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Contents:

(Illustrated articles are marked with an asterisk.)

OSCILLATIONS OF WATER IN STEAM BOILERS.

The peculiar oscillations of water in steam boilers, as indicated by the steam gage, have been a subject of common remark. The causes for these oscillations are imperfectly understood by many in charge of such boilers, and in conversations with engineers of justly high reputation, we have found that certain causes of this fluctuation in hight are unrecognized.

We may regard the following propositions as thoroughly established laws.

First, the pressure of a homogeneous liquid is as its depth. Second, a liquid subjected to pressure from a supernatant fluid, obeys the same laws of pressure as though it were free from the pressure of the over-lying fluid, and the degree of pressure thus sustained upon its surface does not modify or create exceptions to this rule. Third, if the supernatant fluid be a gas, and the liquid upon which it rests be water, a certain amount of the gas, increasing with the pressure, will be dissolved in the water. Fourth, in the absence of nuclei, which serve by their adhesion to assist the escape of a gas from a liquid supersaturated by that gas, the escape will be irregular, unequal, and will partake of the nature of an explosion. Fifth, in the absence of nuclei, the boiling points of liquids are higher than when such nuclei are present. Sixth, when a liquid is agitated so as to render it of unequal depths in different parts, the pressure upon the bottom of the containing vessel and upon the sides against which the liquid rests will be unequal.

A pressure gage, attached to any one point in the side of a vessel thus agitated, would show by its fluctuations the variations of pressure at that point, provided they did not succeed each other so rapidly as not to give time for this gage to act, in which case it would only show the mean pressure.

A water gage is only a form of pressure gage, communicating at the top with the supernatant steam, and at the bottom with the water upon which the steam rests. The pressure of the column in the gage back toward the interior of the boiler is equal to the weight of a column of water having for its base the section of the aperture which connects the boiler and gage at the bottom, and of a hight equal to the hight of the water in the gage above that aperture, added to the pressure of steam upon the upper end of the column. The pressure outward toward the gage is equal to the weight of a column of water having the same base as before, and of a hight equal to the depth of the water in the boiler above the aperture connecting the boiler and gage at the bottom, added to the pressure of the steam upon the top of the water column as before.

When both steam and water are at rest, the water, obeying the same laws of pressure as though there were no supernatant steam pressing upon its surface, seeks and finds a common level in both boiler and gage.

In a boiler supplying steam to an engine, or blowing off steam, the state of internal affairs is *never* one of rest. To suppose the contrary would be to suppose a uniform pressure maintained, a constantly uniform heat applied to all parts of its heating surface, and the escape of steam from the water unattended by ebullition.

That the pressure is never a constant quantity where steam is generated in a closed vessel, any one may see by watching a steam gage attached to such a vessel. The indication of fluctuations in pressure may also be detected in the variable sound of the steam when a boiler is blowing off. It is for this reason that in testing the evaporative power of boilers, it has been found necessary to eliminate the element of variable pressure, by allowing free escape to the steam, so that the pressure is constantly that of the atmosphere only.

We do not, however, regard the constant short bubbling of water in boiling as of much effect in producing the fluctuations of water indicated by the water gage. There are two causes, however, which are sufficient to account for such oscillations.

In the absence of nuclei the steam is generated under tension and escapes with a sort of explosive action; this occurring at one end of a boiler would raise a wave on the surface, which wave would travel along the surface of the water precisely as it would in an open vessel, and when this wave reaches the end of the boiler where the water gage is attached, the water would rise in the gage and recede with the recession of the wave.

Where a boiler is supplying steam to an engine performing variable work, the supply of steam will not be uniform, and the pressure in the boiler cannot be uniform. Whenever the pressure is diminished suddenly the steam escapes from the surcharged water like the gas from so-called soda water, and the volume of mingled steam and water expands; the water in the gage, obeying the same law as the water in the boiler, except in so far as its temperature may be less.

These causes would account for the oscillations of the water even admitting a uniform heat to be maintained in the furnace, a supposition which variations in draft, variable condition of the fire, and quality of the fuel, etc., forbid.

Where two or more boilers supply steam through a common supply pipe, connected to the boilers by branch pipes, the elements of variation in pressure must be still more multiplied, a point upon which it is unnecessary to dwell.

A consideration of the facts we have thus explained coupled with observation, will enable the intelligent reader to determine the causes of peculiar oscillations in individual boilers.

DIRTY SHOPS AND SLOVENLY WORKMEN.

Charles Reade has asserted that workmen are a dirty set and a reckless set. Is this true of American workmen? His observations have been confined to English workmen; would he have occasion to modify the general character of his statement were he to visit and inspect American shops?

Candidly we must say there would be too much in the general want of cleanliness and order in our workshops to justify the assertion. The shops in which cleanliness and order prevail are rather the exception than the rule; and the individual workman who, in the midst of all the carelessness which prevails in this regard, maintains a scrupulous care for personal cleanliness, order in the arrangement of tools, and method in the performance of his work, may be regarded as a rising man.

On our occasional journeys in those most disagreeable conveniences of the age, horse cars, at times when workmen are returning from their daily work, we frequently notice them with begrimed faces and smutty hands, on their way to homes perhaps no less attractive than their persons.

If this were compelled by circumstances, and the unavoidable conditions of their toil, it would be unkind indeed to find fault with it. We should indeed be the very last to look down upon the necessary accessories of honest toil, and, if any American workman is so situated that he *must* utterly disregard cleanliness, let it be distinctly understood we do not complain of him. But cases of this kind are rare, if they exist at all. What then is the reason for the inexcusable slovenliness of a large majority of workmen?

The first reason is that proprietors and overseers do little or nothing to encourage tidiness in their subordinates. They too often look upon a man who is making attempts to keep himself and his work-bench tidy, as a cat in gloves who will catch no mice, and speak contemptuously to him of being afraid to dirty his hands, although his hands may at the time bear the honorable evidence that his duty has been faithfully performed. But tell us pray, is it necessary that they should bear that evidence home with them? Is it necessary that the face should be soiled as well as the hands, and that clothes should be smirched as well as hands and face?

In imagination we hear some mechanic exclaim, "I should like to see that editor do my work a little while, and keep himself clean! I guess he would find it harder work than sitting in his comfortable office and finding fault with us poor fellows, who have no such good luck!"

To whom we reply that, good luck or not, we often sigh for the light-hearted days, when we did just such work, and earned thereby a good appetite and the means wherewith to gratify it; and further we know that you can't get down on your knees in sand, and face your molds with powdered charcoal, and perspire amid a cloud of black dust, and keep your faces and shirts white. Bless you, we know all that, learned it years ago, but it is not *you* we find fault with. It is that slovenly chap who goes in to work at his lathe, on Monday morning, with a clean shirt on, and who, in less than half an hour, has managed to get two or three streaks of black oil down his back, and sundry patches of it on his face, while the handle to every tool on his lathe and even the lathe itself is japanned with the same unctuous material. We can see the use of the black dust and perspiration in a foundery, but we don't see the necessity of a man in a well-ordered machine shop, painting himself up like an Indian on the war-path, and carrying it home with him to the annoyance of those who are, perhaps, obliged to sit in the same seat with him, and who do not care to get into too intimate contact with black-grease and oil.

Personal cleanliness leads to order in work and business, and elevates the moral character of all who exercise it. It is a virtue second only to godliness, and exercises not only a benign influence upon moral character and physical health, but upon intellectual growth.

Would proprietors and superintendents enforce more thorough order and cleanliness in their works, and encourage it in the habits of their employés, they would get more and better work for their money, would render their help more manly and honorable in the discharge of their duties, elevate the character, and increase the welfare of the working classes throughout the world.

ANNOUNCEMENT FOR 1870.—A SPLENDID WORK OF ART AND CASH PREMIUMS TO BE GIVEN.

The SCIENTIFIC AMERICAN enters its twenty-fifth year on the first of January next, and to mark this period of a quarter of a century in which it has maintained its position as the leading journal of popular science in the world, we have purchased from the executors of the estate of the late John Skirving, Esq., and propose to issue on New Year's day, the fine steel engraving executed by John Sartain, of Philadelphia, entitled

"MEN OF PROGRESS—AMERICAN INVENTORS."

The plate is 22x36 inches, and contains the following group of illustrious inventors, namely, Prof. Morse, Prof. Henry, Thomas Blanchard, Dr. Nott, Isaiah Jennings, Charles Goodyear, J. Saxton, Dr. W. T. Morton, Erastus Bigelow, Henry Burden, Capt. John Ericsson, Elias Howe, Jr., Col. Samuel Colt, Col. R. M. Hoe, Peter Cooper, Jordan L. Mott, C. H. McCormick, James Bogardus, Frederick E. Sickles.

The likenesses are all excellent, and Mr. Sartain, who stands at the head of our American engravers on steel, in a letter addressed to us says "that it would cost $4,000 to engrave the plate now," which is a sufficient guarantee of the very high character of the engraving as a work of art.

The picture was engraved in 1868, but owing to the death of Mr. Skirving, a few copies only were printed for subscribers at $10 each. A work embracing so much merit and permanent interest to American inventors, and lovers of art, deserves to be much more widely known. We propose, therefore, to issue, on heavy paper, a limited number of copies at the original price of $10 each, to be delivered free of expense. No single picture will be sold for less than that price, but to any one desiring to subscribe for the SCIENTIFIC AMERICAN, the paper will be sent for one year, together with a copy of the engraving, upon receipt of $10. The picture will also be offered as a premium for clubs of subscribers as follows to those who do not compete for cash prizes:

For	10	names	one	year	$30	one picture.
"	20	"	"	"	50	" "
"	30	"	"	"	75	two pictures.
"	40	"	"	"	100	three "
"	50	"	"	"	125	four "

In addition to the above premiums we also offer the following cash prizes:

$300	for	the	largest	list of	subscribers
250	"	"	second	do	do
200	"	"	third	do	do
150	"	"	fourth	do	do
100	"	"	fifth	do	do
90	"	"	sixth	do	do
80	"	"	seventh	do	do
70	"	"	eighth	do	do
60	"	"	ninth	do	do
50	"	"	tenth	do	do
40	"	"	eleventh	do	do
35	"	"	twelfth	do	do
30	"	"	thirteenth	do	do
25	"	"	fourteenth	do	do
20	"	"	fifteenth	do	do

Subscriptions sent in competition for the cash premiums must be received at our office on or before the 10th of February next. Names can be sent from any post office, and subscriptions will be entered from time to time until the above date. Persons competing for the prizes should be particular to mark their letters "Prize List" to enable us easily to distinguish them from others.

Printed prospectuses and blanks for names furnished on application.

WORK PERFORMED BY THE HUMAN HEART ESTIMATED IN HORSE POWERS.

That wonderful little pumping engine which we all carry around in our bosoms, and which runs without cessation till death ruthlessly closes the throttle, performs an amount of work so great as to be almost beyond belief till substantiated by arithmetical calculation.

If we scrutinize the mechanism of the heart, we shall find that it involves in its operation nearly all the principles of hydrodynamics. It may, therefore, be brought within the domain of mathematics as well as any other machine.

In the attempt to calculate the power of the human heart for a given time, we shall arrive at some curious and interesting, not to say astonishing results. Few would credit, at first, the statement that the hearts now beating in and around the city of New York, exert an aggregate power ample to propel a large steamer across the Atlantic ocean at a fair rate of speed, yet we shall be able to demonstrate that this is as much a fact, as that any of these steamers ever crossed that storm-torn sea.

Blood is heavier than water; its specific gravity being, according to Booth, of from 1·0527 to 1·057. For convenience, however, we shall consider it as being of the same weight as water, extreme accuracy not being essential to our purpose and in our computations we shall, for the most part and for the same reason, throw out fractions and use round numbers.

The pressure required at the mouth of the aorta to force the blood through the vessels of the human body, is estimated by Hales, as being equal per square inch of surface, to that exerted by a column of blood seven and one half feet high. The pressure per square inch was estimated by Poiseuille as four pounds three ounces. Others have estimated the pressure as that of a column of water six feet in hight. The results vary in different experiments, but they are sufficiently accurate to give us an average that we may rely upon as within bounds. They are also something more than mere estimates, as this pressure has been measured by pressure gages inserted into the blood vessels.

We shall consider the pressure as that of a water column six feet in hight, the weight of which would be nearly forty-two ounces, which, for simplicity, we will consider forty-two ounces, or two pounds ten ounces avoirdupois.

The average discharge of the heart at each pulsation may be estimated at one and one half ounces, and its number of beats at seventy-five per minute; making an aggregate of 112 ounces, or seven pounds discharged per minute.

The average internal diameter of the aorta, or the first great artery through which the blood passes from the heart into the general circulation, may be taken as being in adults three quarters of an inch.

Seven pounds of blood per minute is therefore forced through this artery against a pressure of forty-two ounces, equivalent to raising seven pounds six feet each minute, equal to raising forty-two pounds one foot, or forty-two foot-pounds.

From the diameter of the aorta and the amount of blood forced through it we might compute the velocity of flow, but that is not essential to our purpose. All consideration of friction in the performance of this work is also omitted, so that the estimate of forty-two foot-pounds per minute must be considered as considerably less than the actual work performed, this result corresponding to what is called *useful work* in the performance of machines.

Forty years of this work would be equal to the work of twenty-six thousand seven hundred and fifty-seven horses for one minute of time, or the work of one horse for forty-four and one half days of ten hours.

The work of seven hundred and eighty-six adult hearts is equal to one-horse power; therefore seven hundred and eighty-six thousand hearts would perform the work of one thousand horses. The aggregate population of New York, Brooklyn, and Jersey City, was, according to the census of 1860, one million one hundred and twenty-two thousand, and it may be safely estimated now at one and one half millions. Considering this as equal to an adult population of twelve hundred thousand, their united heart-beats exert a power equal to that of one thousand five hundred and twenty-seven horses. Averaging the power of the united pulsations of adults and children as equal to that of four fifths the entire population, and taking the census of 1860 as a basis for calculation, the work done by all the human hearts in the United States nearly equals that of thirty-two thousand horses. The work done by the beating of all the human hearts on the globe is equivalent to the power of one million forty-six thousand and fifteen horses. The nominal horse power of the engines in the *Great Eastern* is four thousand; considering the actual horse power to be ten thousand, the power exerted by the united human heart-beat of the world is sufficient to propel a fleet of one hundred and four *Great Eastern's* at full speed continually. This power could only be generated in average steam engineering practice by the combustion of four thousand six hundred and eighty tuns of coal per hour.

When we reflect that the human family is small in comparison even with the great class of mammalia, of which it forms a part, and that many of the same class, as the whale, the elephant, the rhinoceros, hippopotamus, giraffe, etc., have hearts of very much greater size and power than the human heart; and when we conceive of the enormous additional work performed by the hearts of reptiles, birds, fishes, mollusks, and insects, and to this work add in imagination the power expended in the movement of the respiratory apparatus of animals, and voluntary muscular movement, necessary to obtain sustenance for these animals, we may gain some feeble conception of the enormous expenditure of mechanical power required to sustain animated existence on the earth.

PROGRESS OF INVENTION IN THE SOUTHERN STATES.

One of the most noteworthy features of the revival of industry in the Southern States, is the apparent disposition on the part of the people in that section to render themselves as far as possible independent of other sections for their supply of utensils, machines, and other essentials to the conduct of their agricultural and manufacturing pursuits.

One of the most striking evidences of this fact is found in the increased numbers of original devices calculated to advance the progress of the various branches of industry peculiar to that large, fertile, and, soon to be, most flourishing region. And not only are the Southern inventions which come under our notice in the course of our business applicable to the wants of the South, but many of them will find a widely extended application throughout all sections of the country.

This is a most encouraging sign of future prosperity, and one which all lovers of our common country must rejoice to see.

In this connection it will be interesting to notice some of the more recent and prominent Southern inventions.

A Memphis paper states that George W. Grader, a citizen of that city, has taken the bull by the horns and invented a machine for ginning cotton and relinting cotton seed and cotton motes, which promises to revolutionize the whole system of cotton ginning in the country.

Taking cotton from the boll, Mr. Grader's machine leaves no motes, the falls comprising nothing but the dirt. It cleans the seed, making them more valuable for manufacturing purposes, and saves the planter a large per centage on his crop.

The Memphis paper pronounces this invention of Mr. Grader one of the most extraordinary of the present time.

Mr. Henry Thompson of Mobile, has invented, and obtained a patent on, a submarine telescopic lantern, an ingenious design admirably adapted to the purpose of examining objects at any depth under the surface of the water, as the bottoms of vessels, foundations of piers, giving light under the water, and taking photographs of any objects, even at the bottom of the sea. At the same time it is an invaluable aid in enabling submarine divers to see how to work in laying pier or other submarine foundations, wrecking vessels, and recovering the bodies of persons drowned or valuable articles hidden under the sea.

This instrument is of simple construction, similar to a pilot's sounding pole, sectional tubes joined together with reflectors, mirror, and light at one end, so artistically arranged as to reflect objects under the water to the eye of the observer above.

The same versatile inventor has taken out patents on a life, surf, business, and pleasure boat, and, according to the Mobile *Daily Tribune*, has invented one of the most graceful, rapid and safe three-wheeled velocipedes ever devised.

The Boden safety valve is another Southern invention. According to the Louisville *Courier Journal*, it has been submitted to the most satisfactory tests, and has come out triumphant. It consists of two valves, one of which opens on the inside of the boiler and the other on the outside. Thus it will be seen by any one at all acquainted with the workings of a steam boiler, that an over-pressure of steam will open the outside valve, and a suction or vacuum will open the inside one.

We are in receipt of numerous letters from Southern men, making inquiries in regard to projected improvements, which indicate that an active spirit of invention pervades the Southern mind.

Gen. G. T. Beauregard, of New Orleans, recently obtained letters patent through the Scientific American Patent Agency, for improvements in apparatus for propelling cars and other vehicles on land, and boats on canals or rivers, by means of overhead wire rope, operated by stationary engines or other power placed at intervals along the route.

His invention comprises novel and ingenious clamping devices and spring attachment for the same, attached to the car, for engaging and disengaging the propelling rope, in a manner to avoid shocks and jars to the cars or boats.

In a recent letter to us on the subject, he says: "Thanking you for your prompt attention in obtaining my patent, I would state that this improvement of mine is destined, I believe, to create a rapid increase in the number of street railways in and about cities, and of canals in the country, by materially diminishing their current or running expenses. Moreover, in northern latitudes, where, owing to the ice, canals remain idle part of the winter, they will be used in connection with the stationary engines and endless wire ropes of my system, as so many railways for properly constructed cars and boats. When these arrive at any locks they will be easily transferred from one level to the other by a lifting platform."

We are happy to chronicle these signs of growing prosperity among the Southern people.

HOW SHOE-PEGS ARE MADE.

Shoe-pegs were invented in 1818, by Joseph Walker, of Hopkinton, Massachusetts. At least the invention is attributed to him, though the evidence upon which this opinion is based is not altogether satisfactory. A shoe-peg is a little affair, but its invention was by no means an unimportant event. It worked perhaps as great a revolution in a most important branch of industry as was ever effected by a single device. Before its introduction the soles of all boots and shoes were attached to the uppers by sewing; now, nearly ninety per cent of all the boots and shoes manufactured are pegged.

It has given birth also to numerous other important inventions; pegging awls of improved form, rasps for cutting off the parts of the pegs inside the boot, pegging machines, which will peg on a sole almost before one can think about it, machines for cutting, polishing, and bleaching pegs, etc., etc.

It is within the memory of the writer that shoe-pegs were made by hand. The timber from which they were made was sawed into blocks across the grain, of such a thickness as would, when the block was split into pegs, make them of the right length. Slabs, or bolts, thin as the body of the pegs wanted, were then split off by the use of a long thin knife and a hammer; the knife being used like the instrument called a "*frow*" by coopers and shingle makers. The bolt or slab was next beveled on both sides of one edge. The slab thus prepared was next split into pegs one by one.

Of course such a rude method as this was destined to be supplanted by a far more rapid and perfect one, and there is probably no article so well made and finished that is sold cheaper than the modern shoe-peg.

It is worthy of remark that the same principles are applied to their manufacture by the best modern machinery, as were adopted in the hand method.

The wood must be of some hard, close-grained variety, which splits easily. Hard maple and birch are the favorite woods for this purpose; birch, however, is, we believe, the shoe-peg timber *par excellence*.

The wood is cut into lengths of about eight feet, and is sold by the cord, at three or four times the price of the same kinds of timber cut into fire-wood. The logs are received at the factory in the green state, and are worked up as wanted.

The first operation is peeling off the bark, an adze being employed for this purpose. The logs are next sawed into blocks across the grain, a little thicker than the length of a peg. These blocks are placed on a planing machine and the side which is intended for the heads of the pegs is planed smooth.

The blocks are now ready to be grooved. This is done very rapidly by a machine in which a cutting tool reciprocates rapidly across the face of the block, the block being at proper intervals of time carried along by feed rollers. After the blocks have been grooved one way, they are again grooved at right angles to the first grooves, and both sets of grooves being V-shaped, the surfaces of the blocks on one side, now present a regular succession of quadrangular pyramids, which are the points of the yet embryo pegs.

The next operation is splitting, which is done on machines operating very rapidly and with great precision. The splitting knives on these machines are pivoted at one end, and the other end is made to play rapidly up and down, the motion being similar to that of a shears blade for trimming sheet iron. The pivoted end may be raised or lowered so that the knife may only enter the wood as far as required, the object being to not split the pegs entirely apart, but to have them hang together at the heads. The blocks are fed to the splitting knives by fluted rollers, the flutes of which fit the grooves in the blocks made by the grooving machines. The blocks are fed in with the planed side downward, and the splitting knife at each stroke enters the wood at the bottom of the V-shaped grooves with great accuracy. Thus the splitting is done from the points towards the heads of the pegs. When the block has passed through the splitting machine once, it is turned and fed through again at right angles to the direction in which it was first fed through, and after this operation the pegs are very nearly split apart, but they still hang together somewhat like a bunch of split lucifer matches. The object of keeping them thus together is to enable them to be fed to the machines in a mass. After the second feeding the block is forcibly thrown off the table of the splitting machine on to the floor, and the pegs fall asunder. The pegs at this stage are of different colors, somewhat rough on their sides, unseasoned and dusty. They are therefore dried in a tumbler heated by steam pipes, bleached with sulphur fumes till they assume a uniform white color, run through a fanning mill to free them from dust, and finally packed for market.

The extent of this manufacture is much greater than would seem possible to most people. It would seem at first, that if all the people in the world were shoemakers, they must be overstocked with pegs. There are numerous factories in the Eastern States turning out from fifty to one hundred bushels and upward of shoe-pegs per day, and still the demand keeps up. Anything in universal demand even if individually the demand is small, must foot up large in the aggregate for the civilized world. The New England States manufacture the greater part of all the shoe-pegs used, Germany, we are informed, being one of the best customers.

The Russian Exposition.

We notice that a resolution was unanimously adopted by the Louisville Convention requesting Ex-President Fillmore to appoint a delegation of six persons to attend the Russian Exposition in 1870, these Commissioners to take charge of all specimens that exhibitors in the United States may desire to send, and they are specially instructed to procure thousands of samples of cotton from various States.

The papers containing the report of this proceeding add that the suggestion came from Europe, and that a hundred thousand American specimens are asked for, to show the importance and the diversity of production in our country.

A letter from Baron Osten Sacken, Consulate General of Russia to the United States, published in another column, states that the Exposition is intended only for the display of Russian products. We invite attention to this letter. Before the Commissioners are appointed by the venerable Ex-President, it might be well to first find out if they are wanted.

A Letter from Dr. Livingstone.

There can no longer be any reasonable doubt of the safety of Dr. Livingstone, and there can be no doubt either, that if his life is spared to narrate the incidents of his last great tour in Africa, it will prove a most remarkable narration. The extracts from a letter of Dr. Livingstone, sent by Dr. Kirk from Zanzibar to Sir Roderick Murchison, contain the following information:

"Dr. Livingstone had traced a chain of lakes, connected by rivers, from the tracts south of the Lake Tanganyika to south latitude 10 degrees to 12 degrees, and he conjectures that these numerous connected lakes and rivers are the ultimate southern sources of the Nile. When he wrote he was about to travel northwards to Ujiji, on the eastern shore of Lake Tanganyika, where he expected to find some information from home, of which he had been entirely deprived for two years, as well as to receive provisions and assistance."

OUR predictions in regard to the effect of high-heeled shoes upon female health have been verified. A French physician states that this fashion "has produced distinct diseases not only of the distorted foot, but of the body. As the frame is thrown permanently into an unnatural position, it affects the spine, and as it is a question of balancing, nervous irritation sometimes occurs. You see by the expression of the face how much a woman suffers who has walked about or even stood in high-heeled boots. Besides, we have accidents from falls very frequently."