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Contents:

(Illustrated articles are marked with an asterisk.)

MECHANICAL POWER AND SPECIFIC WORK.

Upon no other point are men so constantly making mistakes as upon the subject of mechanical power applied to a specific purpose. A man having to put a barrel of pork in his wagon, and finding himself unable to lift it, makes an inclined plane of a plank, rolls up the barrel, and thinks he has gained mechanical power thereby. If visionary, he may, perhaps, go further, and argue that as there has been a clear gain of power, there can be no impossibility in constantly repeating the gain, and so, by the aid of suitable mechanism, solving the problem of perpetual motion.

The plank may serve as the type of all mechanism, and if it can be clearly explained what is really gained by its application, we shall have the clue to the general use of all machinery.

In the first place, the barrel is to be raised to a given hight; which, without the aid of the plank, the man finds himself unable to do, no matter how long or how arduously he may labor. If we can now comprehend the reason why he cannot raise it without the plank, we shall be better prepared to comprehend what is the peculiar office of the inclined plane, and shall be able to place it in the same category with those of all the (inappropriately so called) mechanical powers, of which machines are composed.

We must, however, first comprehend the fundamental fact, that the mere exertion of force (bearing in mind that force is not mechanical power) never does any work whatever. A ball may rest upon a table forever, constantly exerting a pressure or force towords the earth's center, but never doing any work. Work is the movement of masses, and the word movement implies distance through which bodies are moved. It is only, then, when force is applied through distance that work is done; and as to traverse space or distance requires time, we only arrive at a standard of measurement of mechanical power, expended in the performance of work, by taking for the unit a body moved against a given constant resistance (1 lb.), through a given distance (1 ft.) in a given time (1 m.); or the foot pound in common use, equivalent to a pound of matter raised one foot in hight in one minute of time.

When we say simply that force performs work, we do not express the whole truth. When we say force, exerted through distance, *in time*, performs work, then we cover the whole ground.

But while any force, operating through any distance, in any length of time, great or small, will perform *some* work, we find that the amount accomplished depends primarily upon the magnitude of the force, and the length of time through which it can be exerted. In mechanics, we increase the time a force acts by increasing the distance through which it acts, and *vice versâ.*

But force (static) and resistance (static) are correlative terms, and if by any means we lessen the action of one, we also lessen the action of the other, since there cannot be any exertion of force unless it is opposed by an equal exertion of force.

Therefore, a force applied to the elevation of a weight, or the overcoming of a resistance, must be a little more than the resistance; that is, the force in pounds, multiplied into the distance in feet it must act to perform the work, must be more than the resistance in pounds, multiplied into the distance through which it is to be overcome. If these products are equal, the body will not move, but will be in a condition to move with the application of the slightest degree of force, the velocity with which it will move depending upon the difference between the opposing forces. The reason why the weight cannot be raised by the unaided strength of the man, in the above illustration, is that his muscular force, multiplied by the distance the barrel is to be raised, is less than the weight of the barrel multiplied by the same distance.

Now, when the barrel rests on the plank while being rolled up, the resistance is divided into two components, one of which acts in the direction of the earth's center, and the other against the muscular energy employed in rolling the body along the inclined plane. The muscles only are called upon to overcome a fraction of the resistance required to be surmounted in directly lifting the body from the ground; but this fraction of the weight, multiplied by the distance through which the barrel is rolled, is precisely equal to the entire weight, multiplied by the hight to which it is raised; and as work is force overcome through distance, the expenditure of mechanical power, measured in foot pounds, is precisely the same in both cases. All the plank has done has been to render possible the application of the limited power of the man to the specific purpose of raising the barrel.

And this is all the lever, the screw, the wheel and axle, or any combination of these elements into a complex machine, can do. They are instruments for the application, not the generation of power. They are "mechanical powers" only in the specific sense that they enable us to apply power to definite purposes. They transmit only; they create nothing. When, then, a man speaks of dynamic power being multiplied through leverage, he is talking utter nonsense. Static pressure may, however, be so increased.

We have never yet met a man who permanently believed in the possibility of a self-moving machine, who could comprehend the distinction between static force, or pressure, and pressure acting in time and through distance, or mechanical power.

Many of those who can make the distinction fail to do so in their reasoning, and thus err in conclusions. Our correspondence reveals to us the fact that many inventors of ingenuity, and well versed in mechanical resources, are wrecking their hopes upon this rock. The law of virtual velocities lies at the very bottom of the science of dynamics, and mechanics cannot comprehend too early that, in the words of Grove, "Mere pressure never does work."

EXTINGUISHING FIRES BY CARBONIC ACID.

It is well known that fires in coal mines have been extinguished by pumping in vast volumes of carbonic acid and afterwards cooling down the adits by water. How far such a method would succeed in the open air and with burning houses is a question that can only be determined by actual experiment. One of the best ways of driving carbonic acid out of caves and wells is to let down a red hot cannon ball. The rarification and expansion produced by the heat soon displaces the carbonic acid, and renders a descent into such a place possible. This experiment, frequently shown in the chemical lecture room, would seem to throw some doubt upon the probable success of any attempt to play a stream of carbonic acid upon a burning building. Another question to be considered is the one of heat of the combustible material. If it were possible to stop the combustion by a stream of gas, the great heat would re-ignite everything the moment the air was allowed free access, unless as, in the case of the coal mine, great volumes of water were poured on to cool everything down below the point of ignition. If this be true, it would be easier to put out the fire by water in the first place than to be at the expense of double engines for gas and water. Another difficulty may arise in the transportation of carbonic acid through iron tubes. It is well known that this gas can be easily split up or dissociated by passing through a system of heated tubes, and although it is not probable that the same thing would take place with cold iron mains, it might be well to institute an experiment or two before laying down a few hundred miles of pipe. When a fire is put out by water, the intrepid firemen are often deluged with water to cool them and to protect them from danger. In the case of carbonic acid, every living being would have to keep at a safe distance, and a bad leakage or an unfortunate aiming of the pipe might produce disastrous consequences.

We understand that at the last session of the Legislature, a law was passed authorizing a company to lay pipes, three feet beneath the level of the streets of New York, for the purpose of extinguishing fires by carbonic acid. It is intended to convey the gas in the same way as illuminating gas is furnished to consumers, from large reservoirs or gasometers, and to have—we cannot call them hydrants—but something on the same plan, for attaching hose all over the city, ready to put out any fires that may occur.

Whether private houses are to be furnished with double pipes so as enable the gas men to deluge them if occasion should require, we are not informed. Nor is anything said in the act of incorporation about furnishing free soda water by saturating the Croton reservoir with the gas. The whole scheme looks suspicious, and we should really like to know if the project has ever been seriously entertained.

HOW BODIES MAY BE FROZEN BY HEAT.

The fact that there now exist several machines which through the consumption of coal produce ice, is one quite inexplicable to many; and perhaps while we are enjoying our iced drinks, so grateful in the hot weather suddenly come upon us, an explanation of this apparent paradox may not be unacceptable. That heat should directly or indirectly produce cold seems, at first thought, an impossibility; nevertheless, in the laboratory of nature this is an operation constantly going on; and it is in this wise:

Whenever a body changes from a solid to a liquid state, or from a liquid to a vaporous condition, large amounts of sensible heat disappear. Either the temperature (sensible heat) of the body itself falls very much lower than it was before its change of state, or sensible heat is abstracted from surrounding bodies to maintain the expanding substance of its former temperature. The heat abstracted and stored up in the body, so that it no longer produces the effects popularly included in the term "heating," has been called latent heat. Its amount varies greatly in different solids, liquids, and vapors.

Now there are two ways in which bodies may be expanded, namely: by adding to their heat—sensible or latent, or both—or by removing the pressure their surfaces sustain. Or we may, if we choose, both impart heat and remove pressure simultaneously.

Thus the gas chlorine, when submitted to a pressure of about four atmospheres, becomes a liquid, and will remain so as long as the pressure is continued. During the act of compression, it gives off a certain amount of heat, which is the exact equivalent of the mechanical power employed in reducing its volume. When the pressure is removed, it expands to its original bulk as a gas, and in so doing takes the same amount of heat, from other bodies, as it lost when compressed. Air, when compressed, gives off heat, and absorbs the same amount again when it expands. In reducing the volume of bodies, we may not only use compression, but we may also abstract heat by bringing them into contact with colder bodies, thus powerfully aiding the mechanical power in bringing about the desired result.

But mechanical power is only another name for heat, the source of all terrestrial power. If we employ a water wheel to generate our power, we find this possible only because heat has raised the water for us. If we use wind as a motor, it is heat that puts the air in motion; and if we employ steam, we must do the same thing. If we use an electro-motor we find our materials prepared for us through the same agency.

The various ice machines employ volatile materials such as expand into gas at ordinary temperatures, or at least do so when atmospheric pressure is removed from their surfaces. In thus expanding they abstract heat from water placed in suitable vessels, brought in contact with the absorbing bodies. The expanded gases are next compressed, the heat given off during the compression being absorbed by some other body—most generally water. The condensed and cooled materials are then allowed to expand in contact with the vessels containing the water to be frozen again, and so on repeatedly until ice is produced.

Thus we see that heat indirectly produces cold, and this is only an expression of a general law. Nothing can gain heat without loss of heat in something else, and though the gain or loss may be latent and not appear in the temperature, yet we may be sure that the sum total is always the same.

CO-OPERATIVE COLONIES.

It seems to us that coöperative colonies might be made the means of improving the condition of a very large proportion of those who crowd our commercial centers, and who have nothing to rely upon for support but their physical toil. There are large areas in this country where a very small amount of labor will supply ample food and clothing for a large family. In many of the Southern States, there are lands where an industrious laboring man could, with the produce of a very few acres, and the wages of such work as he might get to do, live in a measure of comfort which, with constant toil, early and late, he never could attain in any large city.

Some three years since we visited the State of Delaware, and noticed particularly the results of the intelligent cultivation of the worn-out lands of the section through which we passed. A judicious rotation of crops, together with a supply of fertilizers derived from the bodies of king crabs, and other materials of which the shores of Delaware Bay afford an almost unlimited supply, will, it has been demonstrated, render the lands adjacent to the bay extremely productive.

We saw clover, corn, wheat, peanuts, and sweet potatoes growing in great luxuriance; while peaches, grapes, pears, and berries, find there an unequalled climate and soil, the entire country teeming with these fruits.

In addition, the salt marshes abound with game birds; the tidal rivers swarm with fish, so easily taken that large quantities are caught with a small expenditure of time. The shores of the bay furnish such supplies of oysters that we saw them sold at twenty-five cents a bushel. The climate is so mild that cheaper houses, less clothing, and less fuel suffice. Truly, thought we, for men who get their living by their muscles, this is a veritable Canaan.

The coöperative colonies, which have been formed lately in this city, designing to avail themselves of the natural advantages of productive sections of our vast territory will, we hope, some of them prove so successful that they will demonstrate the value of such coöperation.

To be successful these associations should, as much as possible, embrace a variety of the mechanical trades of the most general utility. They should have their own tailors, shoemakers, carpenters, blacksmiths, cabinet makers, and wagonmakers. They should admit only those of sober and industrious habits, fully impressed with the value of coöperative effort and really understanding what coöperation means. They should be particularly careful to exclude all that is liable to breed discord, and should adopt such codes of regulations as can be practically adhered to by all well disposed members.

We are inclined to believe that many of these associations are organized in too hasty and crude a manner to be successful, and that they do not sufficiently scrutinize the character of their members.

In the selection of localities, those which afford the best opportunities for diversity of industry will, in the end, always prove the best.

We are the more inclined to favor these organizations from the fact that they are making an intelligent effort to better the condition of the laboring classes, and that they are composed of select and peace loving workingmen, who see that in the strikes and other means employed by trades unions to force higher wages, the true interests of labor are not really advanced.

STEAM ON THE ERIE CANAL.

We find it necessary to repeat what we have already said in regard to the propulsion of boats, under the conditions specified in the New York State law offering the $100,000 prize.

Many of our correspondents apparently think it is sufficient to confine their thoughts to the invention of a means of propulsion, without regard to speed. We have already shown that the minimum velocity required by the act (three miles per hour) involves a modification of the form of the square box boats now in use. The advance of such a boat at the required speed would create injurious side swells, no matter what means of propulsion were adopted.

Some of our correspondents appreciate this difficulty and regulate their plans accordingly. One suggests the employment of side wheels, with outriggers carrying longitudinal shields running parallel to the sides of the boat and outside of the wheels, the shields to be as long as the boat. This would undoubtedly prevent side swells to a very great extent, but it would make the width of the boat so great in proportion to its tunnage that it could not carry the stipulated load and get through the locks.

Another correspondent proposes a wheel with radial flukes, which shall engage the bottom of the canal and thus propel the boat. This device is old, and besides does not provide for the obviation of side swells.

As we understand the law, the speed may exceed three miles per hour, provided the inventor can so construct his boat that greater velocity can be safely attained.

Inventors will see that the conditions under which success can be attained are few, and those of failure numerous. It would be wise for many of them to give the law more careful scrutiny than they appear to have done.

BUILDINGS FOR MANUFACTURING PURPOSES.

Some two or three years since we called attention to the necessity of a special profession of "Architectural Engineering." Our interest in the subject has now been revived by a failure of an expensive building, designed by a supposed competent architect, for a special manufacturing business, to answer the purpose for which it was built. The proprietors have, we are informed, been compelled to expend considerable money and lose valuable time to rectify its defects, besides having to change machinery from floors upon which it was originally placed to others less convenient.

The fact is that men who can build graceful and handsome churches are not therefore necessarily competent to design a factory, especially one intended for new branches of industry. To imitate is not to design. But every new building intended to be occupied by machinery long used and well understood, must, although the same ground plan is observed, be more or less varied in detail to adapt it to the peculiar circumstances of its location, the soil upon which it stands, etc. It requires more than artistic talent and knowledge of the properties of materials to do this. Knowledge of the nature of the operations to be carried on in the building, judgment matured by experience, and inventive skill, combined with skill in the art of building, are necessary.

Some of the finest manufacturing buildings in the country were in their internal arrangements entirely designed by men familiar with the peculiar industry for which they were constructed, but who were quite unfamiliar with architecture as an art.

Utility rather than beauty must be the controlling idea in erecting such buildings. Yet whenever without sacrificing convenience and strength to appearances, beauty of design can be secured, it is of course very desirable. To combine these elements requires no mean skill, and it is evident that to greatly excel in this class of work a man must have made it a special study.

EX-COMMISSIONER FISHER'S EXPERIENCE IN THE PATENT OFFICE.

We commence this week the publication of extracts from a speech recently delivered before the Young Men's Christian Association, Cincinnati, by Hon. S. S. Fisher.

The incidents he relates occurred while holding the office of Commissioner of Patents, and his amusing experience is not unlike that of the chiefs of other bureaux under the Federal Government. We have withheld the publication a week or two, undecided if we could afford the space the lecture would occupy. But his description is so graphic and racy, and portrays such a good insight into the peculiarities of office seekers generally, that we decide to make copious extracts, which will be continued through several numbers.

INSPECTION OF THE BOTTOMS OF WELLS.—Sufficient light to enable any one to see the water or earth at the bottom of a well, can be directed down the shaft by means of an ordinary looking glass. If the well be under cover, two glasses will be required, and our own ingenious readers will, by a little experimenting, soon be able to arrange them in the right positions.

[Special Correspondence of the Scientific American.]

BURDEN HORSESHOE PATENT EXTENDED---VALUE OF THE INVENTION.

Washington, D. C., June 26, 1871.

On the 14th of June the famous patent of Henry Burden, of Troy, N. Y., for a Horse and Mule Shoe Machine, was extended by Commissioner Leggett. No contestant appeared in opposition to the extension. The patent was issued June 30, 1857, and reissued in 1865.

Mr. Burden died in January last, and the applicants are his two sons, Mr. James A. Burden and Mr. I. Townsend Burden. He was a man of strong intellect, great energy, and untiring perseverance. To perfect the machine referred to was the ambition and success of his life, and no efforts or sacrifices seemed to him too great for its accomplishment. Others had labored in the same direction, but had failed of success, and abandoned their undertakings. It required the inventive talent and extraordinary persistence of such a man, together with his unusual pecuniary resources and mechanical facilities, to work out the difficult problem. Mr. Burden's first efforts to this end were made prior to 1835, in which year he was granted a patent for a machine, which however proved a failure, and involved a heavy expenditure. In 1843, he received a second patent on another device, but this also failed when put to practical use. In 1853, his determined efforts suffering no abatement in the intervening time, he decided to abandon the particular line of devices he had hitherto chosen in his experiments, and to adopt certain others involving different mechanical principles. The happy result appeared in his patent of 1857. He subsequently devised important improvements, which were embodied in another patent issued in 1862. As an automatic feeding, bending, and molding machine, the patent of 1857, just extended, was all that could be desired, but in the process of creasing and punching the nail holes some difficulties arose, which were overcome in the patent of 1862.

When first entering on his experiments, and this was as early as the year 1835, Mr. Burden carried on extensive iron works, of the highest grade, at Troy: but during the years, from 1853 to 1857, his general business was in many ways sacrificed to the one great object he had so long and sanguinely had in view. Many stories are told of his intense and enthusiastic application at that time; how for days and weeks his meals were brought to his place of business; how he often worked, sometimes in company with his favorite mechanics, 24, and even 30, hours without intermission; and how he many times called up all his workmen at midnight to open the mills and manufacture some new device or modification. His rolling mills were often idle for weeks, that all his hands and shops might be devoted to the horseshoe machine, in its embryo, but surely developing, condition. His machine and pattern shops were at that time fully equal to any, if not the best, in the country; and were provided with the most approved implements.

The present machine turns out, with unerring certainty and perfection, one shoe in a second of time. The average weight of a shoe is one pound, and it is not uncommon for one machine, in the ordinary running of the shop, to transform 10½ tuns of bar iron into perfect shoes in 12 hours, which is equal to the hand work of at least 600 men for the same time.

To estimate the saving to the country from a general adoption of this important article, it must be borne in mind that the prevailing prejudice against its use compelled the inventor to place it in market at a price returning him no profit whatever, and not even covering the cost of manufacture. In other words, he offered it at the price of the material, looking for his returns exclusively to the regular profit on the manufacture of the iron, the machine materially increasing the business of his extensive puddling and rolling mills.

With some modifications, this plan has been adhered to up to the present time, and it is contended by the firm that the public, in proportion to its adoption of the machine horseshoe, is saved the entire cost of the manufacture by hand, the profits to the manufacturer being derived from the invention only so far as the iron is thereby put in a more saleable form.

The average charge for making a horseshoe by hand is estimated by some at sixteen cents, by others as high as twenty cents (the material of course not included); the average price of the Burden shoe has been 8½ cents, so that the latter brings to the consumer a saving of at least two thirds on the entire cost. During the last year, the machine shoe has been sold at still lower rates, averaging less than five cents.

Since the introduction of the invention, 82,000 tuns of iron have been used in the manufacture, and the sales have amounted to $9,000,000, showing a saving to the public of $18,000,000.

It would be difficult to estimate the expenditures and losses during the many years of experiments. In the four years previous to the issue of the patent, the losses caused by the interruptions of the general business of the establishment amounted to at least $100,000. A famous litigation suit, in protection of the invention from an infringement, cost the inventor the sum of $25,000.

The prejudice, already referred to, against the article, both among the blacksmiths and the consumers, was general, and often bitter and violent. In New York city the excitement at one time rose to such a pitch that a blacksmith who had resolved to make trial of the shoe, was killed by his fellow workmen. This opposition was caused in part, and not unreasonably so, by the defective quality of the shoes put on the market by other parties, and even by Mr. Burden himself, on his first attempts to introduce them; and to overcome this, when the manufacturing process had become perfected, was a difficult task, and involved great labor and heavy expenditures. Mr. Burden's sons and other responsible agents visited all sections of the country, and personally conferred with the leading master workmen. Charging the machine with the expenses of inventing and perfecting it, of making and selling the product, and the market price of the iron, and crediting it with all the proceeds of the sales, it is pretty clearly shown that the inventor and his heirs have sustained a heavy loss.

The value of this invention in its relation to the military operations of the late civil war may not be generally known. Many thousand men were spared for active field service whose services would otherwise have been required in the shops. Quartermaster-General M. C. Meigs says: "The army depended, to a very great degree, upon shoes made by this machine, and they gave satisfaction wherever used. It is not possible to state its value to a government. It is one of those inventions which add to the military strength of a nation, not to so great a degree, but in the same manner as the steam engine, the steamboat, and the locomotive."

Assistant Quartermaster-General J. A. Donaldson writes: "During our civil war, as Chief Quartermaster of the Military Division of the Tennessee, and afterwards of the Missouri, I had ample opportunity of testing these shoes, and found them superior in every particular to those made by hand. In the great operations of our armies—when it would have been impossible to manufacture a sufficient number by hand—such, for example, as Sherman's Atlanta campaign, and his March to the Sea—the Burden horse and mule shoes were an essential element of success, and I cannot speak too highly of them."

During the war, about 14,000 tuns of shoes were used in the Government service, the price paid being even less than market price to private individuals, and the saving, as compared with the cost of the same if made by hand, was about $4,000,000.

The history of this invention, if fully written, would finely illustrate the workings of a strong inventive intellect, impelled by an energy well nigh heroic and borne over obstacles and through labyrinthine delays by the presence of a never failing hope. Mr. Burden knew no misgivings, and failures only stimulated to greater exertions. But what we know of the inventor's life is sufficient to excite our admiration and quicken our appreciation of the measure of human vital force that may be embodied in one important invention.

Mr. Burden was born in Scotland in 1791, and came to this country in 1819. He received a thorough education in mathematics and engineering, and in boyhood displayed much inventive genius. In 1820, he invented the first cultivator in the country; in 1840, the railroad spike machine, which became widely known, not only from its intrinsic value, but also from an extended litigation to which it gave rise. Other valuable inventions might be referred to. A thorough mechanician and mathematician, he wasted nothing in blind and random labors.

During the war, Mr. Burden took much interest in furnishing to the various Sanitary Commission fairs, held in the leading cities, miniature horseshoe machines, and the suitable white metal for manufacturing diminutive shoes, which were sold in great numbers as ornaments or mementoes. It has been stated that the sum of $20,000 accrued to the Sanitary Commission from these sales; and many will remember that, at the New York city fair, they were conducted with great success by Mrs. General McDowell.

STEAM FIRE ENGINES.

The boiler and works of a steam fire engine with a running gear are so constructed as to dispense with a reach or perch pole, and to allow the forward wheels to be turned completely under the frame in such a manner as to place the weight of the parts upon the axles, and relieve the frame of all strain except what is necessary to preserve the proper relative position of the axles. This construction of steam fire engines renders them less liable to be injured or disabled by the giving way of parts, and adapts them also to be turned or managed with greater facility, accuracy, and safety, while the engineer and firemen have such access to the engine and boiler, respectively, as greatly facilitates the performance of their duties. The parts composing the engine are arranged directly over the front axle, and the boiler on the rear axle, the axle being connected by curved reaches or braces. Thus the front wheels may be turned completely round the engine, which facilitates turning in narrow limits, and enables the tongue and connected parts to be placed out of the way of the engineer. This construction also allows the engineer and fireman to work entirely separate or without one being in the way of another, and removes the weight of both engine and boiler entirely from the reaches, enabling them to be made light so as to reduce the aggregate weight and cost of the machine. The saving effected in repairs, and the increased speed with which this engine may be driven, alone, are claimed to equal or exceed in a brief period its entire cost.

Invented by Lysander Button and Theo. E. Button, of Waterford, N. Y.

Brick Kiln.

This invention consists in improving the construction of brick kilns, so that the over burning of some and insufficient burning of other bricks can thereby be prevented, as well as the unnecessary waste of fuel. It consists in the application to the top of the kiln of a series of horizontal intersecting flues, and of registers above the crossings of the flues, whereby the products of combustion can be directed in their course. Upon a brick kiln of suitable size and shape, and built up of