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Contents.

(Illustrated articles are marked with an asterisk.)

SURFACE ADHESION.

The adhesion of surfaces is of much greater importance and of more general application, in the economy of Nature and in the production of a multitude of phenomena, than appears at first sight. It produces not only the friction between solids in contact (without which it would be very difficult, if not impossible, to attain any stability) but also the retention of liquids against the surface of solids, without which we would be unable to moisten or lubricate effectively any solid surface. This surface adhesion between a liquid and a solid of course increases with the increase of the surface of the solid, and the most direct illustration of this is the fact that, while, for instance, solid stones sink rapidly in water, when crushed they sink much more slowly, and this exactly in proportion as they are more finely divided: thus, while the stones in a river will sink even when the current is swift, the coarse sand will be carried along, and not sink unless the current is slow; while the very finest sand, notwithstanding it consists of the very same material as the stones, will not be deposited at all except where the water is at perfect rest. Hence the coarseness or fineness of the gravel in a river bottom depends on the speed of the current. The most striking illustration of this property is found in the process of elutriation, practised by chemists. It consists in grinding insoluble products with a little water to a thin paste, and then suddenly diffusing the paste through a large quantity of water in a deep vessel, from which, after the subsidence of the coarser portion, which at once takes place, the supernatant liquid is poured into another vessel and allowed to deposit the next fine parts held in suspension. After a time, say 15 or 20 minutes, it is again decanted, and the apparently clear water left to settle for several days, when a small quantity of the very finest impalpable powder is obtained. In the preparation of emery and other polishing powders of numerous grades of fineness, several vessels are employed; and the muddy liquid, first left to settle a short time, is poured in the second, left to settle a little longer, then poured in the third, and so on. The powder of this hard substance, last deposited, is in so minute a state of division as to possess very great value as a polishing agent.

Adhesion also exists between gases and the surfaces of liquids or solids, and is the origin of many phenomena, the sole cause of which must be looked for in this adhesion. If, for instance, there were no adhesion between the air and the surface of water, there would be no friction between them; and the wind would move freely over the surface of the ocean, and would be unable to raise waves. The proof of this is that, if we cover the surface of water with a film of a lighter liquid, like oil, having less adhesion to air, thus having friction less than that of water with air, the winds will glide over it without raising waves: hence the well known quieting influence of oil on the surface of water agitated by the boisterous winds; and use of this property has occasionally been made with good effect when oil was on hand. It is the same adhesion of air to solids which causes the dust to be raised by wind, notwithstanding that the particles of dust are much heavier than the air.

But the most important example of this force of surface adhesion is the power of the air to hold up fine particles of water in the form of clouds. To explain this apparently wonderful support of water in the atmosphere, so great a man as De Saussure had recourse to the absurd hypothesis that the water particles of which clouds and fogs consist were small hollow, vesicular spheres, like microscopic soap bubbles, with a vacuum inside, and therefore specifically lighter than the air. And microcopists even went so far as to investigate the vapor of hot water, to see if the ascending globular particles were hollow inside. Some of them even asserted that they found this to be so; but every one experienced in microscopic observations knows that it is next to impossible to decide if a very transparent globular object is hollow or solid, especially if it moves in the field of the instrument, as is the case with the particles of ascending vapors. In the light of our knowledge of adhesion, such an hypothesis is utterly unnecessary and uncalled for. We know that the dust of heavy solids, even of the metals, is carried by the air, as is proved by the microscopic observations of the dust collected from the roofs of the houses in any large city; why, then, cannot dust of water be carried upward, and remain suspended? If any one doubt the existence of such water dust, let him observe the spray of the Falls of Niagara, or other large falls, and see how it ascends. It is nothing but water ground to dust by the tremendous fall; and when the atmosphere is not dry enough to absorb it and make it disappear, it will rise to elevations of hundreds and thousands of feet, and form real clouds, which will float away with the others. The size of these particles determines the hight to which they will ascend; the finer will form the upper clouds, the coarser the low, floating fogs. Dr. Angus Smith recently recorded a fog which he observed in Iceland, of which the particles were larger than he ever saw before. It rolled low over the ground like a dust, and microscopic observation convinced him that the particles were not hollow but solid, and he found the diameter to be $\frac{1}{400}$ part of an inch. He also refers in his account to the absurdity of the vacuum hollow sphere theory, which only shows that the greatest inventor is liable to invent erroneous theories.

HOW SOME MOUNTAIN GAPS HAVE BEEN FORMED.

Every one who has visited the Delaware Water Gap, or ascended the Susquehanna from Harrisburg, or passed through the cut where the Potomac has pierced the Blue Ridge at Harper's Ferry, or has seen indeed any one of the numerous gaps made by seaward-flowing rivers through the long mountain ridges which flank the Alleghanies, must have been struck by the question how a comparatively small stream could overcome so formidable an obstruction.

Evidently the river could not have taken advantage of a natural cleft or fissure through the mountain dam, for the strata correspond on the opposing sides of the gap, and the river flows over an unbroken stratum under-running the broken strata of the banks. The gap as plainly denotes a section cut out of the mountain as a notch in a stick does the removal of the wood. The disconnected edges of the strata tell precisely the same story as the severed lines of annual growth on the sides of a wood chopper's cut: the connecting portions of wood and stone have been removed. The question is: How?

The first and most natural supposition would be that the valley, back of the dam, had originally been filled, forming a lake whose outlet was over the ridge above the present river channel: and that, as the outlet was lowered by the wearing down of the obstruction, the lake was drained until the entire valley was laid bare.

This supposition is negatived by the plain fact that it would be impossible to fill the valley to the hight of the ridge at the point of the gap. Before the water could reach that level it would find an outlet elsewhere, where the natural elevation of the dam was less. An excellent illustration occurs a few miles above Harrisburg, where the Susquehanna crosses a flexure of the mountain ridge, cutting twice through the mountains within a few miles, when apparently it might easily have avoided the obstruction by going a few miles around.

Another supposition is that originally the river ran at a level corresponding with the top of the ridge, and that the present valley through which it runs is the result of erosion: while the river was slowly wearing through the hard mountain strata, the softer earth of the surrounding country was washed away through its sinking channel, leaving the more unyielding rocks in mountain ridges. From this point of view, the river is to be regarded not merely as the cleaver of the mountain barrier but as the creator of it, by reducing the level of the adjacent land.

Hitherto this supposition has been the most plausible and the most generally accepted. But another and perhaps truer explanation is suggested in Professor Powell's "Exploration of the Cañons of the Colorado."

As our Atlantic rivers cut through the Alleghany ridges, so the Green River, the chief head stream of the Colorado, pierces the Uinta Mountains, flowing through a series of cañons compared with which our eastern water gaps are insignificant. As in the case of the Susquehanna, above noted, the river bursts through the opposing mountains when apparently it might have found an easier passage by going round them. Why did it choose the harder course?

Professor Powell's answer is that it had the right of way. It was running there before the mountains were formed and simply removed the obstruction as fast as it rose in the way.

The contraction of the earth causes the strata near the surface to wrinkle or fold, and such a fold was started athwart the course of the stream now known as Green River. "Had the fold been suddenly formed, it would have been an obstruction sufficient to turn the water into a new course, to the east, beyond the extension of the wrinkle: but the emergence of the fold above the general surface of the country was little if any faster than the progress of the corrosion of the channel. We may say, then, that the river did not cut its way down through the mountains, from a hight of many thousand feet above its present site; but having an elevation, differing but little perhaps from what it now has, as the fold was lifted, it cleared away the obstruction by cutting a cañon, and the walls were thus elevated on either side. The river preserved its level, but the mountains were lifted up, as the saw revolves on a fixed point as the log through which it cuts is moved along. The river was the saw which cut the mountains in two."

The gigantic nature of this aqueous saw cut can be faintly estimated from the circumstance that the mountain log or fold had a diameter of fifty miles, while the depth of the cut, that is, the elevation of the fold above the present level of the river, was over twenty-four thousand feet. But a fraction of this enormous uplift of rock remains. As the rocks were lifted, rains fell upon them and gathered into streams, and the wash of the rains and the corrosion of the rivers cut the fold down almost as fast as it rose, so that the present altitude of the Uintas marks only the difference between the elevation and the denudation. The mountains were not thrust up as peaks, but a great block was slowly lifted, and from this the mountains were carved by the clouds—patient artists, who take what time may be necessary for their work."

THE WOODBURY PLANER WAR.

The manufacturers and users of the woodworking machinery on which the Woodbury Planer Patent Company are endeavoring to collect royalties, on the ground of an alleged infringement, will doubtless learn with gratification that at length the claims of the Woodbury people have been fairly brought before a United States Court. It will be remembered that a motion was granted some time ago in Washington, requiring the claimants to show cause why their patent should not be set aside on the ground of fraud. The time to appear was fixed for June 28, but an extension was granted until the middle of October; and from that period, it appears, still further time has been obtained, so that there is no immediate prospect of the matter being judicially determined from these proceedings. A suit has, however, been commenced by the Woodbury Company against Messrs. Stearns & Sons, large lumber dealers in Boston; and as this firm is resolute in refusing any compromise whatever, the cause at issue will in due process be reached.

Meanwhile the Woodbury Company seem to be resorting to all kinds of efforts to secure their tax. They have compromised with several users by giving licenses of a face value of $100 for $20 per machine; and one of their agents (or rather an individual named Allen, who claims to be such, and who has been endeavoring to frighten royalties out of small manufacturers in Massachusetts by representing himself as a United States Marshal, and acting otherwise fraudulently) has been locked up on criminal charges.

From 1,000 to 1,200 manufacturers and users of machines are now allied against the Woodbury monopoly, and the intention is to devote all possible energy to the breaking down of the claims of the latter by vigorously contesting the matter in the United States Court. The whole affair from beginning to end needs the searching scrutiny of a judicial examination. It began with Woodbury attempting to get a patent for a device which the courts had long previously decided to be an infringement on a prior patented invention. The Patent Office rejected his application in 1852, and thereupon woodworking people throughout the country adopted the pressure bar (intrinsically a most useful attachment) and used it, undisturbed, for eighteen years. In July, 1870, an act of Congress was passed, containing the following clause:

"That when an application for a patent has been rejected or withdrawn prior to the passage of this act, the applicant shall have six months from the date of such passage to renew his application or to file a new one; and if he omit to do either, his application shall be held to have been abandoned."

As a necessary consequence hundreds of old cases were revamped, including Woodbury's; but his application was again rejected. In January, 1873, another application met another rejection, and then, on April 26 of the same year, the Patent Office turned a complete somersault and declared all its previous decisions to be untenable and a tissue of blunders, and allowed the patent. The Commissioner, although the case was not in legitimate course before him, previously ordered that it be decided on its merits, without reference to abandonment, and gave instructions that no interference should be declared under the rule; and thereupon the patent was issued three days after its allowance, and two weeks ahead of the usual time.

When the act of Congress, containing the above quoted clause, was passed, we questioned its wisdom, and expressed the belief that it was framed more with a view to benefit some special case than to meet public exigencies. Certainly the facts relating to this Woodbury job point to the affirmation of that belief. The unusual action of the Commissioner we also stated at the time to be well calculated to create a suspicion of partiality, and not at all likely to impress inventors with the idea that the Patent Office was perfectly fair in its dealings. Mr. Leggett, however, in a recent letter to the *Northwestern Lumberman*, gives explanation of his course in the matter, and states that he felt bound to order the grant of the patent from the fact that the courts had decided that the public use of an invention, between the time of first application and that of the grant of a patent, if without the consent or allowance of the applicant, could not be construed as a public use in such sense as to prevent the grant of a patent. Regarding the merits of the present controversy, and especially in relation to the validity of the patent, the ex-Commissioner unreservedly speaks his mind as follows:

"I knew that the doctrine as laid down by the Court would grant the patent; yet I just as well knew that the patent ought not to be granted, and I believed that it would not be valid if granted. I have never believed from that time to this that the patent could stand a thorough litigation. I believe, if properly placed before any court of competent jurisdiction, they will declare it to be invalid. I so expressed myself upon it openly and frequently before the patent issued, upon its issue, and on every occasion I have had to do so ever since. I believe the whole thing to be a fraud upon the public."

To review the long array of arguments bearing upon the validity of the patent would require more space than is at our present command. It is enough to hope that everything relating to the case will be thoroughly ventilated during the approaching trial. If a broad flood of light can be shed into the inner history of the circumstances attending the passage of the act of Congress, and of the descents made by the Woodbury people upon the manufacturers who, for a score and over of years, have undisturbedly used the pressure bar, we have little doubt but that the public will be treated to a most interesting record of jobbing and rapacity.

EXPANSION AND CONTRACTION BY MOISTURE.

The effect of water or moisture on certain porous materials varies, under slightly different circumstances, so as to be apparently inconsistent. The general effect is to cause an increase in size, as the water is absorbed in the pores by capillarity, which causes them to enlarge, the watery atoms acting as so many wedges, forcibly driven in, causing a general expansion of the body: a sponge is the type of this kind of expansion, as, its structure being similar in all directions, the effects are also alike all round.

A piece of wood presents other conditions. The fibers are directly connected, and this connection is longitudinal, while the pores are between the fibers transversely. When, therefore, the pores absorb water, its particles do not enter between the longitudinal connections, but between the transverse ones, and the result is a transverse expansion or swelling, while the length will not perceptibly increase. This swelling by moisture and the subsequent shrinkage by drying are always in a transverse direction, and are familiar and well understood.

Paper, whether made from wood or any other fiber, will, by the influence of moisture, expand in all its dimensions, if the fibers lay in all directions. Such is the case with the hand-made paper, once in universal use, but now only known in the form of some drawing and writing papers; but in the machine-made paper, especially if made from long fibers, such as those of jute, the fibers lay more or less in the direction in which the paper moved on the machine by which it was made. This fact is easily ascertained by trying to tear it, as it will tear much more easily longitudinally with the fibers than transversely across them. Such paper will expand by moisture less longitudinally than transversely; and if a paper hygrometer be made, for estimating the amount of atmospheric moisture by the elongation of a strip, the little instrument will be much more sensitive if the strip be cut transversely to the direction of the fibers than if it is cut longitudinally, or parallel to this direction. These conditions are still more obvious with wood, and hygrometers have been made of long strips of very porous wood, glued together end to end, but all cut transversely to the board. Very sensitive instruments have been constructed in this way. A long human hair has been used for the same purpose. It elongates by moisture; and when one end is fixed, and the other end wound around the axis of a hand moving over a dial, the slight elongation may be magnified, and a tolerably reliable instrument obtained, the credit of the invention of which belongs to De Saussure. If a hemp or flax rope, in which the fibers are not twisted, but lay all parallel and longitudinally, could be made, it would increase by moisture in thickness, and not at all or very little in length. All ropes, however, are held together by twisting the fibers, giving the whole the form of a long screw; and then the effect of expansion in thickness by moisture influences in a peculiar way the length, it thickens the strands, and, although it has the effect of tightening the twists, as if the rope were more tightly twisted, it shortens the length; and the shortening by moisture or water varies directly with the degree to which the rope was twisted in making. This effect is very perceptible in clothes lines, which will become quite taut when wet, so much so, indeed, as often to extract the hooks to which they are attached, or pull the poles out of plumb. One of the most striking instances of this kind which we ever witnessed was with a bell rope in a lighthouse on the coast of France, nearly 300 feet high, with a first class revolving Fresnel light on top. The attendants were signaled by means of a bell at the top, pulled by a twisted hempen cord suspended inside the tower; and this cord became a perfect hygrometer. On dry days it hung down to about three or four feet from the ground; while on moist days the end was six feet from the earth, and on very wet days even more, so that it had to be elongated in order to be always within reach.

The practical applications of these properties are, besides the use of hygroscopic substances for hygrometers, the insertion of dry wooden wedges in grooves made in stone in quarries, by wetting which they swell and detach the stones; this is largely employed in the millstone quarries in France. The swelling, untwisting, and shortening of ropes by water is often made use of to produce a strong traction for a short distance. As a most remarkable example of this kind, it is recorded that, in the reign of Pope Sixtus the Fifth, a colossal obelisk, which had been brought from Egypt, was being erected in Rome; it was ordered that, during the difficult and critical operation of raising it, a profound silence should be observed by the spectators, so as not to interfere with the commands of Zapaglia, the engineer and architect, who had made all the calculations for the machinery required, so as to secure the success of the enterprise. When the obelisk was raised, however, he found that he had not sufficiently taken into consideration the stretching of the ropes by the enormous weight; he saw that the obelisk was lifted about half an inch less than the hight of the pedestal on which it had to stand. Fortunately, at this critical moment, he remembered the effect of water on ropes, and his voice was heard, in the universal silence, ordering the ropes to be wetted. This was at once done, and in a minute the obelisk was raised, by the contraction of the ropes, to the right hight, and successfully placed on the pedestal.

MAN AS AN AUTOMATON.

A little more than a year ago Professor Huxley startled the world with his famous paper on "Animals as Automata." In that paper, this lucid writer and bold thinker used the word automaton in much the same sense as we use the adjective automatic, namely, to describe something which acts involuntarily, and not, as Webster defines it, "a self-moving machine, or one which has its driving power within itself." Professor Huxley meant to say that the movements of animals were directly caused by external impressions, independently of any exercise of will power; in other words, they were machines, upon which certain causes produced certain effects. We are not yet ready to acknowledge ourselves as automata or machines (and really the two words mean the same thing), even if so great a philosopher as Huxley should tell us we were.

The differences between a man and a machine are numerous. In the variety of work performed, man surpasses any engine that he has yet devised, although many of his machines surpass in perfection their builder. Where great accuracy, great delicacy, or great strength are requisite, the machine outstrips the man; and yet so simple a motion as that of walking has been but poorly imitated by machinery.

The superiority of a man to a machine is shown by his ability to devise and construct machines; it is, in fact, the superiority of mind to matter. But between the machine which can do nothing but what it was expressly built for and the intelligent thinker and inventor who planned the machine, there are all the intermediate stages represented by different members of the human family. There are men of little brains and much muscle, men of big brains and less muscle; men who plod along, year after year, in the paths which their fathers trod, and men who put all their heavy work on muscles of steel and of leather. The proportion of wide-awake, thinking men to dull routine plodders in different countries or sections of country is easily determined by the relative number of patents taken out in that country; and measured by this standard, the United States contains the least proportion of automata.

But there is a word to be said in favor of automata or man machines. Even now, toward the close of this nineteenth century, there remain many kinds of labor which cannot be done by machinery. There is also a large number of men, and women too (for the fair sex are not to be excluded in this classification), required to tend the machines, feed them, prepare work for them, and fill up the gaps in their work. For some of these positions there are required skill, thoughtful care, presence of mind, nerve, and ingenuity. Yet the more nearly all our motions resemble those of a machine, the greater is the amount of work we can do in a given time, and the less the fatigue. As the movements become automatic and regular, removed apparently from the control of the will, they become more rapid and easier. Why has division of labor accomplished so much? Chiefly because a man whose sole work it is to do one particular thing not only comes to do it better, but learns to do it with the least expenditure of time and the least exertion of brain and muscle; in fact he works very much like a machine. The compositor's hand travels the same road every time as it goes from the case to the stick; the bricklayer always seizes his brick with the same hand, and makes no unnecessary motions in conveying to its place, in preparing its mortar-lined couch, or tapping it home; the shoemaker whose sole labor is nailing on heels goes through the few simple motions automatically, no more stopping to think which tool is next required or where he is to look for his nails than an old woman when knitting thinks about the stitch, or an ordinary person thinks what muscles he is to call into play when he is walking. Does a rapid penman ever stop to recall the shape of a letter, or do his words and thoughts flow automatically from his finger ends? The fingers of an experienced player find the keys of his piano as a compositor finds his type boxes, or the hand knitter her needles and yarn, automatically.

Habit is another term often employed to designate what we do automatically, but habit applies alike to mind and muscle. A man accustomed to smoke or drink does not do these things without thinking about them; habit only causes and strengthens the desire. On the other hand a man who habitually swears, like a woman who bites her finger nails, does it unconsciously, and hence automatically. It is acknowledged to be a good thing to possess good habits, and not merely be free from bad ones: so it is equally desirable for a man employed in any specialty to acquire the simplest and best way of doing his work; this way selected, let him adhere to it perseveringly until it becomes automatic. Let the habit become fixed, and he will find his speed increase and the exertion diminish. To accomplish this desirable end, it is, however, absolutely necessary that no superfluous movement be made. In feeding a small hand printing press, where each card must be laid on separately, if the cards be piled in such a manner as to involve turning each one over or around, the speed is reduced at least 10 per cent. Every motion, however slight, which must be repeated 50 to 100 times per minute is time-robbing. The writer who crosses his t's and dots his i's cannot write so fast as he who does not. The man who spells bought, through, received, etc., in their simpler forms bo't, thro', and rec'd, saves a large percentage of time; and if all the silent and useless letters were omitted, the most hasty scribblers could find time to write distinctly. As that system of shorthand which has the fewest strokes consistent with legibility receives the preference, so that language which uses the fewest and shortest words to express an idea perspicuously deserves to become the universal language of the commercial world.

"Practice makes perfect" is a good old proverb and a true one; but what is the use of perfection in bad methods? The man who always carried a stone in one end of the bag to balance his grist may have arrived at perfection in the selection of a suitable stone; but what gain was that? First use your brains in devising the shortest and quickest methods, then by practice learn to do them automatically, and you have a maximum of speed with a minimum of labor.

AMERICAN INVENTIONS RE-DISCOVERED IN EUROPE.

It is no unfrequent thing for us to meet, in the columns of European papers, notices published with all the flourish peculiar to the first announcements of strikingly novel ideas, concerning old American inventions, long known and used here. Here are two examples in point: "A French blacksmith has devised a perforated plate, put in rotation by clockwork, and intended to be placed behind the lock of a safe. The consequence is that the safe cannot be opened except at certain times during business hours, when there is no danger of any robber intruding into the offices." This is from a late number of *Nature*, one of the keenest of English scientific weeklies. A chronometer lock was patented in this country by John Y. Savage in 1847, and has for years been in use here upon safes in banks, government treasuries, and business houses. The French blacksmith and *Nature's* item are twenty-eight years behind the age.

The second paragraph begins as follows: "Of all the extraordinary discoveries which have been announced of late, Germany sends us the most surprising." After which, the English *Textile Manufacturer* proceeds to describe wool made from liquid furnace slag by blowing through it a steam or air jet. This is not a German discovery. It was invented by Mr. John Player, deceased, and patented here by Amelia Player, of Philadelphia, Pa., his administrator, May 31, 1870. Descriptions of beautiful examples of this curious product have heretofore been published in our paper.

SCIENTIFIC AND PRACTICAL INFORMATION.

TO FIX PAPER ON DRAWING BOARDS.

Take a sheet of drawing paper and damp it on the back side with a wet sponge and clean water. While the paper is expanding, take a spoonful of wheat flour, mix with a little cold water, and make it a moderately thick paste; spread the paste round the edge of the drawing paper one inch wide with a feather, then turn the drawing paper over and press the edges down on the board. After this take four straight pieces of deal wood, ¾ inch by 2¼ inches wide; place them on the edge of the drawing paper, and put a large book or heavy weight on each corner to make the paper adhere firmly to the board. In about an hour's time the paper will be straight and even, and quite ready for executing a drawing. When the drawing is finished, take a sharp knife and raise one corner of the paper, then take a scale, run it round the edges, and the paper will come off easily. Turn it over and take the dry paste off with a knife, and all will be perfectly clean, and no paper will be wasted.

A MICROSCOPIC BI-CENTENNIAL.

The city of Delft, Holland, has recently celebrated the bi-centennial anniversary of the discovery of microscopic infusoria by Antony Van Leeuwenhoek. Public memorial services were held, a monument unveiled, a banquet partaken of, and the discoverer's instruments displayed. It is something new to witness people of all classes in a city taking part in an enthusiastic celebration of a discovery made two hundred years ago, and regarding which the average individual knows so little.

FAST HORSEBACK RIDING.—At a fair at Waco, Texas, lately, a horseman rode for a wager sixty miles in two hours and fifty-five minutes, using relays of ordinary Texas horses to the number of forty-two. His last mile was made in two minutes and seven seconds, and his time for the sixty miles was five minutes better than the best time ever recorded in this method of racing.

FARADAY established the fact that gases are but the vapors of liquids possessing a very low boiling point.