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Contents:

(Illustrated articles are marked with an asterisk.)

THE RUMFORD MEDALS.

The recent presentation of the Rumford medals to an eminent American engineer and inventor, has excited much attention in scientific and mechanical circles, and it seems appropriate to give a brief history of the origin of these medals and the nature of the honor conferred by their award.

Benjamin Thompson, Count Rumford, was born in Woburn, Mass., in 1753. He received only a common-school education, and entered a country store as a clerk at the age of 13. During his clerkship, which lasted some four years, he employed his leisure time in study (more particularly of medicine and physics) to such good purpose that in 1770 he was qualified to teach an academy in the town of Rumford, N. H., now Concord, the capital of the State. Two years later he married a wealthy widow, and also received a commission from the Governor of New Hampshire creating him major in the militia. Through personal jealousy on the part of older officers, he was charged with disaffection to the cause of the American colonies which resulted in his leaving Rumford for Woburn, and soon after the latter place for Boston.

He was subsequently tried at Woburn, and although not fully condemned, was neither fully acquitted. He finally left the American lines, and when Boston fell into the hands of the British, he became the bearer of dispatches to England containing the announcement of that event.

Remaining in England he became the secretary of Lord George Germain, at that time Secretary of State for the Department of the Colonies. He subsequently returned to America and raised a regiment of dragoons, receiving the rank of lieutenant-colonel. Again visiting England, and hostilities being at an end, he obtained leave of absence and traveled in Europe. Finally, settling in Munich, he interested himself in military and social improvements and reforms, performing important services, in consideration of which he received his title of Count Rumford, the latter part of the title being chosen by himself. Shortly after, his health being impaired, he traveled in Italy, and finding that he did not improve he visited England.

For a long time previous he had made the subject of heat a special study; and while he remained in England he continued his investigations with highly practical and beneficial results.

Returning to Bavaria, and finding that the climate stilldisagreed with him, he ultimately settled in Paris, where he spent the remainder of his life. He died Aug. 21, 1814.

His time in Paris was mostly devoted to scientific and philosophical inquiries and investigations. The most important of his investigations were upon the relation of heat to friction, and the experiments he performed were among the most remarkable of all those from which the basis of the modern theory of heat has been derived.

Some time previous to his death he instituted prizes for discoveries in heat and light. These prizes, consisting of a gold and a silver medal, were to be awarded by the Royal Society of London and the American Academy of Sciences. Their intrinsic value is $300, and they are only to be given by the American Academy of Sciences to authors of improvements or discoveries in heat and light, in any part of the continent of America or of the islands of America—preference always being given to such discoveries as shall, in the opinion of the Academy, tend most to promote the good of mankind. To this end Rumford donated the sum of $5,000 to this institution July 12, 1796.

At a late meeting of the Academy this prize was bestowed upon Mr. G. H. Corliss of Providence, R. I., for his improvements in the steam engine. The award was made by Dr. Asa Gray, in a very appropriate address in which the merits of Mr. Corliss' improvements and inventions were ably stated and which was very briefly, but gracefully replied to by Mr. Corliss, in accepting the medals.

This is the fifth medal awarded by the Academy, the recipients, and their discoveries and inventions being as follows, in the order stated:

1. Professor Hare, for his oxy-hydrogen blowpipe.
2. Capt. John Ericsson, for his hot-air engine.
3. Professor Treadwell, for his improvements in the construction of ordnance.
4. Mr. Alvan Clark, for his new mode of grinding and perfecting large lenses.
5. Mr. George H. Corliss for his improvements in steam engines.

We congratulate Mr. Corliss on the receipt of this high and well-deserved honor. He has long been widely and favorably known through his inventions, and the appropriateness of the honor conferred will be recognized by all acquainted with his improvements.

SOLUTIONS FOR HARDENING STEEL.

Of all the departments of the mechanic arts probably none is so completely enveloped in superstition and bigotry as that of hardening and tempering steel tools. We have scarcely ever met a man claiming skill in the art who had not some notion upon the subject which *his* experience seemed fully to confirm, or who did not advocate some practice for which he could assign no solid reason. Moreover we never recollect hearing anything recommended as more efficacious than simple water, that some one else would not be found to scout as utter nonsense, but who, at the same time, was a firm believer in something else perhaps even more absurd.

A certain individual, who shall be nameless, tempered stonecutters' implements in cow's urine, and expressed himself as perfectly able to change the character of the steel by using instead the urine of a calf. To our query whether he had ever tried the urine of a jackass, he replied that he had no doubt it had peculiar virtues; and we left him to pursue his experiments "on this line" feeling that many a shining light is hidden by the prejudices of an unbelieving world.

A page might be filled with the record of all the preparations, mixtures, charms, etc., by the use of which success in the tempering of steel has been attempted, and each of which has had its admirers.

A certain virtue has been, by many, supposed to reside in leather shavings, by which, it a tempering fire *be kindled* with them, immunity from cracking is secured; and Byrne states that a man who had tried it told him that, although before its use he was greatly troubled by cracking while tempering, since he had found out the virtues of leather as a preventive, not a single case of cracking had occurred, though he had used it for years.

Argument, of course, would be useless with such an individual; his experience (sic) would weigh with him more than anything that could be said by any one else, though the experience of the latter might have shown the utter worthlessness of the article in which the former placed blind and implicit faith.

The state of things which we have described is scarcely to be wondered at when we reflect that all knowledge on the subject of hardening and tempering steel is empirical. Nothing is accurately known about it except that when steel is heated and suddenly cooled it becomes hard and brittle, and that by heating it again its hardeness and brittleness may be reduced to the degree required, and that this change of character is a molecular change of some kind yet to be determined.

The suddenness of the cooling is of course affected by the rapidity with which the cooling medium conducts or conveys away heat; and any change in the character of the medium which does not increase or diminish its conducting power would certainly seem to have little to support it. Of course the character of the objects to be tempered will indicate in some measure the mode employed. The watchmaker often heats his tiny drills in the flame of a candle, hardens them by sticking them into the cold tallow, and draws the temper by the same flame.

A little salt thrown into the water employed for tempering is quite generally supposed to add to its virtues, but a competent experimenter informs us that in a large number of experiments instituted to test the truth or falsehood of this notion he found nothing to support it.

Thin and small objects, which only need a small degree of hardness, may be advantageously hardened in oil for the reason that it cools them less suddenly, and therefore does not make them so hard as water would, while for large articles requiring to be very hard, quicksilver has been employed with success for precisely the opposite reason.

A recipe for hardening mill picks, which, slightly varied in its proportions, has quite a reputation, is as follows: Two gallons rain water, one ounce corrosive sublimate, one ounce sal-ammoniac, one ounce saltpeter, and one and one half pints of rock salt. The picks to be heated to a cherry red and hardened, and the temper not to be drawn. It is claimed that the salt gives hardness, and the other ingredients toughness to the picks; but no reason why they should do so seems tenable, as there certainly is no chemical reaction in the bath by which these results can be accounted for.

We hazard the opinion that simple water would be just as good, and that for all moderately-sized articles it is just as good as any solution that can be made, though of course in a matter depending so much upon personal judgment as the hardening and tempering of steel, we should not expect any man to succeed perfectly at first with any bath to which he had not become accustomed.

Correspondents frequently ask us to recommend to their use solutions for tempering; but with the views we have stated it will be seen we cannot conscientiously indorse anything of the kind; if given at all it has therefore been generally upon the recommendation of others rather than upon any convictions of our own in regard to the merits of such preparations.

STUDY OF FIRST PRINCIPLES BY INVENTORS.

Let us suppose a man skilled in the use of tools and able to construct what his brain conceives; or at least able to superintend its construction, and get it properly done. Let us further suppose our mechanic to have an inventive mind, capable of striking out new and useful methods of accomplishing work by machinery. Suppose this talent to be so great that its employment in invention is very desirable, and if properly directed, more likely to prove profitable than any other business in which he can engage. Now what kind of knowledge will this man need, in order that his native talent and acquired skill may work untrammeled? We answer he will need first a sufficient knowledge of mathematics to be able to gain a knowledge of first principles; and second, he will need to know the first principles of physics, as well as the first principles upon which modern methods of changing crude materials into finished fabrics are based.

The knowledge of the first principles of physics is necessary not only to render comprehensible the means of transmitting motion and its conversion into work, but also to prevent errors in conclusions in regard to proportions of the parts of machines, and the results which will follow combinations of parts. The knowledge of the first principles upon which modern industries are based is necessary; for, in most cases, these principles must underlie any new method he may be able to devise. Peculiarities of cotton, wool, silk, or linen machinery, originate in the different nature of fibers. Cotton fibers may be readily drawn longitudinally in either direction; wool fibers draw only one way, and need oiling or lubricating in order to be worked; flax fibers will not draw unless wetted; silk fibers are spun to hand by the worms, and are simple threads needing only to be wound, doubled and twisted previous to weaving.

We might go on through all the category of modern industries, and find in each an illustration of the truth that the principles upon which they are based are really first principles, which must be observed in any process designed to supersede them.

Thus the principle upon which sulphur and phosphorus are removed from iron is a fundamental one connected with the very nature of those impurities; namely, their greed for oxygen. And all the methods, from puddling up to the Bessemer, Heaton, and Ellershausen processes, devised to eliminate sulphur and phosphorus from iron, have been based upon the property mentioned. Bessemer puts in oxygen by pumping air into the molten mass; Heaton puts in oxygen chemically combined in nitrate of soda, which, decomposing by heat, liberates its oxygen to combine with the sulphur and phosphorus; Ellershausen puts in the oxygen combined with iron, as found in certain ores; while the old method of puddling consists in stirring the partially melted ore and exposing it to the free oxygen of the air. All these processes rest on a common basis.

The knowledge of first principles comprises what is generally understood by the term theory; and while we are ready to admit that theory alone cannot subserve the purposes of the inventor or the mechanic, we maintain that practice alone will not answer. The truly great inventor gets as much of both as he can.

The inventor should therefore familiarize himself with processes of all kinds, and should first seek to learn the general and fundamental principles which underlie the details, rather than the details themselves; as the details will be far more readily understood and retained in the memory by adopting this method of study, while an intelligent conception of the purpose of each will also be gained by subsequent study.

PUMPING DOWN BUILDINGS.---FALL OF THE DINING HALL OF KING'S COLLEGE, LONDON.

In a recent article entitled pumping down buildings, we alluded to the fall of King's College, London, as an instance of the results to be expected from tapping water bearing strata underlying heavy structures. We have received through our European exchanges further particulars in regard to this event and the causes which led to it, and they strikingly confirm all that we have said in our previous article.

It seems that the cast-iron girders of the building had been weakened by the cutting out of the top flange for convenience in fixing them. This flange, therefore, instead of constituting about half of the whole strength of the girder, became only an additional burden to be supported.

These girders had, however, withstood all strains brought to bear upon them some thirty years, yet when they broke, it was found they cracked at the points where the flange had been cut out, the fracture indicating that the metal was sound up to the time of the building. With the same usage the structure had ordinarily been subjected to, previous to the catastrophe, the building would undoubtedly have stood a century longer.

The prime cause of the fall was, without any doubt, what we stated in our former article. The surface upon which the building stood, and upon which other important and massive buildings now stand, including the massive cathedral of St. Paul's, consists of beds of brick clay of various depths under which lies a stratum of gravel also of varying thickness; and underneath this gravel lies a stratum of stiff blue clay.

The *Builder* states that "through the bed of gravel or beach, penetrated as it is everywhere by water, the engineer of the Thames Embankment has cut a broad and deep trench to the clay below. The foundations of the granite quay wall rest on this geological rock, at the depth of 32 feet 6 inches below Trinity high water mark. To excavate and to keep clear these foundations, a steam engine of fourteen-horse power was in each section constantly at work, and the chain pump which it propelled, discharged a perfect river from the subterranean source. The flow of water thus caused would not desist from exerting its own mechanical influences, out of respect for the Lord Mayor, or for any of the officers, institutions, or buildings of the city of London. What the natural effect of this mighty pumping would be in theory, we all know. Gradual loosening of the permeable stratum, displacement of the smaller particles, consequent tendency of the larger ones to come down together, disposition of the whole water supplying area to move microscopically, infinitesimally it may be, but still with mathematical certitude. As to this there could be no doubt, although we had small thanks for saying so fourteen months ago.

"One point might have been considered doubtful, and that was how far the weight of any massive building compressing and consolidating this adjacent gravel, might have prevented the mischievous action of the infiltration (or rather, if there were such a word, exfiltration) of the water. On this point we have now not only information, but a flood of light, and a very unpleasant flood into the bargain."

How far the same cause which produced the disaster alluded to will affect other more important structures remains to be shown. Certain it is that eminent architectural authorities have predicted further calamity unless the most prompt and skillful measures are applied to their prevention. The embankment has stopped where it is, and precautionary measures in the provision of tie-rods, etc., have been made to such structures as show signs of having been injured.

TEST OF TURBINE WATER WHEELS AT LOWELL, MASS.

Whether a competitive test of anything can at this day be conducted anywhere under the shadow of the wings of the American Eagle in such a manner as to enlighten the public as to the merits of the thing tested, becomes annually more and more doubtful. To implicitly cling to such a faith in the face of two events of this kind which graced, or disgraced—which you will—the year 1869, argues such a trustful spirit on the part of the possessor of such a blind faith, as must certainly render him the most unsophisticated of mankind.

The two events referred to are the tests of steam-engines at the late fair of the American Institute, and the test of turbine water wheels at Lowell, Mass. The announcement of the latter in this journal last June, aroused more attention in the American mechanical public than any other event of the year. Not only ourselves, but Mr. James Emerson, whose dynamometer was employed to test the power of the wheels, were flooded with inquiries concerning it. Mr. Emerson states that the publication of this announcement "decided two points conclusively: first, the extensive circulation of the SCIENTIFIC AMERICAN, and second, the immense interest felt throughout the country in regard to the test." He says: "I have received letters of inquiry from the most out-of-the-way, unheard-of nooks and corners, from every State and Territory in this country, also from the British Provinces."

We wish that we could now say that the test had proved something as well as the announcement. The latter it seems proved two interesting and important facts; but, so far as we can learn, the test either has proved nothing, or it has proved what the parties interested do not care to publish.

The public was invited to attend this trial, and it was generally understood that it was to be conducted in an open and fair manner, and a report made in detail describing the construction and peculiarities of each wheel; if they were made of metal, and if so what kind; if they were finished better than those ordinarily made and sold, or if taken promiscuously out of the stock of the manufacturer. In short, to render the publication of a test of this kind of any practical use or interest to the public, all the conditions under which it is conducted must be known. We have received from Mr. Emerson a report of the result obtained by each wheel, but it is very meager and not by any means complete. Simultaneously with its receipt, our editorial mouth is stopped by the receipt of letters from different exhibitors, warning us against its publication, and stating that it is unauthorized. Writing in this dilemma to Mr. H. F. Mills, of Lawrence, Mass., who conducted the tests, and has, we believe, some reputation as an hydraulic engineer, and who is stated to be the only person authorized to make a report, we learn from him that the public were only invited to witness the test of a *single wheel*, and that a full report upon all the wheels tested will not probably be given.

This being the case, we find ourselves sufficiently human to rejoice in the statement of Mr. Emerson to the effect that, before the Lowell test closed, he went West to test a new wheel, which gave better results than any wheel tested at Lowell, and which will be brought to the East next season to compete with any or all of them. We hope this may be so; but really we find it a difficult matter to believe reliable tests will be made, or that if the tests should be reliable, that the reports will be. We wait with some curiosity to see how the new-comer will come out.

BLACK RIVER FLOOD CASE.

A case of more than usual interest to civil engineers, involving important hydraulic questions, has been pending before the State Board of Canal Appraisers for several months, and is now completed, as to the testimony, and the issues of claim and defense.

In April, 1869, a large reservoir, built by the State in 1856, at the head sources of the Black River, as a feeder to the Black River Canal, was carried away during a spring freshet. A large amount of property was injured by it, along the upper portion of the river; and claims for damage have been made along its whole line, or about 100 miles. The case is tried under a special law of the last session, and involves about $750,000 aggregate damages.

The theory of the claim is, that the State has been negligent in the construction and superintendence of the reservoir, and in consequence of this negligence the damages occurred; for that portion of the damages at and below Carthage, a point about 73 miles below the reservoir, the claim identifies the reservoir rupture as the cause.

On the other hand, the Counsel for the State aver that the rupture occurred during an unprecedented flood, which no engineering skill could have provided for, and that the reservoir rupture did not have sufficient time and power to cause the damages claimed below Carthage.

The Counsel more directly engaged were the Hon. C. H. Doolittle, of Utica, with Messrs. C. A. Sherman and J. T. Starbuck, of Watertown, for the claimants; and Messrs. L. H. Brown, of Watertown, Samuel Earl, of Syracuse, and Chas. Rhodes, of Oswego, for the State. The issue having been mainly dependent upon hydraulic principles of construction and action, the expert witnesses were Hon. W. J. McAlpine and Chas. H. Haswell, Esq., associated with Samuel McElroy, Esq., by whom the case was specially investigated on the part of the claimants; and Messrs. D. Greene, and L. L. Nichols on the part of the State, the latter having been more particularly identified with the case.

As part of the testimony, Mr. McElroy submitted an elaborate analysis of the case, discussing the questions at issue as to the construction and care of the reservoir, the theory of its rupture, and the descent of its flood to Lake Ontario. In this paper the several elements which control the action of the freshet and the descending flood, the topography of the river, drainage area, history and several states of the freshets, testimony as to times and extent of damage, and principles of flood-flow are fully treated, and furnish a large amount of information on a subject not often presented.

The point, however, in the case, which is the most prominent, is the development here on a large scale, of the theory and action of the "wave of translation," which has been the subject of much elaborate investigation by scientific men, but is, so far as now known, first introduced here in a legal case, as a direct cause of serious damage. During the trial, the theory presented by Mr. McElroy and fully indorsed by his associates, was emphatically confirmed by the celebrated English engineer, J. Scott Russell, Esq., who was consulted at Paris, and who is identified with various elaborate investigations of this hydraulic law.

It appears that for nearly one third the length of the river and about its center, there exists a long, wide, deep basin, which in powerful freshets is filled to a great depth, averaging in this instance, about 24 feet, three fourths of a mile wide, and thirty miles long, on a central line.

At the head of this basin or "pool" there is a high fall, called Lyon's Falls, of 70 feet in low water, and about 54 feet in freshets; the hydraulic slope to the Carthage dam being about 26 feet, on the 30 miles.

The theory of these experts is, that the main portion of the reservoir flood plunging over this fall, into a deep basin, discharging, as estimated, about two thirds of 560,000,000 cubic feet of water in six hours, and capable, in all, of displacing about 4½ miles of the upper section, displaced at the lower end of the basin an equivalent body of water, some time before its actual particles could reach Carthage, in the time determined by the laws of the "wave of translation" or "displacement swell," as Mr. McElroy here designates it.

This analysis, in discussing the "principles of flow," shows that, while certain laws of hydraulic motion have been so thoroughly investigated, as to be "implicitly trusted," circumstances occur in flood movements which modify these laws. This general theory is then illustrated by examples from "confluent streams," "overfall weirs," and "submerged weirs," and the experience on the large aqueducts of the country. The paper then proceeds:

"In the upper valley of the Black River, we find the wave traveling with an advance 'bore,' which may or may not have been preceded by a more quiet sheet of water, the rush being distinctly marked at various points; from Dawson's to Bellingertown, and from Forestport to the Lee Bridge, the observed speed approximates to about one half the calculated central velocity; in the lower valley, similar phenomena of action were observed, the 'bore' being distinctly defined on the Carthage dam, at Rason's, Great Bend, and other points.

"In the long reaches, however, and the pool, the descending wave could not take possession of the channel, from the mass of more quiet water it successively encountered, and a different principle of relief is brought into action, by which mechanical impulse is transmitted in advance of actual molecular movement.

"The investigations of science have determined that all liquids and fluids have certain analogous laws of motion and action, and in the movement of light, sound, electrical currents, as also in water, action is frequently most perfect where actual movement of particles is impossible in the same degree. Nature has provided this wave action as a means of communication, which does not involve actual molecular delivery, in those cases where such delivery is inadmissible."

* * * * * *

Various examples are then cited; the experiments and deductions of Scott Russell are given; and the remarkable confirmations of the Hudson River and Long Island Sound tidal waves are described, with this application:

"Now this flood-wave mass was entirely able to sweep down the River Channels of Lyon's Falls, because it found a comparatively free path to travel in, and its whole body in the main, did so pass down; but when the 15,654,000 gross tuns of water, which represent it, plunged over the Lyon's Falls' dam with an impinging velocity of 58 feet per second, a comparatively quiescent body of water, more than seven times its weight, was interposed against its free progress further. According to the laws and examples we have cited, two distinct results followed: one, the displacement of a portion of the pool, equivalent to this falling body, at the other end, by the action of the "displacement swell;" and another, following as an inevitable sequence, was the increase of the former current of the pool towards Carthage."

It is then shown by applying D'Aubuisson's formula to this case, that the time of transmission of motion to Carthage through a basin of this depth is two hours, and the observed accelerated current is between six and eight miles per hour. Various phenomena which corroborate this action, are also cited.

The conclusion, identifying the reservoir flood with the progress of damages along the river, and confirming these calculations by a series of observed facts, is thus given:

"At Dexter (the river mouth), Parker, by 7 A.M., the 22d (April), records accumulated damages; at Watertown, shortly after 5 A. M., serious damages occurred; at Great Bend, by 2 A. M., there was a rise, 3 feet to 3 feet 9 inches, above level of 1862; at Carthage, about 1 A. M., the rush over the dam had swept away a stone wall, and other damages were done that night, doubtless by the same means; at Lyon's Falls, the great reservoir wave struck the pool, then at a stand, certainly by 10 P.M., with a probable advance before this; at Port Lyden (3½ miles above) the corrected testimony makes it plain that this advance may have passed at 7, that the 'bore' passed about 9, and that the full crest swept through at midnight. This forms a chain of evidence which fully accords with the deductions of science, with observations of the highest importance in other localities, and the testimony of localities all along these 70 miles, which differs only in minor details. It is impossible to escape from the conclusion which identifies these events with the same powerful cause, all the more destructive as riding down its successive descents on the fully prepared water way of a powerful freshet, without which it would have been shorn of a great part of its power and swiftness, and whose volume it gathered up and hurled along on its resistless path."

During the trial, an experiment was given by Mr. McAlpine, with a narrow trough about 8 feet long, filled with clear water, the lower part being then charged with blue coloring, and the upper part supplied with red colored water. This illustrated with great exactness, the law of displacement, long before the upper supply reached the lower ledge, and also illustrated the relation between the power of the upper supply and the lower delivery.

All the details of this case involve important principles, which will make a precedent for similar issues hereafter.

FOREMEN AND SUPERINTENDENTS.

The qualities which are essential to a good foreman or superintendent of a manufacturing establishment are rarely all combined in a single individual. When they are not naturally possessed in a high degree, they may, however, be so developed by education and self-discipline as to, in a great measure, supply natural defects. Such education and discipline, however, must, to be successful, be early commenced; and as doubtless many young mechanics who peruse these columns are aiming to qualify themselves for positions of trust and command, it may not be amiss to discuss briefly the qualifications of a first-class foreman and superintendent.

We do not regard it as absolutely essential, though, if possible, desirable, that the foreman of an establishment should be able to perform himself all the various operations, as conducted in it. It would be in many cases almost impossible that should be able to do this, but he ought to be able to determine when these operations are performed unskillfully, so that he may himself instruct, or select subordinates who are competent to instruct operatives how to do their work in the best manner.

In many large manufacturing establishments, and in all large manufactories of textile fabrics, the general supervision is vested in a manager or superintendent, while the different departments are supervised by foremen acting under, and by the authority of the general manager. It is impossible that all the operatives in such establishments should be skilled in their work. Many of them will be of necessity apprentices or learners, and as such will stand in need of direction and instruction. One of the duties of a foreman must therefore be that of an instructor, and an important and responsible duty it is, requiring for its proper execution, patience, power of imparting information with clearness, perception, not only of defects in work, but in the peculiar deficiencies of hand or mind which are primary causes of unskillfulness. And he must not only be able to detect, but to devise readily remedies for such defects where remedies are possible.

Of all the means by which instruction can be readily imparted, especially in those departments of the mechanic arts where skill is required to fashion crude materials into a great variety of forms, there is none of greater value than free-