POWER OF BODIES IN MOTION.

BY JOSEPH W. SPRAGUE.

It is a well-recognized principle in mechanics that whatever amount of power has been expended upon a body in changing it from a state of rest to one of motion, the same amount of power will be yielded up by the body to whatever brings it back to a state of rest. When, therefore, we determine the amount of power necessary to impart to any body at rest the velocity v, we also determine the amount of power necessary to stop the same body when it is moving with the velocity v, for the two amounts are equal.

All our knowledge of force and the work which it accomplishes, or power, is derived from experiment. Let us therefore take some well-known instance of force at work, and deduce from it a general law. The most familiar of all forces is *gravity;* the intensity with which it acts upon any body is measured by the *weight* of that body. Experiment shows that a body abandoned to the sole action of gravity acquires, at the end of one second, a velocity of 32.2 feet per second; at the end of two seconds, a velocity of 64.4 feet per second; at the end of three seconds, a velocity of 96.6 feet per second; at the end of four seconds, a velocity of 128.8 feet per second. If then v represent the velocity in feet per second; t, the number of seconds during which the body has been abandoned to the sole action of gravity; and g, the experimental number 32.2, we have $v=gt$. During the first second, the body falls through a space of 16.1 feet; in two seconds, through 64.4 feet; in three seconds, through 144.9 feet; in four seconds, 257.6 feet. If then s represents the space, in feet, passed over by the body, we have s equal the product of the time and the mean velocity, or $s=[(o+v)\div 2]\times t=vt\div 2=gt^2\div 2$.

Suppose an iron ball weighing 1,440 ℔s. to rest upon the piston of a vertical cylinder having an area of one square foot. Consider the piston itself devoid of weight, and moving without friction. Admit below the piston steam having a tension of ten pounds per square inch, or 1,440 ℔s. per square foot. The pressure of the steam (1,440 ℔s.) upon the under side of the piston just balances the weight of the body, and there is no motion; that is, the expansive force of the steam just equals the force of gravity acting upon the body, and the two neutralize each other.

Next double the tension of the steam, making it twenty pounds per square inch, or 2,880 ℔s. per square foot. We now have a downward force of 1,440 ℔s., and an upward force of 2,880 ℔s. The resultant is an upward force of 1,440 ℔s.; that is, under the combined action of steam and gravity, the ball has the same tendency to *rise* that it would have to *fall* under the sole influence of gravity. We know, then, that the piston and ball will, in one second, rise 16.1 feet, and acquire a velocity of 32.2 feet per second; in two seconds, rise 64.4 feet and acquire a velocity of 64.4 feet per second; in three seconds, rise 144.9 feet and acquire a velocity of 96.6 feet per second; in four seconds, rise 257.6 feet and acquire a velocity of 128.8 feet per second; and in t seconds, rise $s=gt^2\div 2$ and acquire a velocity $v=gt$.

We have for the cubic feet of steam consumed, the area of the piston multiplied by the hight it rises, in the first second, 16.1 cubic feet; in two seconds, 64.4 $=4\times 16.1$ cubic feet; in three seconds, $144.9=16.1\times 9$ cubic feet; in four seconds, $257.6=16.1\times 16$ cubic feet; in t seconds, $16.1\times t^2$ cubic feet.

Thus it will be seen that while the velocity increases as the numbers 1, 2, 3, 4, &c., the power expended (steam consumed) varies as the numbers 1, 4, 9, 16, &c.; that is, the power expended in producing any velocity varies as the *square* of that velocity. In determining the *absolute* quantity of steam used in producing velocity, it must be remembered that one-half of the above quantity is consumed in overcoming the resisting force of gravity, the other half alone producing motion. This would not, however, affect the *relative* quantities used.

For deducing a general rule, let W represent the weight of the ball in pounds; a, the area of the piston in square feet; and b, the tension, in pounds, per square foot of the steam. Making, as before, the pressure on the piston twice the weight of the body, we have $a\times b=2W$.

The quantity of steam consumed, while the piston and ball rise through s feet in t seconds, acquiring a velocity of v feet per second, is $a\times s=a\times(gt^2\div 2)=a\times(g\div 2)\times(v\div g)^2=a\times(v^2\div 2g)$.

As half of this is consumed in resisting the force of gravity, we have for the steam actually employed in producing the velocity, $(a\div 2)\times(v^2\div 2g)$.

The introduction beneath the piston of 10 cubic feet of steam, having a tension of 20 ℔s. per square foot, is equivalent to raising 20 ℔s. 10 feet high, or 40 ℔s. 5 feet high, or is equal to $20\times 10=200$ feet-pounds, whatever be the size of the piston. Hence, if we multiply the cubic feet of steam used by the pressure (b) of the steam per square foot, we shall have a correct measure of the mechanical effect, or power, expended in producing the velocity v. Representing this mechanical effect by B, we have $B=b\times(a\div 2)\times(v^2\div 2g)=(ab\div 2)\times(v^2\div 2g)=W\times(v^2\div 2g)=\frac{1}{2}[(W\div g)\times v^2]$.

This last expression measures the power required to produce the velocity v in a body whose weight is W, and consequently measures the power stored up in this body, when moving with the velocity v. This power the body will yield up when it is forced to come to rest.

In determining the unit of mass of a body, physicists have taken as the unit that body whose weight is 32.2 ℔s (or g). This choice was an arbitrary one, as any other might have been made just as well; the object of taking this peculiar value was to simplify the very result we have just obtained. If M represents the *mass* of a body, then $M=W\div g$. Substituting this above, we have $B=\frac{1}{2}Mv^2$. The product Mv^2 is called by physicists *vis viva* or living force. Hence we say the power stored up in a moving body is equal to one-half its *vis viva*.

AMERICAN ENGINEERS' ASSOCIATION.

[Reported for the Scientific American.]

On Wednesday evening, Dec. 26th, the regular weekly meeting of this association was held at its room, No. 24 Cooper Institute, this city—John. C. Merriam, Esq., President, *pro tem.*; Benj. Garvey, Esq., Secretary.

MISCELLANEOUS BUSINESS.

Carr's Low Water Detector.—Mr. A. Carr, of Jersey City, submitted to the association, for its opinion thereon, his patent low water detector. In its operation no alloys are used, and a new mode for the displacement of water is claimed. These points are considered by the inventor as very important ones. Mr. Carr, by the aid of a drawing, proceeded to explain the manner of its construction and the principles involved in its operation.

His remarks were listened to with considerable attention by the members present, after which his invention was referred to the Committee on Science and New Inventions. This committee, through its chairman, Mr. Louis Koch, then presented the subjoined report:—

Your committee having before it Roosevelt's "Anti-Friction Axle" and West's "Double-Acting, Anti-Freezing, Lifting and Forcing Pump," would respectfully submit their report on said inventions, based on a full and careful inspection and consideration, as follows:—

1. That in regard to Mr. Roosevelt's "Anti-Friction Axle," it is found that the principle being to insert an axis between a series of small rollers working between two plates, forming the sides and the rim of the wheel, your committee find that the area of friction presented by the grooved and tongued rollers, together with the bearing of the side plates, is greater than a common bearing would present, and that the stability of the wheel is less when dependent on such narrow limits as the model indicates would be allowed, than in a proportioned sized hub in a common bearing, and that in consequence of the friction rollers presenting so small a surface of bearing to the axis every tendency of side motion will necessarily increase the wear and tear of the small bearing of the side plates. In consequence of the above stated reasons, your committee are enabled to find properties in this invention, that would make it as valuable as a common axle bearing has been found to be.

2. That in relation to West's improved pump, it is found that, in regard to the claim consisting in a vent-hole over the suction piston, so that the water remaining in the pump immediately after use will flow away, it is the opinion of your committee that, though there is necessarily a small loss of water during the act of pumping through this hole, this inconvenience may be regarded of little consequence, the main object of non-freezing being secured, which is particularly of importance whenever the pump is of difficult access. Your committee also think the arrangement of two suction valves in the air chamber and in the bottom of the lower cylinder, respectively, is good, insuring a greater guarantee against choking. The committee have also been favorably impressed with the arrangement of the combined piston, working at the same time in an upper and lower cylinder, this latter being twice the size of the former, the quantity of water or liquid discharged being dependent on the diameter of the upper smaller cylinder and the length of the stroke, each piston being packed with overlapped expansion leather rings, the friction is always in proportion to the amount of work done, the suction piston being always under water when working, and the upper piston receiving a constant pressure from below, the action of the atmospheric pressure is counterbalanced; this is insured further by extending the exhaust pipes over and above the upper portion of the upper piston, whereby the chamber between the two pistons is kept full of liquid during the working of the pump.

Therefore your committee would respectfully recommend this pump to the favorable consideration of the society.

That part of the above report relating to Roosevelt's "Anti-Friction Axle" was, on motion, postponed to a subsequent meeting, to give an opportunity to members of discussing the principles claimed for it by the inventor. The portion referring to West's pump was then considered by the society. The inventor having kindly sent one of his pumps to the room of the Association, it was taken apart and the principles involved in its construction, together with the manner of its operation, were very clearly shown by Messrs. Koch, Simpson, Garvey and others.

The discussion that ensued did not present any new features; it only more strongly indorsed the pump in its adaptability to railroads, deep wells, decks of vessels, &c., &c., than did the report. A vote then being taken upon the acceptance of the report, it was unanimously adopted as the opinion of the society.

At this juncture, Mr. Garvey introduced to the notice of the members present, the pump styled the "Hydropult." By the aid of a drawing upon the blackboard, he very fully explained its construction and the principle upon which it operates. Although there was no extended discussion upon its merits, the sense of the meeting was adverse to its practicability. It was considered that the power required to work it was purely an exhausting one, in other words, it was a "dead pull." The amount of friction it prevented would compare unfavorably with the double-acting single cylinder pump. They thought it quite useful in washing windows, watering gardens, and even quenching small fires, but where much water or heavy work was required it could not be of efficient service.

The committee on accidents and their causes presented through their chairman, Mr. Merriam, the annexed report:—

The chairman, in company with Mr. G. E. Beach, a member of this committee, visited the steamer *Commonwealth* at her pier on the afternoon of the 19th, reported as having collapsed a flue at Hellgate. We found that she had opened a hole some twelve inches long above a row of rivets in her steam chimney or dome. On examining the plates we found them corroded at the seam so as to be but ⅓ of an inch thick. We account for this corrosion as follows:—The plates instead of being lapped so as to shed water are on the contrary so riveted as to arrest the particles of water at the seam, thus creating a constant rustling at that point. This is apparent from the fact that the iron ¾ of an inch above is as sound as possible.

Again, the chairman of the committee was upon a train coming from Philadelphia on Monday night last. Said train was delayed this side of Newark by the bursting of a tire on the main driver. Most fortunately the tire caught in such a manner as not to throw the engine off. On examining the break he found that the iron was very faulty, containing a flaw transversely of at least one-half the sectional area of the flange and tire.

This report was, on motion, accepted and placed upon file.

Letters in relation to late business before the society were read from Messrs. Ashcroft and Mead; they were referred to the appropriate committee.

SUBJECTS FOR FUTURE MEETINGS.

Mr. KOCH proposed for discussion on the evening of January 9th, "Scale upon Boilers."

Mr. GARVEY proposed for the evening of the 16th, "The Consideration of Cut-offs."

The meeting then adjourned.

Sugar.

The following, from the *Chemical News*, is an extract from a recent lecture on this interesting subject by Professor Lankester, of London, England:—

We find sugar more generally contained in the juices or the sap of plants than in any other form. Sugar has the remarkable property of fermentation, and it is during the process of this change of sugar that alcohol is produced, therefore you see we can make alcohol from starch, but we must first convert the starch into sugar, and I now call your attention to the chemical composition of sugar as being of the same kind as starch. I have here some sugar, and I will submit it to the action of a substance that will draw away the water, and leave the carbon to act freely. I first dissolve it in warm water, and will then pour upon it some sulphuric acid, and this will withdraw a sufficient quantity of water for you to see that the sugar contains a large quantity of charcoal. You see, now, what a large quantity of charcoal is developed from this sugar—there it is black, boiling, and hard from the action of the sulphuric acid. It is thus that we can demonstrate the presence of the charcoal, and in this way that very useful material which we call blacking is manufactured. A quantity of sugar is taken and sulphuric acid is added, and you see in what a shining state the carbon is left when it has been submitted to this process. In this way you see we can prove that the starch contains the same material.

Let me now call your attention to the history of the plant in relation to the sugar. During the germination of plants sugar occurs in great quantities. If we throw these seeds into the ground, the little embryo in the interior grows, and that process is called germination. There is a large quantity of starch surrounding this little embryo, and as it grows the starch is converted into sugar, and this starch is as necessary for young plants as it is for young children. Now this is the case, on a very large scale, in the process of malting. The maltster takes his barley, immerses it in water, causes the seed to germinate, and then he roasts the young plant, seizing the sugar which it has just made, and converts it into beer. Then again we find the stems of plants in certain seasons of the year contain large quantities of sugar; thus, the whole of the grasses, wheat, barley, oats, rye, rice, and maize, contain sugar in their stems when they are about to flower; and it is just at this season of its development that the sugar-cane is used by man as an article of diet. We need not, however, confine ourselves at all to the sugar-cane. The only reason why we get sugar from nothing else arises out of our fiscal system, revenue being obtained from it, and sugar not being allowed to be grown in this country. In China they obtain sugar from the *Sorghum saccharatum*, which, like the sugar-cane, belongs to the family of grasses, and is cultivated in the North of China for the sugar it contains. Then the maize has been cultivated in America and Mexico for the purpose of obtaining sugar. When Cortes conquered Mexico he found the natives cultivating the maize and crushing it for sugar. The cocoa-nut tree of the island of Ceylon is a principal source of sugar, and there are a class of men whose occupation it is to ascend these trees and put on the blossoms of the tree a calabash to catch the exuding juice, which is an article of diet known in Ceylon as toddy, the men being called toddy-drawers. Again, at the budding season, the sap of plants contains sugar. The common osier has it. The birch, too, in England and Scotland is tapped for its sugar, and is converted in Scotland into an effervescing wine, exactly like champagne. In America there is a plant which contains so large a quantity of sugar that I think a third of the sugar consumed in the United States is obtained from it. It is the maple. Then the beet-root, the carrot, and the turnip contain sugar. When Napoleon Bonaparte excluded cane sugar from the French markets, they set to work to supply the loss, and adopted a German process, which resulted in the production of a very successful sugar from the beet-root and now, after years of production, sugar manufacturers are enabled to compete with the manufacturers of sugar from the sugar-cane. There is also another source of sugar in the fruit which we eat,—the fig, the pear, the apple and the orange, would be unpalatable but for their sugar.

I will now draw your attention to the different kinds of sugar. Although sugar is always sweet, and we call everything that is sweet sugar, yet there are various kinds of sugar. Sugar is obtained from milk; and we can, by taking the livers of animals and digesting them in water, obtain large quantities of sugar called liver-sugar, showing that animals have the power of producing or secreting sugar. Thus we have several kinds, and I would just call your attention to the four principal sources.

The cane sugar is found in the stems of plants, and in all those cases where it is procured before the flowering of plants, and in the roots of plants; so that the beet-root sugar and the ordinary sugar that we eat from day to day is cane sugar. But we obtain another sugar from fruit, which is uncrystallizable; and that fruit sugar is almost identical with another, which is called starch sugar; and fruit sugar and starch sugar are both known to chemists by the name of Glucose. The cane sugar is called Sucrose, and the sugar obtained from milk is called Lactose, while liver sugar is called Hepatose. Those are the four sugars. I told you just now that the liver contains a quantity of sugar; I may say that I believe it has been demonstrated that the liver does not contain sugar itself, but a matter which is easily converted into sugar; so that the instant you expose it to the air it becomes converted into sugar. We have in glucose a substance much more easily decomposed than the other forms of sugar; and I will finish by stating that this cane sugar is converted into this form of sugar, and then we have either glucose, lactose, or hepatose in the system. It is in that manner that the starch is converted into sugar, so that it becomes a heat-giving substance capable of maintaining heat in the animal body.

The Needle Women of London.

A correspondent of the London *Times*, describing one of the great mantua-making establishments in that city, communicates the following facts:—

Work is commenced every morning at 7 o'clock and continued till 11 at night—a period of sixteen hours, the only intervals allowed being about ten minutes for each meal; the total amount of time allowed for—eating their food, I was going to say, but, surely, "bolting" it is the more appropreate phrase—being forty minutes per day; thus leaving fifteen hours and twenty minutes as the period devoted to work. And this, be it remembered, is not merely during the busy season, as at the West End, but for all the year round, from January to December; for you must understand that, at the establishment to which I refer, the greater part of the sewing is given out to slop-workers in the busy season, and all that is done indoors is the original cutting out and ultimate fitting together of the separate pieces; but when the slack season comes, there is always as much sewing reserved as will keep the girls of the establishment employed up to the full pitch—so that there is, in fact, no "slack season" at all for them. And yet, for this continued and unrelenting pressure of sixteen hours' work per day, from year's end to year's end, this firm assume to themselves the greatest possible credit. They thank God that they are not as other firms are at the West End—oppressors and destroyers of young women. They never—not even for a few weeks in the busy season—make their people sit up till 3 or 4 o'clock in the morning! Oh, no!—their gas is always turned off in the workroom by 11 o'clock. Why, sir, the West End system, with its few weeks of severity, followed as it is by months of comparative leisure, is mercy itself, when viewed alongside of this unmitigated, "never-ending, still-beginning" slavery to which I am referring.

The only day of leisure which the girls of this establishment have is Sunday. From Monday morning to Saturday night, they are as complete prisoners as any in Newgate. They know not whether the sun shines or the rain falls at that time. They are not allowed to cross the threshhold even to purchase a pair of shoes or a new gown for themselves, and must employ their friends outside to do this for them.

Nor is the accommodation indoors such as in any way to reconcile them to this close confinement. The workroom, in which ten or twelve of them are employed, is only about twelve feet square, and is entirely devoid of arrangements for ventilation, which is the more to be deplored as, during the evening, they have to encounter the heat and foul air of three flaming gas burners right over their heads, every door and window being shut by which a breath of pure air could possibly enter. The bedrooms are equally uncomfortable, no fewer than six persons being huddled into one and four into another.

It is impossible to contemplate the condition of this class of workwomen, as disclosed by the facts quoted, without keenly sympathizing with it, and wishing that something might be done to mitigate its evils and misery.

A Drunkard's Brain.—Hyrti, by far the greatest anatomist of the age, used to say that he could distinguish in the darkest room, by one stroke of the scalpel, the brain of the inebriate from that of the person who lived soberly. Now and then he would congratulate his class upon the possession of a drunkard's brain, admirably fitted, from its hardness and more complete preservation, for the purpose of demonstration. When the anatomist wishes to preserve a human brain for any length of time, he effects that object by keeping that organ in a vessel of alcohol. From a soft, pulpy substance, it then becomes comparatively hard; but the inebriate, anticipating the anatomist, begins the indurating process before death—begins it while the brain remains the consecrated temple of the soul—while its delicate and gossamer-like tissues still throb with the pulse of heaven-born life. Strange infatuation, thus to desecrate the god-like! Terrible enchantment, that dries up all the fountains of generous feelings, petrifies all the tender humanities and sweet charities of life, leaving only a brain of lead and a heart of stone.

To Clarify Oil for Rifle Gun Locks.—Fill a phial three parts with almond oil, then fill up the remainder with clean lead chips. Keep the phial in a warm room and shake it now and then for a month, at the end of which time most of the mucilage and acid naturally in the oil will have combined with the lead, and thus be clarified and fit for lubricating gun locks and other similar work. The lead is easily procured in chips by cutting up with a knife a couple of elongated bullets.

FOREIGN SCIENTIFIC INTELLIGENCE.

[Translated for the Scientific American.]

COAL OIL FOR PAINTING.

The products of the distillation of coal, and especially of coal tar, seem destined to rival india-rubber in the variety of their applications. *L'Invention* describes an invention of Mr. Mallet for rendering the heavy oils derived from coal applicable to painting. The invention consists in dissolving resinous or gum-resinous substances in the oils. The oil is heated in a boiler and resins are added in various proportions from 50 to 100 per cent of the oil. The solution is filtered through a woolen strainer to separate all solid matters, and is either employed directly as a coating for wood, metal and other surfaces, or ordinary coloring matters are ground in it in the usual manner. These oils of coal tar have, in the crude state a very deep brown tint, which would injure the tone of most colors. This inconvenience is, however, remedied to a considerable extent, by purifying the oils by any known process. The quality of the resins also influences the tint of the paintings, and it is necessary for certain tones to employ the qualities of which the shades are the least deep.

These paintings, or the resinous solutions alone, may be used not only on wood, but also on stones, on the coatings of mortar and plaster, and especially on tiles, flower pots, metals, and articles of basket work. Detached objects may be covered by immersing them. These resinous solutions may also be applied to render linen impermeable. In this case the quantity of resin should be small; a twentieth part being sometimes sufficient. To give more suppleness to the solution a small quantity of india-rubber may be added; it readily dissolves in the oil. Two or three coats of these paintings leave a varnish on the surfaces covered with them.

BLEACHING OF PAPER PULP.

The *Annales des Mines* states that Messrs. Firmin-Didot and Barruel, in their experiments on the bleaching of paper pulp by the chloride of lime, have learned that this bleaching may be effected by means of carbonic acid. The carbonic acid gas is introduced into the liquid which contains the chloride and the matter to be bleached; it displaces the hypochloric acid. The generator of carbonic acid may be a furnace; the gas in this case being purified. It passes through three washing reservoirs in part filled with water, a refrigerator, and a purifier provided interiorly with a lattice work of osier covered with wool and with damp moss to arrest all the dust. Beyond this purifier is an air pump, which, after having drawn the gas through the preceding apparatus sends it through a last washer into a supply tube. Pipes, furnished with stop-cocks, lead from this tube, each of them communicating with a worm pierced with holes and placed at the bottom of the bleaching tubs. The carbonic acid is thus distributed as needed, in the same manner as steam is distributed.

THE PRESERVATION OF MEAT BY MOLASSES.

In many receipts for preserving hams, molasses is one of the principal ingredients, but Mr. Margueritte, in an article in *L'Invention*, asserts that meat may be preserved by molasses alone in the most perfect manner, and with the following important advantages: It has an agreeable flavor, it produces no scurvy or other disorders which result from the use of salt food, and it may be prepared at a moderate price.

The process consists simply in cutting the meat into pieces of moderate size and dropping them into molasses, such as is obtained from the sugar manufactories or refineries. By a natural process of osmose the lighter juices of the meat pass out, and the heavier molasses penetrates inward to every part of the meat. When the external molasses has acquired a certain degree of liquidity from the mixture of the juices of the meat, it is a sure sign that the meat is thoroughly impregnated. It is now taken out of the molasses, thoroughly washed, and hung in a current of air to dry. After it is completely dry, it may be packed in boxes and sent all over the world without experiencing any change whatever.

NEW ALLOY FOR SOFT SOLDER.

We find in *L'Invention* directions for preparing an alloy for a very soft solder, which that journal says has the following very valuable properties. It attaches itself very strongly, not only to metallic substances, but also to glass and porcelain; at a temperature of 700° Fah. it is as soft as wax, but in ten or twelve hours it becomes so hard as to take a polish like