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Contents:

(Illustrated articles are marked with an asterisk.)

WOOD ENGRAVINGS.

Not the least of the means by which science and knowledge are disseminated at the present day, and by which the present stage of civilization has been reached, is the art of wood engraving. So far has its power as an educational means been recognized that scarcely a primary school book is now published without illustrations.

From the ape which helps to impress upon the infant mind the first letter of the alphabet, to the zebra which performs a similar office for the last, through the first primer of arithmetic, and so on progressively to the higher studies of geometry, surveying, astronomy, physics, and chemistry, the pupil finds his imagination aided and cultivated by wood engravings; not rude, uncouth caricatures but really meritorious productions.

In our early school-days the only picture contained in any school book then in use, except the geography, was the frontispiece to Webster's Spelling Book. A picture of a female with a forbidding countenance inviting us to come up to the temple of knowledge, and giving us to understand that if we wanted to win fame, we must devote ourselves to orthography with the utmost diligence.

We are confident we fulfilled our part of that contract, but the female with the forbidding countenance has never fulfilled hers.

At that period a picture in a newspaper was a thing to be wondered at and talked about by a whole neighborhood. Now even the dailies endeavor occasionally to grace their columns with pictures, but as yet such pictures can scarcely be called works of art.

We venture to predict that men of two-score years now, will, ere they arrive at three-score, see illustrations in every daily paper as regularly as they now see the market reports.

Of course nothing good will ever be originated that the spirit of evil will not pervert to its own purposes. There now exist a large number of papers, the illustrations in which as well as the reading matter, are wholly vile, and the influence of which is entirely bad. The strong arm of the law ought to be invoked to suppress these obscene publications.

On the contrary, there are a large number of publications which teem with, in some instances, really superb works of art, the circulation of which cannot be too much encouraged, for their refining and cultivating influence on the masses.

One of the earliest illustrated papers in this country was our SCIENTIFIC AMERICAN, and the educating influence it has exercised has doubtless been to a great extent due to the able manner in which our artists have sustained this feature. In a description of machinery a stroke of the artist's pencil will often do more to elucidate a subject, than a page of verbal description.

Many an invention dates its financial success from its illustration and description in the SCIENTIFIC AMERICAN, and the study and examination of these illustrations have probably originated more useful and ingenious inventions in this country than any other cause.

HARDENING AND TEMPERING STEEL.

When we penned our recent article on the above subject, we had little idea what a sensation we were preparing. Such a shower of correspondence as has fallen upon our sanctum, and fairly snowed us in with arguments pro and con, is something we hardly expected.

This correspondence gives evidence that we did not overstate the diversity of opinion existing among mechanics. The urine theory has, we find, many adherents, one individual going so far as to say that in the variety of qualities of this fluid generated by different animals, nature had no doubt special regard for the wants of mankind. He regards the influence of urine on steel as entirely distinct from any of the ordinary forces of nature.

Of artificial solutions we have no end. Most of our correspondents believe in putting salt in the water, but those who advocate this, base their approval on the fact that it seems to prevent the spheroidal state which takes place in pure water, and thus the water adheres more closely to the iron, and cools the latter more rapidly. We are willing to concede this mechanical action of salt, but it is evident that it would not do for such grades of temper in steel as can only be obtained by slower cooling. Indeed, some tools are best tempered in water with the chill taken off.

On the other hand, we have plenty of letters from practical men who are convinced that all solutions are better replaced with pure water.

One gentleman of very long experience and every way a practical as well as a scientific mechanic, takes this ground; and, in addition to his own experience, furnishes us with the experience of Mr. N. P. Ames, late of Chicopee, Mass., who, some thirty-five or forty years since, succeeded in making sabers, swords, and cutlasses in this country, that would stand the U. S. Government tests. After expending much time and more than three thousand dollars in experiments with various solutions and baths, he found that heating in a charcoal fire, hardening in pure spring water, and drawing the temper in a charcoal flame was the best practice.

A correspondent from Chicago writes us an interesting letter in favor of the pure water practice, which we should be glad to publish, as he evidently has based his views both upon study and long practice; but our friends who favor solutions might deem us partial as we publish nothing on their side of the question. This writer seems to have touched hard pan when he says "let co-laborers discard all superstitions, solutions, incantations, etc., and pay more attention to how they heat steel before hardening, and, my word for it, they will soon lose trust in solutions."

It is time we had a new definition of steel. Any compound of iron hard enough to make some kind of cutting implements now goes by that name. The term has even been extended to alloys of iron with other metals, and when steel is spoken of a very indefinite idea is conveyed. The grade of carbonization, the presence of substances other than carbon and iron, or their proportions if present, are not indicated by the term. Upon no subject is there less accurate information diffused among the masses than that of steel, and in the absence of more precise terms by which to indicate the various qualities of what is called steel, it will be very difficult to impart accurate knowledge.

Finally, we consider that chemical reactions do not take place in the act of hardening and tempering steel, when those terms are understood to mean the process of hardening steel by sudden cooling after heating it and subsequently drawing the temper by heat. This being the case, we see no use of solutions except perhaps as in the case of a brine of common salt they cause the water to hug the metal more closely and thus facilitate the cooling. We are confident, however, that if the character of the steel be thoroughly understood previous to hardening and tempering, and heating and working be regulated accordingly, water, pure and simple, is all that is wanted to secure any degree of hardening, and the proper temper upon subsequent heating, if the latter is performed judiciously.

INERTIA AND VIS INERTIÆ.

A correspondent, in another column, under the above heading, criticises, rather more severely than ably, a recent work entitled "Force and Nature," chiefly on account of its denial that there is any such thing as inertia in matter. This correspondent charges the author of "Force and Nature" with having "entered the fourth-story window of the temple of Science," and having never descended to examine the foundations—its axioms and definitions. He might not have adopted this ingenious figure had he seen how easily the author, whom he has attacked, might turn the tables, and charge that his critic had never been able to climb from the cellar of the temple in which he has ensconced himself, and, therefore, cannot be supposed to know what discoveries and theories go to make up the upper stories of the structure.

Newton was a great man, but scientific knowledge has grown some since his day. Because he thought the term inertia an appropriate one, it is hardly safe to say that everybody who thinks will accept it as such for all time. The subject of molecular motion was very little understood in Newton's time, and, had he known what is now known, he might have modified his views.

But we have not taken up the pen to defend the author of "Force and Nature," with whose conclusions we do not agree. We have other matter of difference with our correspondent, who charges *us* with false teaching on this matter, referring to articles on pages 217 and 297, Vol. XX., for confirmation of this statement.

It is true, that in those articles we took exceptions to the term inertia, as being one variously defined, and, at best, negative in its signification; and charged that it grew out of the obsolete notion that there is a property residing in matter by which it resists motion. And notwithstanding our correspondent's reverence for the opinions of the thinkers of a past generation, we shall, in the absence of more light than we can at present attain, still hold that opinion.

We do not say, that the term inertia is now, or was ever understood by our best thinkers as applying to a state of rest alone, but it has been used, even in modern textbooks to express the idea of resistance of matter to motion. In Silliman's Physics, page 13, we find in his definition of inertia the following: "Matter has no spontaneous power, either of rest or motion." In Bartlett's Mechanics, page 20, we find: "Inertia is that principle by which a body resists all change of its condition in respect to rest or motion." In Ganot's Physics, page 7: "Inertia is a *purely negative property* of matter. It is the incapability of matter to change its own state of motion or rest." In Nichols' Physical Sciences, page 465: "The principle generally named the principle of the inertia of matter is two-fold. The first part of it *is a pure but a convenient hypothesis.* This hypothesis is that *all nature is naturally inert, motionless, lifeless; and that action or activity can be impressed on it solely by external agencies or forces. But in so far as we can form any conception of the constitution of matter, this is physically quite untrue, not an atom existing which is not the center and source of manifold and multiform activities.*"

But we have quoted enough for our purpose. We might go on quoting authors by the dozen to show that this term is not accepted as meaning the same thing by those who write and think upon it; and that it had its origin in the "obsolete notion" of the *naturally inert condition of matter.* Morin, in his Mechanics, does not apply the term to matter, *per se*, but to bodies or masses of matter (see page 8. Bennett's Translation).

The idea of the resistance of matter to motion originally grew out of the fact that time is required to transmit *mass motion.* A team of horses attempting to draw a canal boat, does not instantly move it as a mass, but it moves something immediately. Instantaneously, with the application of the power, there begins to exist the state of matter known as tension, in the harness, rope, etc., and this tension is an increase of motion in the molecules in one direction. Gradually this tension is converted into mass motion, and the boat moves. There is nothing about this to indicate that matter resists motion. It only indicates this fact, that, as we can not by any mechanical means apply power instantaneously to all the molecules of a mass, the power we do apply must be communicated from molecule to molecule throughout the mass, and this takes time.

Now is inertia, loaded down—as is every term born of false conceptions and hypotheses—with different meanings and interpretations, a good term to express this fact that time is required for a mass to impart or to receive motion? With all due deference to other people's opinions, and not desiring to force our opinions upon any one's acceptance, we still submit that it is not.

We insist that it is, as Ganot says, purely a negative property of matter, and is as illogical in its use and application as it would be to define snow as being something not black, not made of whalebone, not good to eat, and not having the property of being agreeable to bare feet. There is no end to definitions, if we accept negatives as such, and their use only blinds the mind to positive facts and just conceptions.

AN INEXPLICABLE POWER.

In Dayton, Ohio, on the 17th of Feb., a terrible boiler explosion took place at the works known as the Western Machine Shops, making a complete wreck of the works, killing five persons, and seriously injuring many others.

The Coroner's jury, after a full investigation of the facts in the case, found that the cause of the explosion was from a low stage of water in the boiler, the result of negligence on the part of the engineer in charge.

We learn that Mr. Fetters, late official inspector of boilers for the district, had, in a conversation with the foreman of the works, pronounced the engineer incompetent, and too careless for such a post. The foreman stated that he was afraid of the concern, and had several times complained of the matter.

The boiler was a nearly new one and in excellent order.

An intelligent engineer sends us now an article called forth by this accident, clipped from a paper the name of which is not given, entitled "An Inexplicable Power," which is really a curiosity in its way, and we therefore give it entire.

"A number of engineers insist that there was inexplicable power in the atmosphere on Thursday afternoon, which prevented boilers from operating properly, that they were unable to account for. They found it impossible to run their engines evenly. They either got too much steam, or not enough, and there was difficulty about the working of the pumps; and they were not able to account for it. There are times—these men affirm—when boilers will explode without any apparent cause, despite the most careful labor by the most practical engineers to be found anywhere. We conversed with several practical engineers, yesterday, and they all agreed as to the strange influence to which we have referred. 'What is it?' we inquired of one. 'Why, it's in the air,' he replied, 'but I can't explain it. I can't run my engine even: for a few minutes steam is generated too fast, and that which escapes from the valve gets blue as blazes, and makes things fairly sing again; and it's really not safe. Then, suddenly the water gains on me, and, although there's a good fire, it appears to be impossible to generate steam; it won't rise, do the best I can with it. Now, the engine is in excellent order, and the pumps work like a top, and there is nothing in the machinery to induce this condition. I think it must be in the air. It was just so Thursday afternoon, and I worked with my engine for half an hour, after dinner, and getting discouraged, I drew my fires to let the boiler cool, so that I could have a fair look at things. I hadn't been out doors a minute until I heard the explosion at Taylor's. I knew in a minute what it was. If I'd kept up my fires five minutes longer, I'd been blowed to bits—I *know* it. There are certain times when an engineer feels that there's an influence at work in his boiler which he don't understand and which he is powerless to control. An engineer who don't know and feel this, will explode a boiler. There may be a shade of superstition in this, but the speaker was in real earnest."

We are able to give a full exposition of this inexplicable

power, as it is called. It does not reside in the air, as supposed, although it may easily be traced, as we shall see. It produces a great deal of mischief, other than exploding steam boilers. It is the *love of money*. Avarice is the mysterious agent that is blowing up boilers and destroying property.

The mischief is not in the air, it is in the pocket. All talk about any other "inexplicable power" is inexplicable bosh. Here was a confessed ignoramus and a *careless* ignoramus repeatedly complained of, but still allowed to retain his position until his carelessness resulted in a wholesale murder. We do not gather how much was paid him for his services, but if it was two or three dollars a week less than a competent man would have demanded, that would be a sufficient inducement for many employers to risk the lives of their employés.

If this sort of thing goes on much longer, it will correct itself. People working in steam factories will demand so much greater wages for the extra risk they take, that it will be much cheaper to employ competent engineers.

As to the tantrums of boilers described by engineers (sic) in the above quotation, they are simply sensational moonshine. There has been enough of this kind of endeavor to saddle ignorance and incapacity upon Providence. There is nothing mysterious about boiler explosions, in general. In some cases there is absence of knowledge as to the particulars in which neglect or carelessness has been permitted, but in ninety-nine cases out of every hundred, there has been some neglect. Boilers explode from the disruptive force of steam, aided sometimes by the force of unequal expansion in the iron; and if weakened by age or bad usage, they explode more easily than when sound and strong. This is the whole story in a nutshell. Put ignorance and steam in contact, and you have a very dangerous combination. Place integrity, fidelity, and intelligence in charge of steam generators, and keep them there from the time the first plate is cut, and the first rivet driven, till the boiler is pronounced unfit for service, and boiler explosions will become as rare as they are now abundant.

LOCKAGE WASTE ON OUR CANALS.

The following extract from the *Pittsburgh Commercial*, has been referred to us for opinion:

There seems to be some doubt entertained as to whether a sufficient supply of water can be had on the higher "levels" of the Erie Canal to accommodate the large tunnage that will undoubtedly seek transportation over this line when it is enlarged to the capacity of a ship canal! In discussing this phase of the subject your correspondent, "Observer" (Mr. John F. Bennett), raises the question of the possibility of passing boats through the locks with a less expenditure of water than is commonly required. This is a pertinent inquiry that can be very satisfactorily answered. If boats have never yet been passed through canal locks without the usual waste of water and water power, it must be because *that* economy has not been needed, for a very little practical knowledge will establish the fact that the *power due to the water falling from the higher to the lower level* in passing boats up and down, DOES NO WORK in raising or lowering the tunnage, and may be employed in pumping back into the higher level a volume of water almost equal to the entire lockage. Moderately efficient machinery ought certainly to return more than one half, and thus add more than one half to the ordinary capacity of the canal. No fears of a scarcity of water need operate to deprive us of this great improvement.

In its construction, the locks may be at once made large enough to accommodate any probable future traffic, leaving the "levels" to be enlarged from time to time as the demands of business shall require.

To make the water power that now goes to waste available in preserving the maxmium of water in the levels, it is only necessary, instead of letting the water into the locks through the ordinary wicket gates, to let it pass into the lock *through a turbine wheel*, and employ the wheel in driving suitable pumping machinery that will lift water from the lower to the higher level, and in emptying the lock let the water *pass out through the same* or another wheel, and again employ the power in raising a further quantity of water to the higher level.

When the immense power thus to be utilized is not needed to assist navigation by returning the lockage water to the higher levels, it can be readily made available for other uses, and along the entire line may be the source of no small income to the company owning the canal.

The general theory of mechanical saving in water waste given above is correct, and has attracted the attention of hydraulic engineers for many years, as to convenient and useful *modus operandi*, one favorite idea being to make the summit locks double acting by balanced frames, so that an emptied chamber on one side would in part restore a supply to the upper level. If, however, the gentleman who has advanced this suggestion, with a slight *coleur de rose*, will patiently work out the process by exact calculations of the power available for the net return, and more carefully examine the various sources of loss which go to make up canal waste, as a whole, he will see that the economy is far less demonstrable than the primary impressions indicate.

The lockage waste itself, on a canal of any length, between points of supply, though undoubtedly a large item, does not measure the whole waste.

If we take, for instance, the estimated water supply for the "Improvement of the Champlain Canal," as given on page 98 of Mr. McElroy's Report in 1867, it will be observed that the items for one summit group of locks, on 11¼ miles of canal, 225 and 100 feet lock, were for

	Cubic feet.
Lockage per day	5,203,167
Evaporation, filtration, and weirs	2,368,800
Gate waste	720,000
Total	8,291,967

about 62 per cent being lockage waste on a short length like this.

Taking into account then the restriction of this mechanical device for return supply at the upper lock, the limited quantity of water which is delivered with a descending boat, the absolute limit to time of filling and discharging on any important canal, the necessity of an entire rearrangement of the methods of inlet and outlet, the fluctuating head under which the pumping machinery must work, and the probable or possible ratio of return supply, engineers who have carefully studied the general subject have rather been induced to advise the use of an independent pumping establishment. It would, however, be a professional service, if any detail and careful analysis is presented of the advantages of a local and special lock return, on the general plan above mentioned, by which the actual merits could be carefully estimated.

RESTRICTIONS ON THE WEIGHING OF COAL.

Granted that coal dealers are on the average as honest as any other class of men, and that they are no more disposed to rob the poor than their neighbors who have less opportunity for so doing; is it safe to tempt men as coal dealers must be tempted?

Not one man in fifty, when he orders a tun of coal delivered at his house knows whether he gets full weight; and the coal dealers are perfectly aware of this fact. They know that if a purchaser stands and looks on while the weighing is performed, that he must, perforce, take the weight of the cart on trust, and therefore that even such vigilance would avail little to prevent fraud in the weighing.

It is so inconvenient for people in general to re-weigh their coal, and so difficult to devise any means whereby in the absence of personal attention, and without extra expense to themselves, they can be secured against fraudulent weighing, that in our opinion the system of selling coal by weight is a bad one. It would be far better to sell it by measure.

There is no doubt that short weights are common in the retailing of coal, and cases have come to our knowledge where such fraudulent dealing has been practiced in the filling of contracts to large manufacturing establishments, which ought to be able to take care of themselves, and therefore are not much to be pitied.

But the poor who are only able to get coal by the very hardest, and who are wholly at the mercy of the dealer, ought to have some protection. This would be afforded were coal sold by measure. They would soon learn to detect frauds in bulk, and thus the power to cheat would no longer exist so far as quantity is concerned.

We do not suppose coal dealers more likely to take an advantage of opportunities to defraud than retail grocers, or even milkmen, but we respect them too much as a class, to wish them subjected to temptation, which might be removed by a prayer to the Legislature to deliver them from it.

THE WATER WHEEL TESTS AT LOWELL.

There are always two sides to every question. Our recent article on the test of turbine wheels at Lowell, has called forth a communication from Mr. Emerson, whose testing apparatus was employed at Lowell, and which will be found illustrated and described in another page of this issue.

We have so far resisted all importunities to publish communications upon this subject, and we shall adhere to this rule; but having given a *resume* of one side of the question, as gathered from our correspondence, we do not wish to commit the injustice of refusing the same for the other side. We therefore, now give the gist of Mr. Emerson's statements, leaving our readers to form their own opinion upon it.

It is denied that the charges made in the correspondence, upon which our former article was based, are true, and a copy of the circular sent to manufacturers inviting them to send wheels to be tested, and stated to contain the only terms ever made in any way whatever, now lies before us.

The statement that the wheels were required to be of a specified power, is not contained in the circular; but, on the contrary, it is distinctly announced that "each competitor will select the size and finish of wheel to suit himself."

The circular further specifies that "for use of flume and weir, competitors will be charged $250; for use of dynamometer and water, enough to cover expenses. Cost of flume, water, and dynamometer will not exceed $300. The arrangements have cost $1,500. If there is sufficient competition, the cost will be divided fairly with all. Each will make their own arrangement with Engineers." It adds that further information may be obtained by addressing James Emerson, and invites all who wish to witness the test.

That anything different from this was communicated by letter in answer to subsequent inquiries, is denied by Mr. Emerson, who positively states that "*these were the only terms ever made.*"

The arrangements alluded to as costing $1,500 was the flume only. The dynamometers cost $1,700 and nearly a year's time was given by Mr. Emerson to the tests, and to preparations for it.

In regard to the cost of the tests, we are informed that as the wheel specified in the circular as one of those to be tested, was distinctly announced as finished in the ordinary manner. it was expected that the others would follow in the same way and without delay; instead of which, four months elapsed before some of the wheels were prepared for the test, and it was well understood by the tardy competitors that the expense would be increased by this delay.

Mr. Emerson states that in return for over a year's expenditure of time, and an outlay of several thousand dollars, he has received in all only $650, a considerable part of which has been paid out for freight on wheels, telegrams, oil, etc. This certainly does not look much like extortion.

In regard to the settling of the flume, we are told that it still stands in the same place, and has been in use all winter for testing large and expensive wheels, and that it is considered as being in good condition.

It is stated that there was abundance of water for months after the test was announced. Early in the autumn there was a slight drought, but before the wheels were ready there was plenty of water again. At the time of the disastrous freshet which occurred in the fall, there was a break in the canal which caused a delay of four or five days, but Mr Emerson states that at the time of testing there was so much water that unless restrained at the head gates it would over flow the flume. So much for the statement that there was a scarcity of water.

In regard to the placing of the wheels, we are told each party placed his wheel as he liked, and if there were any fault the exhibitors were solely to blame, as each party had full control of the flume, while their wheels were tested, cutting out or filling in as they liked.

The steadiness of the brake is attested by Mr. Hiram F. Mills, C. E., under whose supervision the tests were conducted. Our own reporter also stated that when he was present in July (see issue of July 17, 1869), the arrangements seemed perfect and the brake worked satisfactorily.

It seems then that the question resolves itself into one of fact, so far as this controversy is concerned; and we have endeavored to give impartially every essential statement made on either side.

The apparatus for testing turbine wheels, shown in the descriptive article we this week publish, is the same as that used in the Lowell tests, and our readers will be able to judge intelligently of its probable efficiency.

We may, in closing, remark that the terms in which the tests were announced in the circular before us, seem not to be sufficiently specific. There cannot in such matters be too definite an understanding. It would seem that not only the size and finish of the wheels, but the time when they were to be on the ground ought to have been definitely fixed, and no departure from the prescribed conditions permitted. A competitive test will always give dissatisfaction if performed under variable conditions.

An Immense Salt Mine.

The great Humboldt salt mine, near Austin, Nevada, is described by a California paper as looking like a lake frozen over. The salt is as hard and as smooth as ice. Were it not for fine particles which are condensed from vapors arising from beneath, and which cover the crystalline salt to the depth of perhaps one eighth of an inch, it would make an excellent skating rink at all times of the year, except on the very infrequent occasions when it is covered with water. The expanse of crystallized salt is no less than twenty miles in length and twelve in width, without a break or flaw for the greater portion of that extent. The stratum of solid salt is about six or seven inches thick, under which comes a layer of sticky, singular looking mud, about two feet thick, and under this again another stratum of solid salt, as transparent as glass, of which the depth has been found in some parts to be six feet. In summer, this salt plain, glittering and scintillating in the light of an almost tropical sun, presents a brilliant appearance. The frosty covering and the solid salt is as white as the snow, while the crystalline portion, when exposed, reflects dazzling prismatic colors. This immense deposit is remarkably pure, being ninety-five per cent of salt and five per cent of soda—which is purer than what we commonly use for our tables.

Opera House Dirt.

The dust obtained from the places of amusement in New York have recently been analyzed by the scientific officers of the Metropolitan Board of Health. Over one hundred specimens of the particles floating in the air and falling as dust, were collected on plates of glass, and were examined under the microscope. The proportions of the different ingredients varied, but the same substances were found in all the specimens. The composition of the matter subjected to the microscope was as follows: "The dust of the streets in its finer or coarser particles, according to the hight at which it had been collected, with a large proportion of organic elements; particles of sand, of quartz and feldspar; of carbon, from coal dust and lampblack; fibers of wool and cotton of various tints; epidermic scales: granules of starch, of wheat, mainly the tissues of plants; the epidermic tissue, recognized by the stomata or breathing pores; vegetable ducts and fibers, with spiral markings; vegetable hairs or down, either single or in tufts of four or eight, and of great variety, and three distinct kinds of pollens. Fungi were abundant from mere micrococcus granules to filaments of mold. When water was added to a portion of dust from whatever source, and exposed in a test tube to sunlight or heat for a few hours, vibriones and bacteria made their appearance, and the fungous elements sprouted and multiplied showing that they maintained their vitality, and proving that the germs of fermentation and putrefaction are very widely diffused."

Zinc Light.

By digesting metallic zinc in iodide of ethyl, we obtain a volatile liquid which takes fire spontaneously in the air, and is known to chemists under the name of "zinc-ethyl." It can be distilled in an atmosphere of hydrogen, and if this gas be made to pass through the liquid it will carry off some of the zinc-ethyl, and when ignited will burn with a magnificent white flame. It is probable that ordinary illuminating gas would answer as well as hydrogen for this experiment. The light produced in this way can be employed to take photographs, but its actinic properties are not equal to the effects produced by burning magnesium.