A few practical trials will soon set matters right in this respect, under the supervision of an intelligent manager, who who ought to know how to approximate his dose of lime to the quality of the juice he is working.

An excess of lime being detrimental to the economical production of sugar, considerable nicety of judgment and practical experience are required in order to determine the proportion of this substance which ought to be employed; a quantity which varies according to many circumstances, the scientific discussion of which is impossible in the pages of this journal.

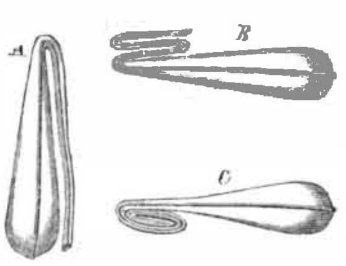
THE SCUMS OF DEFECATION.

The scums formed during the process of defecation of the beet root juice being rich in saccharine matter must be made to give up as much of their valuable contents as possible. For this purpose they are collected in a special reservoir provided with a wide-mouthed faucet, through which they are filled into sacks. These sacks, made of a strong, close-woven tissue of raw flax, are laid to drip in special tanks, where about two-thirds of the included juice is run out of them in the space of a few minutes. They are then submitted to the action of powerful presses.

The liquid obtained from the presses and tanks is taken directly to a *monte-jus*, from whence it is conveyed to the carbonatation pans, while the juice from the reservoir is best passed through a small quantity of grained bone-black, covered with a loose permeable cloth, before being run into the same *monte-jus*.

Scums are worked while hot from the defecating pans, and must never be allowed to cool before they are pressed.

As the contents of the scum sacks is of a slimy, slippery nature, which would work its way out during the pressing without certain precautions, it is necessary to fold them in a different manner from what we indicated in speaking of the pulp sacks.



As soon as a sack has received its contents, a smart shake is given to it so as to collect the scum at the bottom, it is then folded through the middle, as seen in Fig. A, and laid on a table, where it is further folded, as is shown in Fig. B, after which the whole folded portion is tucked underneath, as in Fig. C. It is then ready to be placed between two sheet-iron trays, or in some cases mattings, and taken to the presses.

The "dead" scums constitute a very valuable fertilizer, rich in nitrogen and lime, and is hoarded with care until needed for use in the fields or for sale to the farmer.

The specifications for the "scum" department of a factory for working 150,000 lbs. of beet every twenty-four hours are as follows:

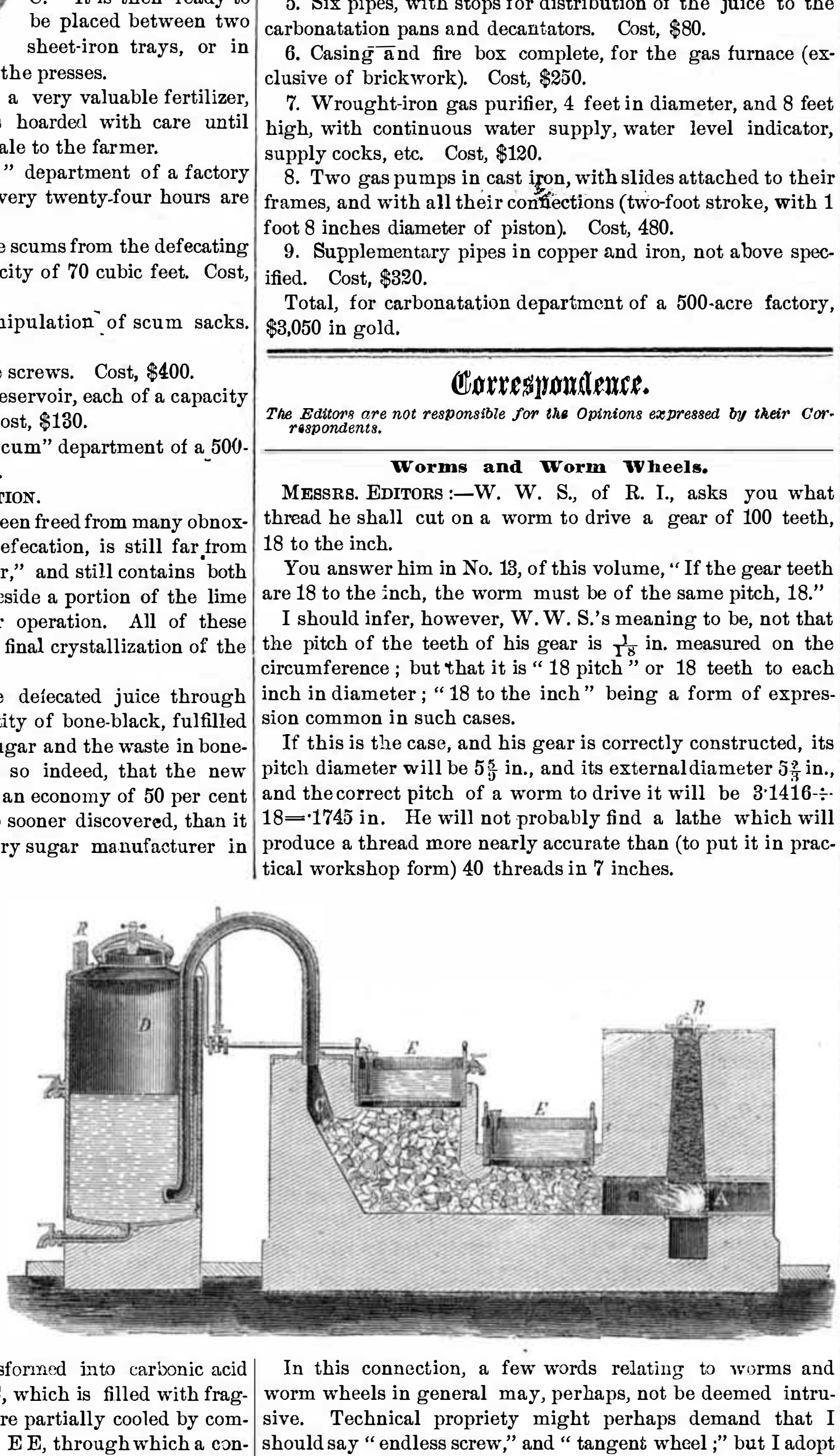
1. One reservoir for receiving the scums from the defecating pans, with large faucet, and a capacity of 70 cubic feet. Cost, $60.
2. Two cast-iron tables for manipulation of scum sacks. Cost, $50.
3. Two iron presses, with bronze screws. Cost, $400.
4. One *monte jus* and its special reservoir, each of a capacity of 80 cubic feet, for scum juice. Cost, $130.

The total cost, in gold, of the "scum" department of a 500-acre factory would be $640 in gold.

CARBONATATION.

The beet root juice, after it has been freed from many obnoxious substances by the process of defecation, is still far from constituting pure "sugar and water," and still contains both organic and inorganic matter, beside a portion of the lime which has been used in the former operation. All of these are more or less detrimental to the final crystallization of the sugar and must now be got rid of.

By the old methods, passing the defecated juice through filters charged with a large quantity of bone-black, fulfilled the desired result, but the loss in sugar and the waste in bone-black were considerable; so much so indeed, that the new process of carbonatation (by which an economy of 50 per cent of bone-black was effected) was no sooner discovered, than it was adopted without delay, by every sugar manufacturer in Europe.



Carbonatation consists in the saturation of the defecated beet root juice by means of carbonic acid gas.

The cheap production of this gas is effected in many different ways, one of which we shall here describe as the simplest and easiest to put in practice.

A furnace, of which the figure annexed is a section, fulfills our purpose:

The cover, B, on the top of the furnace, is for the introduction of charcoal, which falls on the grate, A, and spreads itself in the neighboring empty space. Air is admitted through A, which, after favoring the combustion of the coal, and having been partly transformed into carbonic acid gas, penetrates into the chamber, C, which is filled with fragments of limestone. The gas is here partially cooled by coming in contact with the water pans, E E, through which a continuous stream of cold water is allowed to flow. From C the gas next passes into the receiver, D, where it is washed and purified by being passed through pure water or through water in which a small amount of soda has been dissolved. R is a pipe through which a double-acting air pump draws the gas out of the receiver, D, and forces it into the liquid to be charged. The same suction causes the necessary draft for sustaining the combustion of the charcoal at A.

During the combustion of charcoal, 6 lbs. of pure carbon, combine with 16 lbs. of oxygen to form 22 lbs. of carbonic acid gas, and each 22 lbs. of this gas are sufficient for the precipitation and elimination of 28 lbs. of the lime retained in the juice. This furnishes all necessary data for the calculation of the quantity needed in any case.

The carbonatation pans, into which the combined defecated and scum juices have been conveyed, are furnished at their bottom with a pipe pierced with three parallel rows of small holes, one-eighth of an inch in diameter, through which the carbonic acid is forced through the liquid. They are also furnished with coil pipes or double bottoms for heating by steam while the process of carbonatation is going on.

After a certain period of time, which is indicated by the cessation of "foaming," the carbonatated juice is run into large receivers, or decantators, where it is allowed to settle, after which the juice is ready for the filters, unless, as is often done, it is submitted to a double carbonatation. In many works the carbonic gas is obtained by the calcination of limestone instead of the combustion of charcoal. In places where this rock is abundant and of good quality this method has its advantages.

The deposit formed during carbonatation is a good manure, which must not be lost or wasted.

The specifications and valuations in gold for the carbonatation department of a factory for working, per diem, 150,000 lbs. of beet root, are as follows:

1. Three sheet-iron carbonatation pans, 6 feet in diameter, and 40 inches high, with copper coil pipe and full complement of valves and cocks for admitting steam, for the emptying of the pans, for introducing steam into the gas blowers in case of obstruction, etc. Cost, $660.
2. Three decantators, each of a capacity of 70 cubic feet, with three bronze cocks to each for drawing off the liquid at various hights. Cost, $240.
3. Three carbonatating pans, same as the first, for second operation. Cost, $660.
4. Three decantators, same as the first, for second operation. Cost, $240.
5. Six pipes, with stops for distribution of the juice to the carbonatation pans and decantators. Cost, $80.
6. Casing and fire box complete, for the gas furnace (exclusive of brickwork). Cost, $250.
7. Wrought-iron gas purifier, 4 feet in diameter, and 8 feet high, with continuous water supply, water level indicator, supply cocks, etc. Cost, $120.
8. Two gas pumps in cast iron, with slides attached to their frames, and with all their connections (two-foot stroke, with 1 foot 8 inches diameter of piston). Cost, 480.
9. Supplementary pipes in copper and iron, not above specified. Cost, $320.

Total, for carbonatation department of a 500-acre factory, $3,050 in gold.

Correspondence.

The Editors are not responsible for the Opinions expressed by their Correspondents.

Worms and Worm Wheels.

MESSRS. EDITORS:—W. W. S., of R. I., asks you what thread he shall cut on a worm to drive a gear of 100 teeth, 18 to the inch.

You answer him in No. 13, of this volume, "If the gear teeth are 18 to the inch, the worm must be of the same pitch, 18."

I should infer, however, W. W. S.'s meaning to be, not that the pitch of the teeth of his gear is $\frac{1}{18}$ in. measured on the circumference; but that it is "18 pitch" or 18 teeth to each inch in diameter; "18 to the inch" being a form of expression common in such cases.

If this is the case, and his gear is correctly constructed, its pitch diameter will be $5\frac{5}{9}$ in., and its external diameter $5\frac{2}{3}$ in., and the correct pitch of a worm to drive it will be $3{\cdot}1416 \div 18 = {\cdot}1745$ in. He will not probably find a lathe which will produce a thread more nearly accurate than (to put it in practical workshop form) 40 threads in 7 inches.

In this connection, a few words relating to worms and worm wheels in general may, perhaps, not be deemed intrusive. Technical propriety might perhaps demand that I should say "endless screw," and "tangent wheel;" but I adopt the former terms, justified by custom, almost universal in this country.

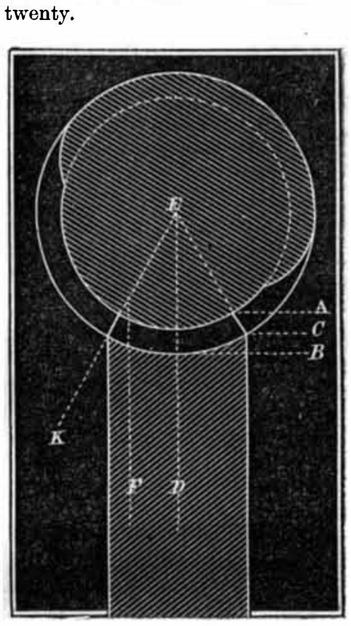
A well-constructed movement of this kind meets completely mechanical wants which could, otherwise, with difficulty be provided for. Its general proportions admit of considerable variation, but the range of proportions within which the best results are reached, is not so great as might be supposed.

It is not advisable to use the "diametral pitch" in calculating the diameter and number of teeth of the wheel, as inconvenient fractions are thereby introduced into the pitch of the worm, and the threads required cannot be accurately cut. But a simple fraction of an inch should be adopted as the pitch of the worm, and all well-equipped lathes will furnish sufficient variety between $\frac{1}{8}$ in. and 2 in. And from the given pitch the diameter and number of teeth of the wheel can be readily determined by the well-known rules, No. teeth × pitch $\div 3{\cdot}1416 =$ diameter, and Diameter × $3{\cdot}1416 \div$ pitch = No. teeth.

The pitch circle of the wheel, on which to calculate the foregoing, cannot be correctly located until the other principal dimensions are fixed. Of these, the diameter of the worm should never be less than three times the pitch; the best proportion being from five to eight times, avoiding undue obliquity of strain on the one hand, and unnecessary movement of the surfaces under friction on the other.

The width of face of the wheel should be one-half the diameter of the worm; no particular advantage is gained, in general, by making it greater.

Now, make the depth of the teeth $\frac{3}{5}$ the pitch, and their ends to coincide with the radius of the worm (as by the line *e k*, in the figure), and a simple, easily-constructed form thus far is obtained, entirely suitable for nineteen cases out of twenty.



Extend horizontal lines, as A and B, from the extreme upper and lower points of the tooth thus described, and bisecting A B we have C, a point in the pitch circle. No allowance need be made for clearance, unless the work is to be cast, or is of very heavy character.

The form of the teeth and its execution now remain to be considered.

Most treatises on mehanical construction treat of this movement as simply a rack and pinion, which is well enough as far as it goes, but is very far from covering the subject. Not only must the tooth in its general form coincide with the helical curve described by the thread of the worm, but to each different point in the length of the tooth the thread presents itself in a different position, requiring each section of the tooth, from the one made by the central plane of revolution, to the end of the tooth, to be of constantly varying form. For example, in the figure a section of the thread by the central plane at A will evidently be different from a section made by another parallel plane at F, and the same may be said of any two points on one side the central plane.

A little consideration will show that none of the ordinary expedients for cutting teeth will give these such a form as they require; but there is a very simple means of giving them their proper form with accuracy, certainty, and economy. It consists in finishing them (after they have had most of the metal removed in the ordinary cutting engine) by means of a cutter or hob, made in the same form as the worm, and caused to revolve in contact with the wheel in the same precise relation to it that the worm is afterward to occupy. The hob should be a trifle greater in diameter than the worm, and should be grooved spirally, and rather finely; a hob of 2 inches diameter, having perhaps 8 grooves. In other respects it should be a careful counterpart of the worm. It may be mounted in the cutting engine in place of the ordinary cutter, and such arrangements made as will allow the wheel to revolve by its action easily, yet steadily. Or it may be applied by other methods; probably no average mechanic, having a lathe of any kind, would be at a loss how to execute this simple but beautiful process.

In work requiring accuracy, proper gearing is sometimes so applied as to give the wheel a positive revolution at a velocity exactly proportionate to that of the hob and its pitch. By this means a piece of work may be produced well nigh perfect.

Since the means for nicely adapting the teeth of the wheel to the thread of the worm are so ready and efficient, we shall retain great practical simplicity in the whole construction if we give that thread as simple a form as possible. And a thread whose sides are bounded in section by two straight lines making an angle with each other of 30°, having a depth, as before mentioned, of $\frac{3}{5}$ the pitch, with all its angles slightly rounded, will be found to meet almost every possible case satisfactorily, and is certainly as simple as need be.

These brief notes are very far from exhausting the subject, but seem to me to touch the principal points necessary to the proper construction of a screw and tangent wheel in any ordinary case. CALLIPERS.

Worcester, Mass.

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The Wheels of all Vehicles, Dynamical Levers.

MESSRS. EDITORS:—Mr. R. Desbonne, on page 230, current volume, in criticising my theory of the economy of short-stroke engines, rests his whole argument on the fact that if 75 lbs. of power, passing one foot, will displace 70 lbs. of resistance to the extent of eight feet, it would be an actual creation of power, a subversion of all the fundamental laws of mechanics, and hence a very extraordinary discovery.

Without fully admitting his deductions to be sound, I wish to call his attention to a fact, by which corresponding results can be shown.

The average capacity or power of a horse, is 33,000 foot-pounds.

Now, giving a cart weighing 500 lbs., and loaded with 2,000 lbs., total weight being 2,500 lbs., a horse will propel this on wheels at the rate of 176 feet per minute, or 2 miles per hour: here we have a power of 33,000 foot-pounds, moving 2,500 × 176 =440,000 foot-pounds.

This fact which none can dispute, will, I trust, prove to Mr. Desbonne and others that my theory does not subvert the laws of mechanics, any more than the common cart wheel, and that however perfect we may deem the text-books of mechanics, an important mission has been made in not treating of leverage under the head of dynamics, as well as under the head of statics.

This wonderful economy (which is only limited by mechanical possibilities) is due to leverage alone, for, although some may urge that the mere rotundity of the wheel alone accounts for this, by overcoming the friction, yet it is easy to show, it does not; for if it did, a round wheel of 6 inches diameter, would be as good as one of 6 feet, being equally round, but this is not the case; on the contrary, the larger the wheels, the greater load the horse can carry at the same speed, which as the wheel is a lever, is proof conclusive, that the greater the leverage the greater the economy.

Thanking you for space kindly afforded—with these few remarks I beg leave to close my testimony in defence of the theory advanced, trusting that this proof positive of the economy of the dynamical lever, may serve to open new fields of thought to mathematicians and scientific explorers. F. R. P.

New York city.

Do We Measure Horse-power Correctly ?

Messrs. Editors:—I have observed the communication by "Mathematician," in No 13, current volume, Scientific American, asking "Do we measure horse-power correctly?" and in which your correspondent states:

"When we wish to find the actual horse power of a steam engine, and compute the same by multiplying area of cylinder by stroke of piston, pounds of steam, and number of strokes per minute, without other qualification, the result is erroneous; as, for instance, apply the foregoing rule to a steam engine furnishing power for a machine shop, and running at the rate of seventy-five revolutions per minute, and let the result in horse power be thirty; then disconnect, throw the belting off the power wheel, use the same amount and pressure of steam, and the number of revolutions will be doubled on account of outside resistance being removed. Now measure the horse power by the same rule, and the result will be sixty horse power, which is evidently absurd; for it is equal to saying that the engine uses most horse-power when doing least work, and least horse-power when doing most work."

Your correspondent is right in stating that the power will be represented as doubled, but not the power of the engine; as there is no power in that of itself, but in the agent which sets it in motion. If the speed of the piston be doubled, double the quantity of steam will pass through the cylinder, thus representing double the amount of active force operating on the piston. Let the volume of steam giving thirty horse-power with the engine driving its machinery, and making seventy-five revolutions per minute, be taken as 100, then with the machinery disconnected and running at double the spead, the same volume would be exhausted in half a minute, or twice the volume in one minute, requiring double the quantity of power producing agents to keep up the supply. I therefore think the accepted formula for calculating the power of an engine is correct, as it is in reality only the measurement of the force acting at any time on the piston according to its rate of motion. Wm. Horsnell.

Montreal.

Kerosene Lamps---A Good Suggestion.

Messrs. Editors:—I have noticed in your paper remarks from different quarters in relation to the difficulty of putting out kerosene lamps, and all to me seem to be of no avail. One of your correspondents directs "to turn the lamp down low and blow across the top of the chimney." I have tried this too, and on my lamp I might blow there till I blow myself out before I would get the light out. Now allow me to make a suggestion which may be profitable to some person. Advise the manufacturers of lamp burners to put on an additional wheel to the burners, so that when turned it throws a damper over the blaze, instantly putting it out. It might be made to work by means of a spring, which, when pushed would press the damper flat on the light. There is room under the thimble for the working of the damper. A patent on this might be very valuable. J. S. Fetzer.

Brunswick, Mo.

Contents of Cylinder in Gallons.

Messrs. Editors:—On pages 182 and 215, current volume, we have two simple rules for finding the capacity of cylindrical vessels in gallons, when the dimensions are taken in inches. Another, quite as simple, is to multiply the square of the diameter by the hight, both in feet, and by $5\frac{7}{8}$, which gives a correct answer to one gallon in twenty thousand.

New York city. R. F. H.

Copying Copperplate Engravings on Stone.

Messrs. Editors:—That the Coast Survey of the United States is a useful commission, probably no one will doubt. Neither does one doubt—from the great array of diagrams, figures, etc.—the industry or knowledge, in their particular sphere, of any individual member of the same. Lieut. Hall, for example, is eminently qualified to run a base line, and sight his many tri-colored staffs, at each shore indentation, and plot the same upon paper, thereby giving valuable aid to the many "who go down to the sea" in steamships, or other craft. But Lieut. Hall. in his description published in No. 17, current volume, Scientific American, of the transferring of a copperplate engraving to stone, evinces *less* knowledge of lithography than the already many published blunders. Copperplate engraving *may* be transferred to stone but *never* from Lieut. Hall's quoted information! He tells us to use a "paper which does not expand by wetting," which unknown paper is to be sized with a "*fatty* coating," rather than one totally free from fat. The stone, that must always be kept *cool*, is next "heated," and the culmination of this absurd statement is reached, when "the heated fat is softly brushed away, leaving only the ink (also heated black fat) lines."

One would suppose that Lieut. Hall, of the Coast Survey, had instructed the outside public of a *new* process, instead of which he has simply blinded them in a process *old* as lithography itself, and simplified this is the correct method: Coat a sheet of india paper, which expands but little with moisture, with, say, three coatings of starch, laid on smoothly with a brush, each being permitted to dry before laying on the other. Take an impression from the copperplate, having filled the engraving with a very fat ink, upon this coated side of paper. The impression is now on the interposing starch surface and not upon the paper. Lay the printed side down on a clean stone, and run through the press: the ink lines are thus forced in close contact with, and, being greasy, received by the stone. Pour water upon the back of this paper and the soaked paper softens the starch, permitting the paper's removal. We now have only a soluble starch, and fat ink lines absorbed by the stone upon the surface. Gently wash away the starch, and with the stone *moderately* moist, a printing roller charged with printing ink, may be rolled over its surface, leaving ink *only* on the parts affected by the greased ink lines from the copperplate. Lay on a clean sheet of paper and run through the press, and you have the first impression.

I have purposely omitted some details; the principle is all embodied in the above. Lith.

New York city.

Does Resistance Increase as the Square or Cube of the Velocity ?

Messrs. Editors.—Silliman, in his work on "Physics," says: "The resistance which a moving body meets in air or water, is an affect of the transfer of motion from the solid to the particles of fluid. For the moving body must constantly displace a part of the fluid equal to its own bulk, and the motion thus communicated is so much loss to the motive power. · · · The resistance increases as the square of the velocity; for, if the velocity is doubled, the loss of motion is quadrupled, because twice as much fluid has to be moved in the same time and it has to be moved twice as fast."

The mistake in the above is, that the two terms, *twice as much and twice as fast*, in this case, signify the same thing. In the passage from New York to Liverpool, a vessel will displace no more water if the distance be made in five days than if ten days were occupied. That the water is moved twice as fast is sufficient reason why twice as much is displaced in the same time, and the time saved is equal to the additional expense of power.

If the resistance is equal in a given distance, which I maintain, the power required to overcome it will increase in the same ratio with the increase of speed. If all the power required to do ten days' work is applied in five days, the work of ten days will be done in five. So far as the time is concerned, the vessel has gained enough to make the passage back to New York within the ten days, doubling the distance by doubling the power.

But the arguments of "Mathematician" were intended to prove that it would require but *four* and not *eight* times as much power to double the velocity.

So far I have only intended to define the actual relative resistance that a vessel has to overcome at varying degrees of speed—supposing it to be understood that the power will be as effectively applied in one case as the other. But in practice we know that there is a loss in the application of power to that of propelling boats by the paddle wheel or screw, and that loss is so indefinite, that no mathematical calculation can determine its true value. Until we have a practical test to determine the quantity of this loss, the case is not ready for the mathematician because he has no sufficient data.

A. Dean.

Otto P. O., Clark Co., Ind.

Calculating Horse Powers of Engines.

Messrs. Editors:—Having seen several communications in regard to calculating the horse powers of engines in the Scientific American, I thought that perhaps a few words on the subject from an "old hand" might not be improper. Having been engaged for the last twenty years in building, setting-up, and running engines, I have had good opportunities for observation, and I beg leave to differ in some respects, from the rules laid down in text-books, and in the Scientific American (an authority for which I have a great respect, as its statements are generally sound), and I will therefore give my reasons for thus differing.

Being called upon to set up an engine, 14 by 26 inches, in a mill adjoining another, in which was an engine 8 by 12 inches, the owner desired to know the combined power of the two and the difference between them. The pressure in each was the same, the large engine making 80 revolutions and the small one 450. The answer of a scientific engineer—according to rule—was that the smaller engine had most power because of its higher rate of speed. The absurdity of this was so apparent that the answer was not satisfactory.

I give this simple rule: Four superficial inches of piston, with steam at 56 pounds per inch, develops one-horse power with a speed of piston 400 feet per minute. The proportions of an engine, I have found by experience, should be, stroke two-and-a-half the bore and speed 400 feet per minute.

S. G. Shirland.

Paper-making Fifty Years Ago.

The Ashtabula *Sentinel* has been giving a series of articles on the industries of Ohio, in one of which it gives the method of making paper as it existed a half century since. It says:

When we commenced these articles we mentioned paper as one of the manufactures of the State, and then had in view, the paper molded by hand, as all paper was made, till about forty years ago. And as that way of making paper has gone into entire disuse, a description of the process may be interesting—both to those acquainted with the present process, and those who have never seen any paper made. At what time the manufacture of paper from a pulp formed of ground rags, bark, or straw, was introduced, is very uncertain as a matter of history. But for many centuries past it has been a staple article of commerce, and for the manufacture of books; during the last three or four centuries there has not been any material change in the method of making it, till the invention of the machines now in use. We shall therefore describe the manufacture of paper from rags, as we saw it about 1819. As the present mode of bleaching by chemicals, was then unknown, the dependence for white paper was white rags of linen or cotton. The white rags of the stock were then very carefully selected from the rest, and after thoroughly washing them they were placed in the engine for grinding. These engines have not been changed by the new process, and perhaps never will be, as they seem to be a kind of machine that must always be used in grinding paper stock to pulp. They are really revolving shears, that cut and beat the fiber at the same time. The engine consists of an immense tub of oval shape, ten feet long and five wide; made very heavy and strong, and fixed permanently. This is divided in the middle by a heavy partition that reaches within two feet of each end. In one side of this tub are placed a series of cutting bars, bedded into a heavy wooden concave, fastened to the bottom of the tub. Over these bars is placed a cylinder, covered also with cutting bars, set so as to come within a short distance of the cutters in the concave below, which is made to revolve with great rapidity, while it forms with the concave a series of powerful shears. In general arrangement it looks like a thrashing machine, with these bars instead of teeth. It is covered with a wooden cap to keep the pulp from being thrown out, and for safety. The speed of this cylinder is much like a circular saw. The tub is filled with water and rags and the machine is set in motion. The motion of the cylinder will establish a current by which the rags and water will be carried continuously around the tub passing through this "beating engine," as it is called, till the whole is reduced to a pulp. Thus far the process of making paper is unchanged. Under the old process, this pulp was transferred to large square vats, from which the sheets of paper were molded. At each was a man and assistant, who worked up this pulp. Two molds were furnished them, which were square sizes, not unlike a picture frame, of the size of the sheet to be made, about half an inch deep, and bottomed with fine woven wire of copper. The molder (after stirring the pulp, which had to be done frequently) then dipped the mold into it, taking up enough of the pulp to form one sheet, and shaking it, he passed it to his assistant, who slipped the other mold to him, and then turned this mold upside down upon a piece of felting cloth of the same size, leaving the newly-formed sheet of paper there, and covering it with another felt. In this manner, alternating sheets of paper and felt, the process would continue till the heap was two or three feet high. It would then be taken to a press and the water squeezed out of it. After this pressing, the sheets of paper would bear sufficient handling to separate them from the felting. They were then pressed again; after which they were taken to the dry loft and hung on poles to dry. Thus far the process of making writing and printing paper was the same. Writing and fine paper was further handled in sizing, by dipping into a vat of the size that was made of glue or tanner's scraps. After this it was dried, pressed, and picked, which consisted of scraping all knots and motes out of the sheets with a knife. Then it was hot-pressed and trimmed, and then counted into quires and packed in reams. The printing paper was neither picked nor trimmed; and in this way the old-fashioned paper can be told from the new. If the sheet has a rough edge all around it, it is hand-made. In some parts of Europe paper is still made by hand. A few years ago the Mormons, at Salt Lake City, made their own paper in this manner. The machines by which the pulp is now formed into paper, dried and cut into sheets, by one continuous process, are very expensive, as well as heavy of transportation. An inferior one will cost four or five thousand dollars.

In the old way of making paper it was very difficult to give it as nice a finish as even the commoner kinds now have. But by hot-pressing and calendering in various ways, much of the finer paper was finished in excellent style. A very large amount of the bank-note paper used in the extensive banking of the paper-money period after the war with England, was made in Ohio. We recollect particularly that the paper for the Bank of Mount Pleasant, in Jefferson county, was made at Updegraff's Paper Mill on Short Creek. Bank-note paper was also made at Steubenville and Cincinnati. At that period there were nearly, if not quite, as many paper mills in Ohio as there are now; but it is doubtful if any one of the best mills now would not turn out as much paper in a day as the whole of them did then. Certainly the present demand of either Cleveland or Toledo could not have been supplied by all the mills in Ohio in 1819; and the entire paper-making force of that time could not keep the New York *Tribune* going. Indeed they could not have made a sheet of the size now required. In hand-made paper the sheets were made of the fixed size of the molds—none of which were over 24 by 36 inches, which was called mammoth, from its unusual dimensions. Of printing paper, for books, the common size was *demy*, 16 by 22, and *medium*, 18 by 24.

Newspapers were commonly printed on *medium*, in country towns. City sheets aspired to *super-royal*, 20 by 28; and thriving establishments used *imperial*, 22 by 32. Those that went ahead of all others used the mammoth size, for which they paid extra in proportion to the size, as the molds had to be worked with a crane in making it, being too large or a man to handle without. Some extraordinary sheets were made for special purposes by the use of cranes, in molding.

Before the introduction of the power press and the paper-making machine, the demand and supply kept about even pace, as they do now; and the small quantity of paper then produced so well supplied the market, that prices do not materially differ from the present. In the art of paper making, the great mechanical agency is the beating engine for grinding the rags, which may be a thousand years old as an invention. With that and the process of molding that we have described, they jogged along down till they got into the nineteenth century, that gave birth to power-presses, stereotyping, steamboats, railroads, and telegraphs, when it became necessary to make more paper, and they had to resort to machinery for that. We might give a description of the machines now in use, for making paper; but as papermills can be seen by any one who will take the trouble to visit them, we advise those who are curious, to pursue the course we have done from childhood up—go and see any manufacturing that can be seen, and look into its details, and get intelligence by the shortest possible route.

THE PHILOSOPHY OF ALUM AND DRY PLASTER FILLING FOR FIRE-PROOF SAFES.

The use of alum and dry plaster as a filling for fire-proof safes, is based upon sound chemical and philosophical principles. The two essentials in a fire-proof safe are, that in ordinary use, it shall be perfectly dry, and that, when heated, it shall become wet. So long as it is wet the temperature in the interior of the safe can never exceed 212° Fah., the boiling point of water, at which temperature everything within it is safe, no matter how excessive the external heat may be.

In order that the first requisite (dryness in ordinary use), may be attained, the filling should contain no deliquescent salts. A train of serious evils will result from the use of such salts, as swelling of the filling, and consequent bulging of the plates; corrosion of the metal until it becomes so rotten that a pocket knife may be thrust through its walls; and dampness of the walls, producing mildew and destruction of papers and books.

Potash alum contains $\frac{216}{475}$ of its weight, of water, or nearly one-half. All of this water, with the exception of $\frac{9}{475}$ of the weight of alum, is liberated by a temperature of 356°. At ordinary temperatures it is a perfectly dry substance. It gives off water gradually as the temperature is maintained, and commences to liberate it at 140°. Some other alums contain 55 per cent. of water. A safe, having alum in lumps as an ingredient in its filling, will, when heated, be immediately filled with steam, and, as long as it remains so, must preserve its contents. The dry plaster absorbs the water as it is liberated, and holds it until the heat converts it into steam. Nothing could be more simple than this action, and its efficiency has been often corroborated by the severest tests.

Having deemed it necessary to obtain a new safe for the security of our valuable correspondence, in addition to a number already in use for our books and more valuable papers, we have been supplied with one with alum and dry plaster filling, made to order, at the manufactory of Marvin & Co., of 265 Broadway, this city, which is, in every way, so satisfactory both in elegance of design and finish, that we are constrained to bear testimony to the superior workmanship of the safes made by this firm.

The safe in question has a feature not before used, which is very convenient for filing correspondence. Two doors are provided on opposite sides of the safe, and a double row of tills, of the right capacity for folded letters, built within the walls; access being had to the files through the doors from one side or the other, without the trouble of lifting out one case to get access to another set of pigeon holes behind it. The doors are secured with Sargent's celebrated magnetic combination lock, and the whole safe is a remarkable specimen of good workmanship, both for convenience and in ornamental design. Any one desiring a double safe for their correspondence, or other purposes, will be likely to get some good hints by examining the one at our office before ordering.

ON THE TECHNICAL APPLICATIONS OF DIALYSIS.

BY PROF. CHARLES A. JOY.

A few years ago, Prof. Graham, Director of the Royal Mint in London, discovered that a certain class of substances could be more readily diffused through water than others; he found, for example, that salt, sugar, gum, and dried albumen, if placed in different vessels, and covered with water, will all of them be diffused through the water, but not in the same period of time. The salt spreads rapidly; the sugar requires twice the time, the gum four times, and the albumen twenty times longer. He found, as a rule, that substances which crystallize are diffused more rapidly than those which are amorphous. The first class are called crystalloid, and the second class colloid. When they are both in solution we can employ a thin membrane, or a piece of parchment paper, and, as it were, filter or strain the crystalloid through its pores, while the colloid remains behind. This operation is called dialysis, and the contrivance for effecting it, is known as the dialyser.

A sieve, a half barrel, a drum, a glass jar open at both ends, or even porous earthen cells, will serve for the apparatus. By tying a piece of bladder, or of parchment paper, over one end of any of the above pieces of apparatus, and floating it upon water, we have all that is required. If we pour into such a contrivance a solution of albumen and of common salt, and partially sink it into a larger vessel filled with fresh water, the common salt will very rapidly strain through the membrane into the outer water, and leave all of the albumen behind. Even silicic acid, which crystallizes in the form of quartz, can be separated from compounds in this way, provided it has been previously fused with soda. Graham has performed a series of experiments upon a large class of bodies, a recapitulation of which may suggest some practical applications of his simple device.

He discovered that tannic acid diffused through parchment paper two hundred times more slowly than common salt, and finds in this fact an explanation of the reason why it takes tannin so long to penetrate hides so as to convert them into leather. All processes for making leather rapidly will be found to be based upon the facility with which the substances employed pass through membranes, and the agents used are generally composed of crystalline salts. We are not aware of any practical application of Prof. Graham's discovery to the tanning of leather, but it is certainly worthy of the attention of persons engaged in the business.

Gum-arabic diffuses four hundred times more slowly than salt, and hence belongs to the class called colloid.

The method of dialysis can be employed for the detection of arsenic, emetic, corrosive sublimate, or any crystalline poison, in the stomach, blood, milk, or any organic compounds. The poisons will pass through the membrane into the outer vessel, and their presence can be shown by the usual tests. The same process can be made available in the case of organic poisons, such as strychnine and morphine, and it is further valuable as a method of original research in seeking for alkaloids in any new plants, and it has even been proposed as the best way for the preparation of alkaloids on a large scale. Many plants contains niter and other mineral salts, which can be separated and detected by dialysis better than in any other way.

Nitrate of silver, from photographers' waste, when put into the dialyser, passes through to an outer vessel, where it can be precipitated and saved; the albumen and other organic matter will remain in the inner vessel. For this purpose a half barrel, with parchment tied over the bottom, and immersed in a barrel of water, would be a good contrivance.

Great expectations were raised in reference to the separation of sugar from molasses, and its purification by dialysis. Several patents have been taken out for this purpose. At the Paris Exhibition of 1867, Messrs. Carmichel & Co., sugar refiners and distillers, exhibited dialysers for refining sugar, which they called *osmogenes*. Each apparatus contained fifty or sixty frames, forming partitions one-quarter of an inch in thickness, and furnished with nettings of strings to support the sheets of parchment paper destined to accomplish the work. The frames with water alternate with those for molasses or sirups. Each frame is provided with an interior opening for the hot water, and another for the sirup, so arranged that each section receives, the one the water, the other the sirup. Both liquids start from a hight of three feet, and, after descending to the bottom of the apparatus, return again, at a temperature of 160° to 170° Fahrenheit, and pass out at the top. The water is introduced and regulated according to the extent of purification required.

The inventors of this apparatus claimed for it very important results, and as it was founded upon thoroughly scientific principles, we see no reason to doubt the truth of their statements. The process is particularly valuable in the manufacture of beet sugar, and for removing potash and lime salts from sirups, but it does not appear to have been generally adopted, probably because it is not well understood.

Mr. Whitelaw took out a patent in England, in 1864, for the removal of salt and niter from salted and corned meats by means of dialysis. It is well known that the brine contains a large proportion of the nutritious constituents of the meat, and if we could remove the salt and evaporate the residue we should have all of the properties of a good soup. It so happens that the savory and valuable constituents of meat are colloids, and will not, therefore, pass through a membrane. The salt, which is added to keep the meat from decay, is crystalline, and, as we have before seen, passes very readily through parchment. Mr. Whitelaw takes advantage of these two facts, and puts the brine into porous jars or bladders, which he suspends in water, that must be renewed three or four times in twenty-four hours. After a few days, the contents of the jars will be found to be fresh and sweet, ready for use as soup, or they can be evaporated down to dryness and converted into meat biscuit. In this country, where such large quantities of corned and salted meats are consumed, the saving of the brine is a matter of much practical importance, particularly as what is thrown away is too often the most nourishing portion of the food.

FILTERING OXYGEN FROM THE AIR.

The same principle of dialysis was successfully applied by Graham to the concentration of the oxygen in the air. By passing air through shavings of india-rubber, the rubber retains a portion of the nitrogen, and the quantity of oxygen is increased to forty-one per cent., being twenty per cent more than its usual capacity. An atmosphere with forty-one per cent of oxygen will re-ignite a glowing taper, and, in general, support combustion and respiration in a very active manner. The experiment points out such a simple and cheap way of procuring oxygen from the atmosphere, that it ought to be put to a thorough trial before more money is expended in complicated and costly methods. If, by filtering the air through a membrane, or shavings, or any cheap substances, we can get rid of the nitrogen, we have made a discovery of the highest importance, and the experiments of Graham certainly seem to point out the feasibility of the plan.

Certain physiological phenomena can be very well explained by the doctrine of dialysis; for example, according to Professor Daubeney, of Oxford, gums, starch, oil, or any similar class of bodies secreted in the cells of plants, must be classed among the colloids: they have no tendency to pass through the walls of the cells where they have been elaborated, and consequently arrange themselves into groups. On the other hand, the acids and alkalies are crystalloids, and pass freely through the pores of the cells, and are frequently found on the outside, or they pass to the organs of the plant, where they undergo transformation by action of the vital force. The mucous membrance of the stomach may be compared to the parchment of the dialyser—the crystalloid elements are absorbed, while the colloid remain to be subjected to the action of the gastric juice, which elaborates them according to the laws of nutrition.

The action of different kinds of medicines can be explained according to the same law. Those which are crystalloids will diffuse rapidly through the coating of the stomach, while the amorphous medicines will remain, subject to the action of the gastric juice and the laws of digestion.

The application of dialysis in the dry way has been proposed by a Frenchsavant. He assumed that substances which fused at different temperatures could be separated by passing them through a porous vessel on the same principle. Such an application would be most valuable in metallurgy, but thus far it has not been reduced to practice. In the manufacture of paper from sea-weed, after the weeds have been boiled in caustic soda, the black liquor is thrown away. It would be well to put the waste liquor into porous cells, suspended in tanks of fresh water, to see if the crystallizable salts of iodine would not pass into the outer vessel, where they could be reclaimed.

We have thus hastily noticed some of the leading applications of dialysis. It is a process so very easy, so simple, and so cheap, that it only needs to be better understood to acquire great popularity.—*Journal of Applied Chemistry.*

Alleged Discovery of Petroleum at Wismar.

A strange rumor, says the *Grocer*, is afloat in Germany of the discovery of a petroleum spring at the seaport town of Wismar, in the Grand-Duchy of Mecklenburg-Schwerin. Our Hamburg correspondent informs us that, on March 19th, the workmen employed in digging out the earth for the new sewers in course of construction on the promenade surrounding the town, came suddenly, at a depth of five feet below the surface, upon a spring of oil, which proved to be petroleum of excellent quality, pure, and limpid. It was at first surmised that it might be caused from the leakings from the gas works at no great distance off, but the officials of that establishment declared that such was not the case. The news spread through the town like wildfire, and, in a very short time, hundreds of people rushed to the spot with bottles and pitchers, which they filled with the liquid, and Herr Beckmann, the chemist of the corporation, carried away a sample for the purpose of analyzing it. When one considers that the geological formation of that part of Germany is purely alluvial soil, or at the very oldest of diluvial origin, while the total absence of all rocks, and, on the other hand, the abundance of erratic blocks of Swedish granite of all colors and sizes, covering the surface, suggests a reference to the glacial period, it certainly does appear extraordinary that an oil spring should have been struck within five feet of the surface of the ground. As far as we have been able to ascertain, there are no artesian or other deep wells at Wismar or in the neighborhood, and, therefore, in the absence of any such borings, it is impossible to ascertain, or even approximately to hazard an opinion, as to the nature of the rocky substratum underlying the diluvial surface, though in some parts of Mecklenburg large beds of marl and gypsum have been discovered at a great depth.

Calculating Areas by Weight.

The *Engineer* contains a very novel method for computing areas by weight; an accurate square of homogeneous paper of uniform thickness being used for plotting the map of the area to be measured. The whole is accurately weighed in a delicate balance, and then the tracing of the boundary is cut out, when the weight of the piece cut out, divided by the entire weight of the square will give the ratio of the surface to be measured to that of the square, both being drawn to the same scale. Areas of the most irregular form may thus be very readily and quite accurately determined.

THE Brazil (Ind.) *Miner* says that the furnace of the Indianapolis Furnace and Mining Company, at Brazil, is the largest establishment of the kind in the United States. The furnace, or rather the double furnace of the Western Iron Company, at Knightsville, two miles east of Brazil, though not so large as the one first mentioned, has been a paying institution from the start. The cost of the first stock was nearly $100,000, and the profits of the concern paid for it inside of six months after it first commenced operations.

OVER ninety per cent of the rays issuing from most kinds of artificial lights are according to the German chemist, Landsberg, calorific or heat rays, and as such non-luminous. Sunlight has only fifty per cent of heat rays. He attributes the painful effect of artificial light upon the eyes to this large amount of heat rays. By passing artificial light through alum or mica, the heat rays are interrupted and the light is rendered much more pleasant and less injurious.

A CURIOUS experiment is said to have been recently performed in France to ascertain whether fishes can live in great depths of water. The fish were placed in vessels of water made to sustain 400 atmospheres, under which they lived and preserved their health. It is therefore concluded that fishes may penetrate to very great depths in the ocean with impunity.

During the past seven months, there have been in the United States sixty-one boiler explosions, the great majority of them involving loss of life.