THE OBSTRUCTION TO THE NAVIGATION OF RIVERS CAUSED BY THE PIERS OF BRIDGES.

BY J. W. SPRAGUE.

Before proceeding to the discussion, to which this article will be principally devoted, for the sake of comparing the method usually adopted for determining the hight of *remou* with that recommended in this series, I will here give D'Aubuisson's formula:—

$$x = Q^2 \div 2g\,[\,(1 \div m^2\,l^2\,h^2) - 1 \div L^2\,(h+x)^2]$$

where x is the value of the hight of *remou*; m a variable co-efficient; and the other quantities are constants to be determined for each particular case. It will be observed that x enters both sides of the equation, and that on one side its square is in the denominator. Hence, to obtain an expression for the value of x, in which its own value does not enter, requires the solution of a complicated equation of the third degree. D'Aubuisson recommends, instead of this, the introduction of experimental values for x into both sides of the equation, until one is found which will fulfill its requirements; which is, in fact, a solution of the equation by gradually *approximating* to the value of x. Whoever attempts this will find himself involved in a labyrinth of figures, from which he will gladly escape to the more simple and *more accurate* method I have indicated.

In the suit alluded to in the first article of this series, a distinguished engineer quotes D'Aubuisson's formula as above, and states that for a certain stage of water the velocity will be increased from 5.9 feet per second to 6.36 feet per second, and the corresponding hight of *remou* will be 2½ inches. This value of the hight of *remou* is more than twice as great as is required to produce such a change. Inconsistencies like this, between the changes of velocity and hight of *remou*, which are extremely liable to creep into investigations made under such complicated formulæ, are entirely guarded against in the method now recommended. The change in velocity and hight of *remou* being made to depend directly upon each other, both being arrived at by a short series of easy approximations, each acts as a check on the other, and renders error in calculation almost impossible to escape detection. There are some circumstances influencing the results already given which I do not deem it necessary to describe, because their influence is so small that it would not materially affect the result, in such cases as generally occur, while to treat them in detail would crowd out more important matter. One other element affecting the value of the hight of *remou*, I had intended to discuss, but have since concluded merely to make this illusion to it, thinking that any engineer competent to carry on investigations to that degree of refinement, implied by the introduction of this element into the investigation, would himself readily see how it was to be introduced. The element to which I allude is the effect of the water impinging upon the starling of the pier, and causing a loss of head by impact, to regain which would require an increase in the hight of *remou*.

Having indicated the method of determining the increase of velocity between the piers, and the hight of *remou* or back-water, we now pass on to another branch of the subject—the actual obstruction offered to the ascent of a steamboat through the draw. It is evident that when the boat is in the draw, the water-way of the river will suffer an additional contraction, equal to the greatest cross section of the submerged portion of the boat. This additional contraction of the water-way will cause an increase in the velocity between the piers, and an increased hight of *remou*. Hence, in determining the maximum values of velocity and hight of *remou*, we must add to the cross section of the submerged portion of the piers and abutments, the greatest cross section of the submerged portion of the largest boat liable to attempt the passage of the draw—that is, the boat is to be treated as if it were an immovable floating pier.

We have now determined the greatest velocity and hight of *remou* which can oppose the passage of a steamboat. What is the measure of the obstruction offered to the passage of an ascending boat? Is it the velocity of the water in the draw? I answer: *the velocity of the current passing through the draw is no criterion whatever of the obstruction to navigation caused by the intervention of the draw*. In a subsequent article it will be shown that of two draws, constructed precisely alike, both having the lines of their piers parallel to the current, it may require *less power* for any boat to ascend through one of them, where the velocity is *six* miles per hour than for the same boat to ascend through the other, where the velocity is *one* mile less or *five* miles per hour.

The true key to the solution of the problem is this:—Is the velocity of the current one that is *increasing* at the point where it is to be resisted; or is the current moving on *uniformly* with a velocity acquired at some point above? Where the longitudinal surface of a river is horizontal, or in other words, where the velocity of the current is uniform, having been acquired at some point above, the measure of the resistance offered to an ascending boat may be taken as the velocity of the boat plus the velocity of the current. Hence, if a boat ascends at the rate of five miles an hour against a current of three miles an hour, the power expended in propelling it is the same as would be required to move it at the rate of eight miles per hour in still water.

It is evident that the surface of the water above the piers is higher than the surface of the water between the piers, and that this difference in level is measured by b, the hight of *remou*. A boat in ascending the draw must then, besides resisting the current, lift itself from the lower to the upper level. This rising of the boat takes place gradually, not abruptly; hence we may compare the ascent to one up an inclined plane whose hight is b. What is the length of the inclined plane up which the boat ascends? Let a represent the horizontal distance within which the surface of the water passes from the upper to the lower level; then $b \div a$ represents the tangent of the angle which the inclined surface makes with the horizontal, and measures the steepness of the inclined plane formed by the water. If the boat could be regarded as a material point, then as it moved upon the surface of the water it would follow every undulation of the surface, and $b \div a$ would measure the steepness of its ascent from the lower to the upper level. But we cannot regard the boat as a material point; we cannot neglect its length. When the bow of an upward-bound boat is at the *foot* of the inclined surface of the water, then the whole boat is floating in the lower level, and is just on the point of commencing the ascent to the upper level. When the stern of an upward-bound boat is at the *head* of the inclined surface of the water, then the whole boat has just completed the ascent to the upper level. Is it a violent supposition to consider that an uniform ascent between these two points is equivalent to the actual ascent? Granting this, and representing the length of the boat by l; then $l + a$ will represent the horizontal distance passed over in making the ascent, b, and $b \div (l + a)$ will represent the inclination of the plane up which the ascent has been made. The quantity, a, is however so inconsiderable, when compared with l, that the difference between $b \div (l + a)$ and $b \div l$ will not be of material consequence. Hence if we *divide the hight of the remou in feet, by the length of the boat in feet, the quotient will give the tangent of the angle, which the line of ascent of the boat makes with the horizontal.*

If, as before, v represent the velocity of the current above the piers, and V the velocity between the piers, then a boat, in ascending the inclined plane of the *remou*, passes from water whose velocity is V into water whose velocity is v. Taking the arithmetic mean of these two, as the equivalent mean velocity of the water through which the ascent is made, and representing it by v^o, we have $v^o = (V + v) \div 2$.

The condition of the boat is then reduced to this: in moving its own length (l) it ascends the height of the *remou* (b), through a current whose velocity is v^o. They who measure the power required to ascend through a draw, by the power required to resist a horizontal current V, plus the power required to lift the boat vertically from the lower to the upper level, greatly underrate the real power.

[To be continued.]

THE SHEATHING OF SHIPS.

We pay to England, annually, $111,698 for copper and $183,394 for brass sheathing; and as one or the other is employed on all our ships and steamers, useful information relating to the subject is of interest to our shipbuilders and merchants. In recent numbers of the London *Mechanics' Magazine*, we find a history of the applications and patents granted for ships' sheathing. It stated that, as far back as the reign of Edward the III.—in 1336—several compositions containing pitch, tar, sulphur and oil were employed for coating the hulls of ships to prevent the attack of sea worms and the adherance of barnacles and sea weeds. It was also a common practice to use a thin planking, secured by nails, over the main planking, in those olden times. In 1625, a patent was granted to one William Beale, in England, for a composition not described, but the object of which was to render the hull and rigging incombustible. In 1670, a patent was granted to Sir Philip Howard and Francis Watson, for sheathing ships with milled lead. These inventors state that they had discovered they could draw out lead into thin sheets by passing it between rollers, which was a very valuable invention. After this, many of the English ships were sheathed with thin lead fastened by copper nails, and it continued in moderate use for about a century. It was better than nothing, but was too soft for the purpose. In 1727, Benjamin Robinson and Francis Hanksbee obtained a patent for sheathing ships either with thin copper, brass, tin or iron plates. This was the first application of brass and copper to the purpose; but it was not until 1761 that copper sheathing was applied to any war vessel. In that year, the *Alarm* (a 32-gun frigate) was sheathed with this metal, and she soon afterwards made a voyage to the West Indies—the very place to test the sheathing completely. Upon her return to England, the metal was found clean, and as good as when it was put on; but the iron straps of the rudder were rusted almost entirely off, and when some of the copper sheets were removed for examination, the naval authorities were surprised and alarmed to witness all the iron fastenings corroded to a dangerous extent. To prevent this in other vessels which were afterwards coppered, the holes at the outer ends of the iron bolts were filled with pitch, and over these pieces of canvas were laid, then the copper on the top; and the rudder braces were covered with lead. These measures all failed to prevent considerable deterioration of the iron fastenings when copper sheathing was used, and it therefore became a question whether to use some other fastenings than iron, or else give up the use of copper sheathing. The former course was adopted, and brass and copper bolts were employed in 1783. The reason why the iron fastenings corroded so rapidly, in connection with the copper, was unknown in those days; but since the discovery of the galvanic battery, the cause has been obvious to scientific men. A simple galvanic battery is composed of two plates of different metals (the one more oxydizable than the other), and when they come in contact with moisture, such as sea-water, a galvanic action at once ensues, at the expense of the rapid destruction of the positive or most oxydizable metal. Iron-fastened and copper-sheathed ships generate galvanic action when the two metals are connected, and, as a consequence, the most oxydizable metal (the iron) corrodes rapidly.

The green oxyd formed on copper sheathing is a benefit rather than an injury, because, although it is a sign of slight decay in the metal, the oxyd prevents the adhesion of barnacles because it is very poisonous. The copper of ships may be kept perfectly bright by connecting it with small plates of zinc; the latter are decomposed and the former remains perfect. This was a discovery of Sir Humphrey Davy; and it was supposed that by it the copper of a vessel might be made to last forever, with only the expense of some zinc plates. Such hopes, however, proved fallacious.

An important question arises, namely, what is the best metal, as a whole, for sheathing ships? Copper possesses the advantage that, no matter how old it may be, the sheets will sell for only about five cents less per pound than when new. On the other hand, it is not very durable, while it is very dear. By experience, it has been found that the purest copper sheets decay most rapidly; some of the sheets will wear into holes in one year, while sheets of alloys endure much longer. In 1800, M. Collins secured a patent in England for alloys to make sheathing more durable. These consisted, first, of 8 parts of copper and 1 of zinc, which could be rolled cold; the second consisted of 180 of copper and 80 of zinc, which required a low red heat to work; and a third was composed of 16 of tin, 16 of zinc and 1 of copper. In 1817, he obtained another patent for a bronze sheathing, composed of 80 of copper and 20 of tin. In 1823, John Revere secured a patent for a brass sheathing composed of 95 of zinc and 5 of copper. Subsequent to this (in 1832), the Muntz metal was patented, which is simply a brass sheathing composed of copper and zinc, and had been previously patented by Collins, but, for all this, it made a fortune to Mr. Muntz.

His proportions were about equal weights of copper and zinc; but he preferred an alloy of 60 of copper and 40 of zinc, which is like the second alloy of Mr. Collins, patented in 1800. A very small portion of zinc, tin or iron, mixed with copper, for sheathing, renders it far more durable.

THE PRESENCE OF SILVER IN THE WATERS OF THE SEA.

[Translated expressly for the Scientific American.]

We believe that we shall interest our readers by extracting from a paper, read before the Academy of Sciences, the following interesting historical details relative to the ascertaining of the fact of the presence of silver in the waters of the sea. This interesting discovery was made, according to Mr. Chevreul, more than 70 years ago, having been, if not perfected, at least indicated as probable by Proust. In support of this assertion, the following letter is cited, written on April 4, 1787, by that learned chemist, from Madrid, and addressed to La Metherie, who published it in the *Journal de Physique*, of the same year:—

Of the Action of the Waters of the Sea on Silver.—If the bed on which the waters of the ocean repose should one day become habitable land, the men who will then traverse that new continent will, without doubt, begin to recover those immense treasures which the voracity of the seas have ceaselessly swallowed ever since the New World has been frequented from the Old. The wrecking of the vessel, *Le Saint-Pierre d' Alcantarra*, on the coast of Portugal, has just put us in position to predict the metamorphosis under which silver will show itself in the times to come Marine acid—that first element of the saltness of the sea—overcoming the attraction which fixes it to its base, will have changed that metal into a mine of horn silver (chloride of silver). The short space of time in which the money was under the water after the wreck until it was recovered, sufficed to alter the surface of the coins to the depth of a quarter of a line. On being taken from the water they were found to be covered with a black film, which came off in scales, and which I have recognized as horn silver.

In another note of a little later date, published in 1799, in the *Journal de Physique*, we find the following passage relating principally to the indications of mercury in the waters of the sea and in sea salt:—

If some one, after reading this, will take the trouble to observe whether the copper sheathing of a new vessel becomes silvered in any part, especially when it goes to sea for the first time; if he will furthermore suspend a plate of gold in the water and observe the changes in it, he may be able, perhaps, on his return, to furnish one fact more to the natural history of marine salt. Who knows that the destruction of sheathings (sometimes so rapid and the cause of which is so unknown) may not depend on the existence of mercury being more abundant in certain seas than in others?

Such was the state of the question when, some years after, Messrs. Malaguti, Durocher & Sarzeau, by a series of the most interesting experiments, proved the existence of chloride of silver in the waters of the ocean. A short time after, a more distinguished *savant* (Mr. Forchammer, of Copenhagen) confirmed the fact in regard to the waters of the Baltic.

It would seem to result from the citations above, that Proust concluded, not that silver exists in solution in the ocean, but that silver cast to the bottom of the sea (by wrecked ships) is not preserved in the metallic state, but passes to the state of chloride of silver soluble in chloride of sodium, and that if the bottom of the sea should ever rise and become a continent, the precious metal would be recovered in the form of that ore. Furthermore, it will be understood that the quantity of silver dissolved in marine waters from the ingots or coins lost in wrecks would be too small, considering the great extent of the seas, to be perceptible. It was from an entirely different point of view that Messrs. Malaguti, Durocher and Sarzeau commenced their researches; the diffusion of silver in metallic minerals being a fact well established, these learned men thought that this metal ought also to be found in the waters of the sea. By multiplied experiments they have fully proved its presence in the waters of the ocean, and they have even succeeded in determining approximately the quantity, which amounts to about the one-thousandth part of a pound of silver in 100,000 lbs. of water. They have also detected the existence of a small quantity of silver in a sample of rock salt taken from the mines of the department of La Meurthe, where it constitutes, as is well known, a marine deposit formed in regular beds intercalated in marl; which leaves no doubt in the minds of these chemists that silver existed in ancient seas as well as in those of the present day.

It is, then, to causes inherent in the physical elements of the globe, and wholly independent of the existence of man, that the introduction of silver into the waters of the globe is to be attributed. Messrs. Maluguti and Durocher have pointed out two sources from which it may have come—one the emanations of the chloride of silver coming from the bosom of the earth, or more simply, by the slow action which salt water exercises on the argentiferous sulphurets of existing formations, either at the surface of continents or at the bottom of the sea.

We shall terminate this curious historical sketch by informing our readers of the experiments made in connection with this subject (during the last year) by Mr. Tuld, who, by repeating in America the experiments of Messrs. Malaguti, Durocher and Sarzeau, has confirmed in a very interesting manner the fact established several years ago by these chemists. Considering the reductive action which a plate of copper exercises on chloride of silver dissolved in chloride of sodium, Mr. Tuld thought that the copper and brass used in protecting vessels which have been some time in the sea, ought to contain silver. On examining a piece of copper sheathing taken from a ship which had cruised seven years in the Pacific Ocean, he found it so friable that it could be pulverized between the fingers. It contained more than a half per cent of silver. Another experiment was made on two specimens of copper sheathing, one of which had been used three years in the Pacific Ocean, while the other had never been in salt water. The former contained eight times more silver than the latter.

In a word, the silver contained in solution in the waters of the sea represents a mass more considerable than that which has been extracted by man since the origin of the actual epoch from the bosom of the earth! Mr. Tuld comes to the conclusion that the ocean contains at least 2,000,000 tuns of silver. What able chemist will find the practical means of extracting this enormous mass of treasure?—*L'Invention*.

ADULTERATION OF WINES.

Many people seem to doubt the extent to which wines and liquors are adulterated. The following cool letter, which we have just received from Indiana, may help to open their eyes. That liquors may be made by mixing oils with alcohol which will produce the same effect as genuine fruit brandy, we have no doubt is erroneous. Saratoga water may be analyzed and all the substances discovered in it by chemical tests may then be mixed together, and a liquid produced resembling the genuine, but all physicians know that the effect of this factitious stuff on the human system is entirely different from that of the real Congress water. The same principle holds in factitious liquors. The proof and the flavor may be closely copied, but the subtle and mysterious influence upon the stomach, nerves and other viscera is entirely different, the pure juice of the grape or current being healthful in many cases, while the mixed drugs are simply liquid death.

Messrs. Editors:—The subject which I desire to bring before you is the fabrication of wines. My invention is founded on a quantitative and qualitative chemical analysis of natural wines, and consists in the fabrication of all kinds of wines, red or white, of whatsoever quality and in any quantity to suit, from pure vegetable ingredients representing the constituents of the grape-juice. The wines by this method, are made both without grapes and without fermentation; merely from mixing the ingredients, and after the short time of only 12 or 24 hours, a clear, sound wine, of a natural taste and flavor, is formed, improving more and more by age, so that wines made according to my method, after long keeping, have been mistaken for natural wines by good judges. The manufacture of wines by this method will pay large profits on the capital invested, as the cost of one gallon amounts to 25 cents only. According to my method, one acre of a single vineyard will produce as many gallons of wine as one vineyard of 40 acres will produce in the ordinary way.

A wine is wanting whose price would be within the means of all—a sound and pure table drink, to relish our dinners, enliven our too low spirits, help gently our poor digestion, correct our sour stomachs, expel the evil humors of our blood, and abate the whisky plague in our land. A continent without wine cannot but be a drunken continent! Please let me know (either by letter or through the journal) your opinion, of what has already been done in the matter under consideration, and oblige me by giving your advice accordingly. A. S.

Hankstadt, Ind., March 26, 1860.

CAN PARTICLES OF MATTER BE INHALED INTO THE LUNGS?

Messrs. Editors:—The possibility of the inhalation of matter by the lungs is denied by some with plausibility. It is said that Claude Bernard made some experiments to determine this—that he tied a bladder containing a quantity of powdered charcoal about the nose of a rabbit. Except during feeding, the bladder was kept constantly on for several days, and when the rabbit was killed and opened no powder was found in the lungs or bronchial tubes; the *cilia* (which protect the lungs of all animals) having acted as a strainer to keep all particles from the air tubes. Is this statement correct? if so, many have a wrong idea of the subject. I take the account substantially from an article on "Animal Life," published in the *Cornhill Magazine*. E. T. C.

Philadelphia, Pa., March 26, 1860.

[We consider the *Cornhill Magazine* in error and the statement about Bernard of little or no value in comparison with other well-known facts which have never been disputed. Take the case of coal miners, for example. Some of them are troubled with what is called the "black spit" when they become old, and this usually ends fatally. The lungs of several who have died from this disease have been dissected and found perfectly black in color, and containing a substance similar to coal tar, which could only get in by being inhaled in very minute floating particles. Take the cases of stone-cutters and tool-grinders also, and we find testimony going to prove that many of them die by inhaling fine stone dust. It is well-known that the dry grinders of tools are very unhealthy; they die early of lung disease. Did they not inhale particles of matter, such as fine dust, we see no reason why they should not be as healthy as other men. We were recently informed of the case of a dry grinder of tools who died suddenly in a factory not many miles from this city, and when his lungs were dissected they were found entirely coated with stone dust and particles of iron. We had the information from one who was conversant with all the circumstances.

It puzzles us to conceive how the poor rabbit of Claude Bernard could live two or three days with its nose tied in a bladder. How could it breath at all?

STEAM FIRE-ENGINES.

Messrs. Editors:—Here in Louisville we have disbanded the old companies of hand engines; we have five steam fire-engines of Cincinnati manufacture, I believe, and the wonderful change to the citizens is highly agreeable. The loss by fire is trifling compared to former times. Besides the saving of property and expense to the city, there is also the great luxury of resting after retiring to bed. Fires now seldom take place, and when they do, instead of the great noise and confusion usually attending them, everything is conducted quietly and with dispatch. When the alarm is given, the fuel is lighted, two horses in the meantime being attached to the engine (these operations occupying but four minutes), and the machine is driven through the streets with as much ease as a private carriage. When arrived at the fire, steam is up, and the engine ready for operation. The result is a quick extinguishment of the flames. Thus is seen the importance of small machines; but little time is required to get them on the spot, and when there they can be handled with ease—can be taken to alleys and back places, which it would be impossible to do with larger machines. There is not a town or city but would save a large amount of property by using small steam fire-engines. I trust the time is not far off when these kind of machines will come into general use. G. V. B.

Louisville, Ky., March 28, 1860.

BELTS FOR DRIVING MACHINERY.

Messrs. Editors:—On page 150 of the present volume of the Scientific American, in an article bearing the above caption, Mr. W Barbour (of Lawrence, Mass.) gives a table of the power, width, &c., of belts (a very useful table for all persons interested in machinery), with a promise to extend the table at a future period to 30 inch belts. From Mr. Barbour's long experience, I conclude he has fully tested the relative merits of leather and rubber belting, and my main object in writing this note is to request him to give his experience on this subject. Which is the cheapest kind of belting in the end? Inquirer.

Memphis, Tenn., March 29, 1860.