that of all reflecting nautical instruments.

"The reflection from the plane mirrors can serve to project the luminous rays in all parts of space, without, however, altering the relative positions; two rays parallel before reflection; those at first inclined to each other 1 minute, 10 minutes, or 20 minutes, etc., will form precisely the same angle after the reflection has deviated them.

"Instead of a single ray, let us consider two horizontal rays setting out from *two neighboring* points situated in the same vertical. Admit that they strike on two points of the median line (also vertical) of a plane vertical mirror. Suppose that this mirror revolves on itself uniformly and in a continuous manner around a vertical axis whose prolongation coincides with the median line just mentioned, the direction in which the two horizontal lines will be reflected will depend evidently upon the moment they may reach the mirror, since we have supposed that it turns. If the *two rays* have *set out simultaneously from the two contiguous points*, they will also reach simultaneously by the mirror. Their reflection will take place at the *same instant;* consequently in the same position of the turning surface; consequently as if that surface was stationary with respect to them. Therefore their primitive parallelism will not be changed.

"In order that the rays which primitively were parallel may diverge after their reflection, it is necessary that one of them should arrive at the mirror later than the other. It is necessary that in its course from the radiating point to the reflecting and turning surface, the velocity of the ray should be accelerated, or what will be precisely the same thing, it is necessary (the velocity of the first ray remaining constant) that that of the second should experience a diminution. It is necessary, finally, that the two rays should be reflected one after the other; and, consequently, from two distinct positions of the mirror, forming with each other a sensible angle.

"According to the theory of emission, light moves in water notably faster than in air. According to the wave theory, it is precisely the opposite which takes place: the light moves faster in air than in water. Suppose that one of the rays (the upper ray for example) has to traverse a tube filled with water before it strikes the mirror. If the theory of emission be true, the upper ray will be accelerated in its progress; it will reach the mirror first; it will be reflected before the lower ray; it will make with it a certain angle, and the direction of the deviation will be such that the lower ray will appear in advance of the other, that it will appear to have been deviated more by the turning mirror.

"Circumstances remaining the same, let us admit for a moment the truth of the wave system. The tube of water will retard the progress of the upper ray; the ray will arrive at the reflecting mirror after the lower ray; it will be reflected not the first, as in the former case, but the second in order, and from a position of the polished reflecting face in advance of the position it had when it reflected the upper ray a moment before; these two rays will make with each other the same angle as in the other hypothesis, except (and we should well remark it) the deviation will take place precisely in an opposite direction; the upper ray will now be in advance, always indicating thus the direction in which the mirror revolves.

"To recapitulate: two radiating points, placed near each other on the same vertical line, flash instantaneously before a revolving mirror. The rays from the upper point cannot reach the mirror until after traversing a tube filled with water; the rays from the second point arrive at the mirror without meeting in their course any other medium than air To be more definite, we will suppose that the mirror, seen from the position the observer occupies, turns from the right to the left. Well, if the theory of emission be true; if light be material, the upper point will *appear to the left* of the lower point. *It will appear to the right*, on the contrary, if light results from the vibrations of an ethereal medium.

"Instead of two isolated radiating points, suppose that we instantaneously present to the mirror a vertical luminous line. The image of the upper part of this line will be formed by rays which have traversed the water; the image of the lower part will result from the rays which have throughout their whole course traversed the air. In the revolving mirror the image of the single line *will appear broken;* it will be composed of *two* vertical luminous lines, of two lines, which will not be prolongations of each other.

"The upper rectilinear image, is it behind the one below? Does it appear to the left?

"*Light is a body.*

"Does the contrary take place? The upper image, does it show itself to the right?

"*Light is an undulation.*

"All that procedes is theoretically, or rather speculatively exact. Now (and here is the delicate point), it remains to prove that, notwithstanding the prodigious velocity of light, that notwithstanding a velocity of 190,000 miles a second, that notwithstanding the small length that we will be obliged to give to the tube filled with liquid, that notwithstanding the limited velocities of rotation that the mirrors will have, the comparative deviations of the two images, toward the right or toward the left, of which I have demonstrated the existence, will be perceptible in our instruments."

Arago then enters into the most minute details of all the parts of the experiment—the velocity of rotation that can be given to a mirror, the visibility of the image formed by light after having traversed the necessary length of liquid, the posibility of reducing that length of liquid, or the velocity of rotation of the mirror by employing simultaneously several rotating mirrors from which the light would be successively reflected, and also in substituting for water bisulphide of carbon, which acts more powerfully on the velocity of light, are, on his part, the object of a thorough examination. He then terminates thus:—

"Suppose in the experiment that I propose to execute we make use of electric sparks, or of lights sucessively screened and unscreened by the use of rotating disks, as their emissions should only last during a few thousandths of a second, it may happen that an observer, looking in the mirror from a given direction, and with a telescope of limited field, will only by chance perceive the light. To this I immediately reply that in renewing very often the apparitions of light—every second, for example—that if, instead of a single mirror, we rotate a vertical prism of eight or ten facets, that with the concurrence of several observers, placed in different directions, and each with his telescope, we cannot fail to have numerous and clear apparitions of the reflected rays. But these are details on which I shall not dwell today. I will reserve for another communication the exposition of the system of experiments in which we will render sensible, and in which we will measure, to a certain degree, the *absolute velocity* of light without having recourse to celestial phenomena."

Before proceeding further in the perusal of the essay of M. Delaunay, it is necessary that all who have not given especial attention to the study of recent optical research, and who desire to appreciate the beauty and importance of the remainder of this essay, should understand *why* light should move faster in water than in air according to the emission theory, and slower in water than in air according to the undulatory theory. This is not explained by the author, and without this knowledge it is impossible to appreciate the excellence of these classical experiments of Arago, of Fizeau, and of Foucault.

We would advise the above class of readers to study the points here spoken of in the "Lectures on the Undulatory Theory of Light," by Professor Banard, Smithsonian Report for 1862. In the admirable "*Traite de Physique*," by Daguin, Paris, 1862, and in Pouillet's "*Trait de Physique*," will be found detailed accounts of the apparatus mentioned in this essay, illustrated with engravings. The origina memoirs in the transaction of the Academy of Sciences of Paris should also be continued.

RECENT AMERICAN PATENTS.

Marking Wheel.—This invention consists in a revolving type wheel arranged in a suitable handle in combination with an ink roller, in such a manner that by carrying the type wheel over the cover of a bed, orover any other surfaces, the types on the wheel produce an impression, and the marking of a box or other article can be effected neatly and distinctly with little loss of time. The ink roller is composed of a hollow cylindrical reservoir perforated with small holes, and surrounded by a strip of cloth or other absorbent material, so that the same is capable of holding a supply of ink for a large number of impressions. The type wheel is provided with yielding rims or flanges made of india-rubber or other elastic material, so that the types can be depressed on the surface to be marked with the requisite force to produce the desired impression, and a coiled or other spring is applied to said type wheel, in such a manner that it carries the same back after each impression to the starting point, and thereby the types are brought in contact with the ink rollers and supplied with the requisite quantity of ink for the subsequent impression; and, furthermore, the type wheel readjusts itself in the required position for starting. Horace Holt, of No. 264 Broadway, New York, is the inventor.

Checking the Recoil and Operating and Pointing Cannon.—Much time is lost in the ordinary method of controlling, by means of friction, the recoil of heavy guns, in consequence of the time consumed in tightening and relieving the compressors which produce the required friction. Much danger is also incurred in working heavy guns on board of ships during bad weather at sea because the compressors must be relieved in order to roll the gun out after being loaded. Any sudden lurch of the vessel while the compressers are thus relieved, renders the gun uncontrollable, and endangers the lives of the gunners as well as the safety of the gun and carriage. Much difficulty and danger are also experienced in training or pointing heavy guns on board of ships, particularly during bad weather. The object of this invention is to overcome the difficulties thus enumerated. In order to save the time lost in tightening and relieving the present friction gear of gun carriages, a rotary compressor is employed, kept under constant pressure, composed of a series of circular metallic disks secured to an axle which passes through the side frames of the gun carriage, this axle having attached to it pinions, the teeth of which work into toothed racks bolted to the inside of the gun slides. Between the metallic disks are inserted wooden ones fixed within a cylindrical box made of brass or iron, the circumference of which is provided with cogs. Into this toothed cylindrical box wheel is geared a pinion, which, by means of suitable hand gear, enables the gunners to run the gun in and out; and by it the box wheel may also be instantly locked, and the movement of the gun carriage thereby checked at any time. The training or pointing the gun is effected by means of a toothed rack attached to the slides upon which the gun carriage moves, said rack being actuated by a pinion attached to the lower end of a vertical shaft which the gunners turn round by means of winches and cog wheels. John Ericsson, of New York City, is the inventor.

Wood-tenoning Machine.—This invention consists in so arranging the cutter heads of a wood-tenoning machine, that while they can be adjusted with regard to each other, to any thickness of tenon which it is desired to form, they can be, after such adjustment, brought to any position with regard to the end of the board or plank upon which they are to operate without disturbing their relative position with regard to each other, as previously adjusted. H. B. Smith, of Lowell, Mass., is the inventor.

Glass Mold Board for Plows.—Messrs. O. F. Burton, of this city, and L. B. Hoit, of Cedar Falls, Iowa, obtained a patent through this office, on the 9th inst., for making mold boards for plows, of glass! The idea is quite novel, but we are told that on the prairies they have been tested with the best practical results.

PATENT-OFFICE DECISIONS.

Application for patent for improvement in steel-facing vises and various other articles of iron.

S. C. Fessenden, for the Board.—The applicant says:—"I do not claim the brazing process of itself; neither do I claim the hardening of steel by heating it, and subsequently suddenly cooling it. But what I do claim as my invention is, the combination of the two processes of brazing and hardening the piece of steel, or facing, with that of so firmly holding the facing piece of steel to the iron while the hardening process is being carried on, as to prevent the displacement or escape of the brazing metal from between the contiguous surfaces against which it may be." The Examiner rejects the application; first, on the ground that the specification presents no patentable feature; and second, that the patent already granted to the applicant, No. 44,739, covers all the improvements which he claims.

We have compared the Letters Patent, No. 44,739, with the application now under consideration, and we fail to perceive that the specification in said application is similar to any specification in the former Letters Patent, and for which the patent was issued. It is well put, that, in the Letters Patent, the invention covered consisted in brazing and hardening the steel under one and the same heating of it, such as may be requisite for effecting the melting of the brazing metal to accomplish the brazing.

In the new process, the tempering of the steel facing of an article is not accomplished under the heat produced by brazing of the facing to the article, but after the process of brazing has been completed, and the steel is in a soft state, the article is filed and finished.

To harden the steel facing requires a re-heating of the article. Under ordinary circumstances this would be destructive of the brazing, as it would melt the brass, which would run out of the joint.

Evidently the one process is not the same with the other. N. claims that he has discovered a process by which this loss of the brazing is prevented, which is both novel and useful. He describes this process. It is that of so firmly holding the facing to the article, in connection of brazing and reheating, by a clamp, as to cause them to retain the brazing in position between them.

It is true that "the mere matter of clamping articles together for any purpose is not new;" but the matter of clamping them together for this purpose, although very simple, apparently, is new.

It was held by Mr. Chief Justice Marshall, in David *vs.* Palmer, 2 Brock 298:—"That it was not every change of form or proportion which was declared to be no discovery, but that which was simply a change of form or proportion, and nothing more. If by changing the form and proportion a new effect is produced, there is not simply a change of form and proportion, but a change of principle. The question will be, therefore, whether the change has produced a different effect.

Here the clamping is to a certain degree accompanied by certain effects which could not otherwise be produced, and without which there would be no improvement, as alleged. By the affidavits of experts, N. shows, moreover, that his process is in its results as described by him in his application.

In the opinion of this Board, the decision of the Examiners in this case should be reversed.

Washington, Dec. 20, 1865.

THE USE OF AMMONIA AS A MANURE.

It is a curious fact that plants cannot obtain the nitrogen that they need from the atmosphere, but that this element must be supplied by costly manuring. What makes this fact so curious is, that only $2\frac{1}{2}$ per cent of the substance of plants is nitrogen, while this element forms the principal portion of the atmosphere—76·9 per cent. Furthermore, plants obtain their carbon, which forms about half of their substance, principally from the atmosphere, although the proportion of carbon in the atmosphere is not more than one-seventh of one per cent. The explanation of this is of course to be found in the relation of the chemical affinities.

Of all the eighty elements at present known, nitrogen has the feeblest affinities. It has no desire to enter into union or combination with other substances. It is the old bachelor—the recluse—the solitary among elements. It prefers to exist in its free uncombined state, rather than in combination or union with any others; and if, in exceptional circumstances, it is induced to combine with other elements, the slightest cause is sufficient to break up the union and restore nitrogen to its free and independent existence. In the atmosphere it exists in company with other substances, but though with them it is not of them—the association is a mechanical mingling—not the close union of chemical combination.

Before nitrogen can enter into the constitution of a plant it must be induced to combine with some other element which will carry it in. A plant may be perishing for want of a few grains of nitrogen, and though three-fourths of the wind that fans its leaves are constituted of this element, not a single particle can it drink in to save its existence. This was long in dispute, but now seems to be settled. Dr. F. Grace Calvert, in a recent lecture before the Society of Arts, England, after a very learned summary of the investigations on the subject, remarks—

An animated discussion, based upon a long series of researches, ensued between Boussingault and Ville, the latter contending that plants could absorb nitrogen from the atmosphere and fix it as a part of their organism; the former contending that the nitrogen contained in plants was derived either from ammonia or nitric acid. This discussion was still proceeding when Mr. Lawes and Drs. Gilbert and Pugh published, in the "Memoirs of the Chemical Society of London," 1863, such a complete and elaborate series of researches that chemists came to the conclusion that the nitrogen existing in plants was not derived from the atmosphere as nitrogen. There can be no doubt that the general tendency of scientific as well as practical investigation, as above stated, proves that it is most probably under the form of nitric acid, or more so in a state of nitrates, that nitrogen penetrates into plants, and becomes one of the essential elements of the formation of albumen, fibrin, legumin, or other nitrogenated substances which are found existing in vegetables.

An atom of ammonia is composed of three atoms of hydrogen and one of nitrogen, $N H_3$, and as an atom of nitrogen is fourteen times as heavy as an atom of hydrogen, the proportion by weight is three pounds of hydrogen to fourteen of nitrogen. Ammonia contains more nitrogen in proportion to its weight than any other compound. Nitric acid is composed of nitrogen and oxygen in the atomic proportion $N O_5$, and as the atomic weight of oxygen is 8, the proportion by weight is forty pounds of oxygen to fourteen of nitrogen. Dr. Calvert concludes that the nitrogen is first taken from ammonia to form nitric acid before it enters into the combination of plants. He says—

If the conversion of nitrogen into nitric acid, under the influence of certain mineral substances, has been known by its results for a long period in what is called the nitrification in the walls of our dwellings, still the demonstration of the conversion of ammonia into nitric acid is the result of comparatively recent researches.

The most interesting series of researches published on this subject are those due to M. Millon, which you will find in the "*Comptes Rendus de l'Academie de Sciences*, 1864," in which he has shown that the production of niter is in ratio with the quantity of vegetable matter, especially humic acid, that a soil contains, and that the most favorable land for the production of niter is that which is called mold by gardeners. He further ascertained that if he made a mixture composed of ordinary earth, 20 parts, ashes 4, mold 3, the production of niter was most active, and also that the oxygen of the air had a great influence on its production, converting the ammonia resulting from the decay of the organic matter into nitric acid.

These facts are well illustrated in the following table quoted from his researches:—

Nitrification.		Parts.
Soil	Earth	20
	Ashes	4
	Decayed manure	3
		Quantity of Niter.
Upper layer		440
Middle layer		441
Bottom layer		009

From the above you will gather that in the upper part of a bed (one meter in depth, and composed as above shown) there is far more niter than in the lower portions of it. These researches of M. Millon threw much light on those published some years since by M. Boussingault, who ascertained the rate of proportions of niter that existed in various qualities of soils and also the influence of manured land on the production of niter in soils. Thus, M. Boussingault found that the quantity of niter in non-manured land was a mere trace; in uncultivated land there were from 1 to 0·5 in 1,000 parts of soil, while in cultivated land, and in highly-manured ground, 18 parts in 1,000. He further observed that if he manured a piece of land, after 7 days there were 12 parts of niter per 1,000; in 17 days, 81 parts; in 15 days more, 233; in 15 days more, 280; and in 15 days further, 260; and then the quantity decreased rapidly.

Continental Telegraphic Convention.

An imperial decree has just been published in Paris promulgating a convention, concluded in May last, between France on the one part, and Belgium, Austria, Baden, Denmark, Spain, Greece, the city of Hamburg, Italy, Holland, Portugal, Prussia, Russia, Saxony, Sweden and Norway, Switzerland, Turkey and Wurtemberg on the other, and which has for its object the organization of the entire telegraph system, and the establishment of a fixed international tariff. The dispatches are classed under three heads—those of the State, or Governmental dispatches, those connected with the public service, and, lastly, private telegrams. The tariffs will affix the amounts to be received by each country as regards transmission, receipt, and transit. The ratifications have been exchanged between all the powers, with the exception of Greece, Portugal, and Turkey, in which there has been some delay, and the convention was to come into operation on the first day of the present year. This arrangement will be of essential service to the commercial world by doing away with inconsistencies, and setting up a regular and fixed scale of charges.