blue of distinctly smaller particles than those sought for in vain by Mr. Huxley. These particles, as already stated, must have been less than $\frac{1}{100000}$ of an inch in diameter.

And now I want you to submit to your imagination the following question: Here are particles which have been growing continually for fifteen minutes, and at the end of that time are demonstrably smaller than those which defied the microscope of Mr. Huxley. What must have been the size of these particles at the beginning of their growth? What notion can you form of the magnitude of such particles? As the distances of stellar space give us simply a bewildering sense of vastness without leaving any distinct impression on the mind, so the magnitudes with which we have here to do impress us with a bewildering sense of smallness. We are dealing with infinitesimals compared with which the test objects of the microscope are literally immense.

From their perviousness to stellar light, and other considerations, Sir John Herschel drew some startling conclusions regarding the density and weight of comets. You know that these extraordinary and mysterious bodies sometimes throw out tails 100,000,000 of miles in length, and 50,000 miles in diameter. The diameter of our earth is 8,000 miles. Both it and the sky, and a good portion of space beyond the sky, would certainly be included in a sphere 10,000 miles across. Let us fill this sphere with cometary matter, and make it our unit of measure. An easy calculation informs us that to produce a comet's tail of the size just mentioned about 300,000 such measures would have to be emptied into space. Now suppose the whole of this stuff to be swept together, and suitably compressed, what do you suppose its volume would be? Sir John Herschel would probably tell you that the whole mass might be carted away at a single effort by one of your dray-horses. In fact, I do not know that he would require more than a small fraction of a horse-power to remove the cometary dust. After this you will hardly regard as monstrous a notion I have sometimes entertained concerning the quantity of matter in our sky. Suppose a shell, then, to surround the earth at a hight above the surface which would place it beyond the grosser matter that hangs in the lower regions of the air—say at the hight of the Matterhorn or Mont Blanc. Outside this shell we have the deep blue firmament. Let the atmospheric space beyond the shell be swept clean, and let the sky matter be properly gathered up. What is its probable amount? I have sometimes thought that a lady's portmanteau would contain it all. I have thought that even a gentleman's portmanteau—possibly his snuff-box—might take it in. And whether the actual sky be capable of this amount of condensation or not, I entertain no doubt that a sky quite as vast as ours, and as good in appearance, could be formed from a quantity of matter which might be held in the hollow of the hand.

Small in mass, the vastness in point of number of the particles of our sky may be inferred from the continuity of its light. It is not in broken patches nor at scattered points that the heavenly azure is revealed. To the observer on the summit of Mont Blanc the blue is as uniform and coherent as if it formed the surface of the most close-grained solid. A marble dome would not exhibit a stricter continuity. And Mr. Glaisher will inform you that if our hypothetical shell were lifted to twice the hight of Mont Blanc above the earth's surface, we should still have the azure overhead. Everywhere through the atmosphere those sky particles are strewn. They fill the Alpine valleys, spreading like a delicate gauze in front of the slopes of pine. They sometimes so swathe the peaks with light as to abolish their definition. This year I have seen the Weisshorn thus dissolved in opalescent air.

By proper instruments the glare thrown from the sky particles against the retina may be quenched, and then the mountain which it obliterated starts into sudden definition. Its extinction in front of a dark mountain resembles exactly the withdrawal of a veil. It is the light then taking possession of the eye, and not the particles acting as opaque bodies, that interfere with the definition.

By day this light quenches the stars; even by moonlight it is able to exclude from vision all stars between the fifth and the eleventh magnitude. It may be likened to a noise, and the stellar radiance to a whisper drowned by the noise. What is the nature of the particles which shed this light? On points of controversy I will not here enter, but I may say that De la Rive ascribes the haze of the Alps in fine weather to floating organic germs. Now the possible existence of germs in such profusion has been held up as an absurdity. It has been affirmed that they would darken the air, and on the assumed impossibility of their existence in the requisite numbers, without invasion of the solar light, a powerful argument has been based by believers in spontaneous generation.

Similar arguments have been used by the opponents of the germ theory of epidemic disease, and both parties have triumphantly challenged an appeal to the microscope and the chemist's balance to decide the question. Without committing myself in the least to De la Rive's notion, without offering any objection here to the doctrine of spontaneous generation, without expressing any adherence to the germ theory of disease, I would simply draw attention to the fact that in the atmosphere we have particles which defy both the microscope and the balance, which do not darken the air, and which exist, nevertheless, in multitudes sufficient to reduce to insignificance the Israelitish hyperbole regarding the sands upon the seashore.

The varying judgments of men on these and other questions may perhaps be, to some extent, accounted for by that doctrine of relativity which plays so important a part in philosophy. This doctrine affirms that the impressions made upon us by any circumstance, or combination of circumstances, depends upon our previous state. Two travelers upon the same peak, the one having ascended to it from the plain, the other having descended to it from a higher elevation, will be differently affected by the scene around them. To the one nature is expanding, to the other it is contracting, and feelings are sure to differ which have two such different antecedent states.

In our scientific judgments the law of relativity may also play an important part. To two men, one educated in the school of the senses, who has mainly occupied himself with observation, and the other educated in the school of imagination as well, and exercised in the conception of atoms and molecules to which we have so frequently referred, a bit of matter, say $\frac{1}{50000}$ of an inch in diameter, will present itself differently. The one descends to it from his molar hights, the other climbs to it from his molecular lowlands. To the one it appears small, to the other large. So also as regards the appreciation of the most minute forms of life revealed by the microscope. To one of these men they naturally appear conterminous with the ultimate particles of matter, and he readily figures the molecules from which they directly spring; with him there is but a step from the atom to the organism. The other discerns numberless organic gradations between both. Compared with his atoms, the smallest vibrios and bacteria of the microscopic field are as behemoth and leviathan.

The law of relativity may to some extent explain the different attitudes of these two men with regard to the question of spontaneous generation. An amount of evidence which satisfies the one entirely fails to satisfy the other; and while to the one the last bold defense and startling expansion of the doctrine will appear perfectly conclusive, to the other it will present itself as imposing a profitless labor of demolition on subsequent investigators. The proper and possible attitude of these two men is that each of them should work as if it were his aim and object to establish the view entertained by the other.

(To be continued.)

PROFESSOR TYNDALL'S LECTURE ON ELECTRICAL PHENOMENA.

MAGNETO-ELECTRIC MACHINES.—SAXTON'S MACHINE.—SIEMENS' ARMATURE.

Faraday's discovery of magneto-electricity was announced in 1831. In 1833 a machine was constructed by Saxton for the more copious development of magneto-electric currents.

In it copper-wire coils, within which were placed cores of iron, were caused to rotate before the poles of a powerful magnet.

On the approach of a coil to one of the poles of the magnet, a powerful current, whose direction depended on the nature of the pole, was induced in the coil. When the coil retreated from the magnetic pole, a current in the opposite direction was induced.

By means of an instrument called a *commutator*, which reversed one of the induced currents at the proper moment, the opposite currents were caused to flow in the same direction.

The cores of soft iron and their associated coils constitute what is called an *armature*. In Saxton's armature the coils were wound *transversely* to the iron cores.

But, by winding his coils *longitudinally*, or parallel to the axis of the core, and placing the armature so formed between the poles of a series of horse-shoe magnets, Siemens obtained magneto-electic currents much more powerful than those of Saxton.

WILDE'S MACHINE.

Things were in this state when, in 1866, Wilde made an important addition to our knowledge of magneto-electricity.

He conducted the current obtained by means of Siemens' armature round an electro-magnet, and found that the magnetism thus excited was far greater than that of the entire series of steel magnets employed to generate the magneto-electric current.

Thus, in one case, he found that, whereas the series of permanent magnets taken collectively was competent to support a weight of 40 pounds only, the electro-magnet which they excited sustained a weight of 1,088 pounds.

To produce this effect, however, it was necessary that the armature of the magneto-electric machine should rotate with great rapidity.

But Wilde went farther. Forming his electro-magnet from a large plate of iron, and placing between its long poles a correspondingly long armature, similar in shape and construction to that of the magneto-electric machine, he obtained from this second armature currents of enormously greater power than those obtainable from the first.

These currents could in their turn, be sent round a second electro-magnet, formed from a larger plate of iron. Furnished with a rotating armature, this second electro-magnet produced effects previously unknown. Rods of iron a quarter of an inch in thickness were fused by the currents, and they were also found competent, when discharged between carbon terminals, to produce a light of intolerable brilliancy.

SIEMENS' AND WHEATSTONE'S MACHINE.

The next great step in magneto-electricity was made simultaneously by Dr. Werner Siemens and Sir Charles Wheatstone.

Expressed generally, this discovery consists in exalting, by means of its own action, to a high pitch of intensity an infinitesimal amount of magnetism.

Conceive an electro-magnetic core with a very small amount of residual magnetism, which is never wholly absent when iron has been once magnetized. Let a secondary coil, with cores of soft iron, rotate before the poles of such a magnet. Exceedingly feeble induced currents will circulate in the secondary coil. Let these induced currents, instead of being carried away, be sent round the electro-magnet which produced them; its magnetism will be thereby exalted. It is then in a condition to produce still stronger currents. These also being sent round the magnet, raise its magnetism still higher, a more copious production of induced currents being the consequence. Thus, by a series of interactions between the electro-magnet and the secondary helix, each in turn exalting the other, the electro-magnet is raised from a state of almost perfect neutrality to one of intense magnetization.

When the magnet has been raised to this condition, other coils than those employed to magnetize it may be caused to rotate before, or between, its poles; the currents from these coils may be carried away and made use of for magnetization, for chemical decomposition, or for the electric light.

The first magneto-electric machine used to produce a light sufficiently intense for lighthouses was constructed by Mr. Holmes. In it permanent steel magnets and rotating helices were employed. Mr. Holmes has lately constructed a very powerful machine on the principle of Siemens and Wheatstone.

INDUCED CURRENTS OF THE LEYDEN BATTERY.

If a Leyden jar, or battery, be discharged through a primary spiral, it evokes a current in a secondary spiral. With a strong charge this secondary current may be caused to deflagrate a foot of thin platinum wire.

If the current from the secondary spiral be led round a third spiral which faces a fourth, on discharging the battery through the primary spiral, the secondary in the third spiral acts the part of a primary, and evokes in the fourth spiral a *tertiary current*.

With another pair of spirals this tertiary current can be made to generate a current of the *fourth order*; this, again, with another pair of spirals, a current of the *fifth order*. All these currents can impart shocks, ignite gunpowder, or deflagrate wires.

For the investigation of the induced currents of the Leyden battery we are indebted to Professor Joseph Henry Director of the Smithsonian Institution, and to Professor Riess, of Berlin.—*Chemical News.*

To Telegraph Learners.

A great many persons are now learning to telegraph. There will be many more in the years yet to come. A large number of men and women, in addition to the fifty per annum who die, will be ever leaving the business; the former, to engage in new pursuits; the latter, to marriage and the care of households; thus leaving spaces to be filled by fresh recruits. It is interesting, therefore, to many, to know how to learn easiest and most rapidly. Many excellent plans have been proposed, among which we recall those of Prof. Smith and Mr. Pope, and Mr. Little. We propose to add our own, or rather, to state how we acquired the language. It may help some one to know how that was done.

We were first ordered to telegraph service Sept. 14, 1845 We had, at that time, never seen a telegraph register, or key. But we had given to us a copy of Vail's pamphlet, in which was the Morse alphabet. That alphabet, we at once decided, had to be learned thoroughly. Immediately, therefore, we commenced, what to us was very solemn and mysterious work, thumping out the dots and dashes on the table, with every finger of the five hugging its neighbor, and using this quintuple digit as an electric hammer. And we got on nicely. At night, we kept up the practice on the bed post, until the stars began to fade. On the cars, we drummed it out on the window pane, oron the back of the seat before us, to the wonderment of those who sat thereon. But none of these plans fixed the characters so thoroughly in mind as a practice we adopted, of writing letters to friends in the telegraphic idiom. In a very short time, by this telegraphic correspondence, we got such hold of the language that the letters soon came instinctively to us, as they must always come before any one can ever do telegraphic service worth the name. It is an easy and pleasant way to learn; an hour in the evening may thus be spent as a pastime—passing notes to companions at the table, and receiving replies. The memory will speedily become so charged with every letter that, when the fingers come to touch the key its chief difficulty will be gone, and the learner will carry to the key the same exactitude which was found necessary to execute intelligibly the letters on paper. So true was this in our own case, that, on reaching Washington, and being placed at an instrument for the first time, we at once wrote out these very euphonious lines without hesitatiou:

"Butcher's meat has riz,
People say it will be rizzer,
But 'tiz as 'tiz,
And it can't be no 'tizzer."

And we did it about as well as ever we have done it since. We had the reputation also, for some years, of writing symmetrically. We were indebted for that to this mode of learning. Now, we have not patented the process, and all may try it who please. We think it will greatly facilitate learning at the key. When once the alphabet is thus thoroughly impressed on the memory, so that the mind has nothing to do but attend to the mechanical movement, the process of learning at the instrument is simple and readily acquired. Experience will do the rest.

Learning by sound may be acquired, after such a beginning, by as simple a method. Thus, the letter E is a single sharp click, which can be made by striking the table or plate with the edge of a cent. Two clicks make I, three make S, and so on. Now, families may learn these around the tea-table, and it may be that, in some day not far distant, the fair president of a dinner table may communicate orders to the kitchen by the Morse alphabet, or scold the juniors by a similar vernacular.—*Journal of the Telegraph.*

Improvement in Hulls of Vessels.

Our engravings illustrate a recently patented mode of constructing the hulls of vessels, which is such a radical change of form, that practical experiments with full-sized models can only prove its real value.

The great desideratum claimed, and which the patentee states he has demonstrated, is that the vessel is lifted above the static water line in proportion to speed attained heretofore.

Fig. 1 is a perspective view of the bottom of a vessel constructed in this manner. Fig. 2 is a plan of the same. Fig. 3 is a side plan view, and Fig. 4 is an end plan view

The object sought to be attained is to cause the water displaced by the cut-water to be gathered together convergingly under the center of the boat, and to be thence divergingly passed over at the stern in order to retain the vessel in a horizontal position, and thereby facilitate its motion through the water.

A is the center or keel line. B is the diagonal or grade line which runs from the cut-water to any given hight, and to the center of the boat or the line, D. The line, C, is produced by passing a straight edge over the lines, A and B, at a right angle with the line, A, as shown in Fig. 4. That is, if straight lines be drawn at right angles from the line, A, and also passing through the straight line, B, they will, when produced, also pass through and form points in the curved line, C.

The positions of the lines, A and B, therefore, determine all the other lines of the hull, and the modeling becomes a matter of absolute measurement, leaving nothing for the eye or judgment to do except to secure accuracy in performing the work, as indicated.

E is a central chamber commencing where the cut-water ends, where it ceases to displace the water. This chamber terminates where the counterpart of the cut-water begins to separate the volume of water from the central chamber. The opposite sides of the chamber, E, incline gradually, attaining their maximum at the center where their depth is also greatest.

The water, when the boat is in motion, is displaced by the inclined sides of the cut-water, and is converged by the reversely inclined sides of the chamber, E, until it reaches the center. The further progress of the boat brings the reversed cut-water over the united mass of fluid, which is then laterally divided, at first by a very obtuse angle or the arc of a very large circle, which gradually becomes more and more acute.

It is claimed that the converging of the volume of water displaced by the cut-water, by the gradually converging sides of the chamber, E, so as to quickly fill up the trough made by the cut-water, furnishes a firm support to the hull in the line of its center of gravity rendering it steady.

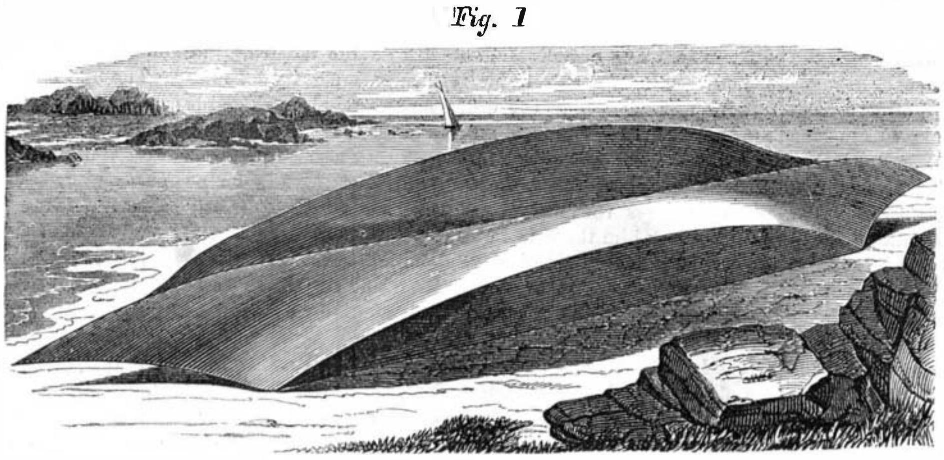
It is also claimed that as an upward pressure is produced at the stern in passing over the volume of water from the chamber, E, equal to the upward pressure of the water upon the moving sides of the cut-water, there is no tendency of the boat to rise higher at the prow than at the stern, so that the boat may be urged to any practicable speed without losing its horizontal position, as is the case in boats constructed on other principles. This, it is claimed, admits of a more economical application of propelling power, as the power required to propel a boat which rises at the prow is partly expended in raising its weight up the incline thus formed.

It will be seen that in this method of construction the lines are placed geometrically so as to open and close the water with equal speed, and to maintain the horizontal position, both laterally and longitudinally.

It is claimed also that the water leaves the stern of the boat as compact as when the cut-water enters it, which gives the rudder a powerful hold at high speed.

Patented, through the Scientific American Patent Agency, October 4, 1870. Address, for further information, L. P. Rider & Co., Pittsburgh, Pa.

Fig. 1



RIDER'S IMPROVED BOAT HULL.

Fig. 2

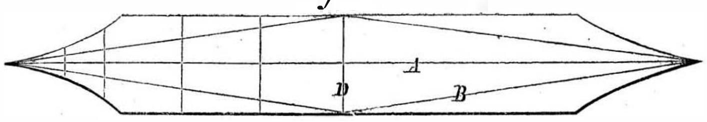


Fig. 3

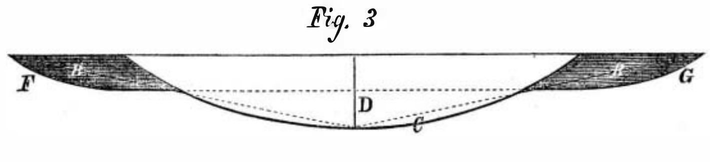
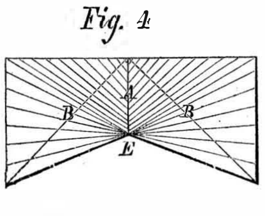


Fig. 4



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THE STEREOSCOPE.

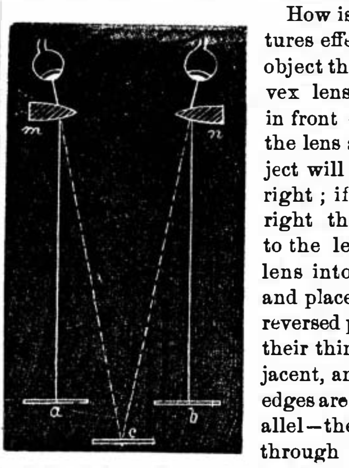
The stereoscope is comparatively a new invention, dating back only some twenty years. A form of the instrument in which mirrors were used to produce the effect was devised by Wheatstone, in 1838; but the stereoscope, as we are familiar with it, was invented by Sir David Brewster, in 1849. The former is known as the *reflecting* stereoscope, and the latter, in which lenses take the place of Wheatstone's mirrors, is called the *refracting* or *lenticular* stereoscope.

We have taken it for granted that the philosophy of the stereoscope was generally understood, but a little inquiry among our friends—including some of the better informed among them—has satisfied us that this is not the case. Even some of our leading teachers know nothing about it. A few months ago, at a little gathering of gentlemen interested in physical science, the fact that the pictures formed in the two eyes are different was referred to by one of the company, together with the related fact that the two pictures of the stereograph differ in the very same way, when, much to the surprise of most persons present, both facts were squarely denied by a gentleman who had for many years been at the head of one of our best high schools, and for the greater part of the time a teacher of mathematics and physics. It was only after a long and rather lively discussion that he became convinced of his error. He had never before understood either the stereoscope or the eye, so far as its action is like that of the stereoscope.

Why do we have two eyes, when we see but one image with them, and apparently one eye would serve to form that image? There may be other reasons for the arrangement, but the most obvious one is *that we may see objects solid*, or in relief, and not merely as pictures on a plane surface. It was not until Wheatstone made his experiments on binocular vision, in 1838, that this matter came to be thoroughly understood, even by scientific men. He showed that the pictures in the two eyes are not exactly alike, and that it is the blending of these two pictures which causes objects to appear solid.

A moment's reflection ought to satisfy the reader that the pictures in the two eyes cannot be exactly alike, since the eyes are not in precisely the same position with reference to the object. But if "he don't see it," a simple experiment will enable him to see it. Let him hold a book or any other solid object about a foot from the eyes, and look at it first with one eye and then with the other. He will find that with the right eye he sees a little more of the right side of the object, and with the left eye a little more of the left side. The same will be true, of course, whatever may be the distance of the object from the eye, though when the distance exceeds 250 or 300 feet the difference is too small to be appreciable, and objects beyond that distance are not really seen to be solid.

Now the stereoscope is simply a contrivance for blending two pictures which differ from each other as the images in the two eyes differ. When thus blended the pictures produce the same impression of solidity as the object itself does when viewed with both eyes. Hence the name of the instrument, which is from two Greek words, meaning *to see solid*.



How is this blending of the pictures effected? If we look at an object through the center of a convex lens, it will be seen exactly in front of the eye; if we move the lens a little to the left the object will appear to move to the right; if we move the lens to the right the object appears to move to the left. If now we cut the lens into two semicircular pieces, and place them side by side in a reversed position—that is, so that their thin or curved edges are adjacent, and their thick, or straight edges are turned outward and parallel—the right eye will then look through the left half of the lens, and the left eye through the right half. If two pictures, like those of a stereograph, be placed at a proper distance behind the lens as thus divided and arranged, they will be seen, not in their actual places, but in a position midway between the two. The figure illustrates this: *m* and *n* are the halves of the lens; and *a* and *b* are the two pictures, which appear as one at *c*.

How are the two pictures obtained? They are photographs of the object taken from slightly different points of view Theoretically, they should be taken from points separated by a distance equal to that between the two eyes, or about two and a half inches; and for all objects within short distances this is just what is done. For objects farther off—as large buildings or landscapes of considerable extent—photographers usually take the pictures from points farther apart, the distance ranging from a few feet up to a quarter of a mile.

In this way, objects which are so distant that they are not really seen as solid with the unaided eye are brought out into clear relief by the stereoscope. Even the moon may be made to show her rotundity of figure by means of this instrument. Although she always turns the same side towards the earth she swings a little at times, so that we get a view of a little more of her eastern or western side; and by taking advantage of this swinging (or *libration*, as the astronomers call it), photographs can be taken corresponding to the images in the two eyes—or rather, as Sir John Herschel has remarked, "it is as though the moon were seen with the eyes of a giant, placed thousands of miles apart."

It has been suggested that similar photographs might be taken of the planet Saturn, with his system of rings. In this case an interval of two or three years would be allowed between the times of taking the pictures, in order that the position of the rings might change enough to answer the purpose.

A curious effect may be produced by tinting the pictures of a stereograph with different transparent colors. If, for example, one be colored blue and the other red, their blended image will appear purple; if blue and yellow be used, it will appear green, and so on. The colors are mixed *in the eye*, and the resultant color is precisely the same as if they had been mixed by a painter and applied to the picture outside the eye. We have seen French stereographs of statuary which illustrate this principle. One of the pictures is colored green and the other yellow, and the mixture of the two in the eye produces the exact tint of bronze.

Quite an amusing story is told of the first introduction of the stereoscope to the *savants* of France. The Abbé Moigno took the instrument to Arago, and tried to interest him in it; but Arago unluckily had a defect of vision which made him see double, so that on looking into the stereoscope he saw only a medley of four pictures. The Abbé then went to Savart, but he was quite as incapable of appreciating the thing, for he had but one eye. Becquerel was next visited, but he was nearly blind, and consequently cared little for the new optical toy. The Abbé, not discouraged, called next upon Pouillet, of the Conservatoire des Arts et Métiers. He was a good deal interested in the description of the apparatus, but unfortunately he squinted, and therefore could see nothing in it but a blurred mixture of images. Lastly Biot was tried, but Biot was an earnest advocate of the corpuscular theory of light, and until he could be assured that the new contrivance did not contradict that theory, he *would* not see anything in it. Under the circumstances, the wonder is that the stereoscope ever got fairly into France; but if you have any doubts on that point, a short walk under the arcades of the Rue de Rivoli, in Paris, will soon settle them. We question whether you will see anywhere else on earth more stereoscopes or stereographs than are displayed in the windows of the picture-shops of that noted thoroughfare.—*Journal of Chemistry*.

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Patents.

Every really valuable invention is the result of long previous training, expensive experiment, and hard earnest thought. Such being the case, it becomes a matter of prime importance to the inventor that that which has cost so much in the past should be well secured for the future so as to insure to the owner an adequate return for his outlay, his anxiety, and his toil. If experience is worth anything in such matters (and in what department is it not of value?) no better aid can be found than in the office of Messrs. Munn & Co., of this city, the well-known publishers of the *Scientific American*. It is probable that they have taken out more patents than all the other patent agencies in the United States put together. The consequence is that their office is so extensive that, for the several departments, they can afford to give constant employment to specialists, men who have made a particular study of some one or two things. Hence, in their office an improvement in potato-diggers need not necessarily be confided to a man who has applied himself all his life to steam engines, nor an improvement in woolen carding to one who, though great, is great in fire-arms. A word to the wise is sufficient.—*Technologist*.

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MINK FURS.—In all parts of Canada where a mink track is to be seen in the soft mud along the banks of streams or lakes, dead-fall can be found also. Trappers calculate that there is not a mink in the country for which a trap is not set. The animal being voracious is easily caught, and will soon become exterminated if not better protected. The fur is of very little use before the 1st of November, and yet minks are caught by hundreds during the month of October.