Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT

NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

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VOL. XXXIX., No. 17. [NEW SERIES.] *Thirty-third Year.*

NEW YORK, SATURDAY, OCTOBER 26, 1878.

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THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 147,

For the Week ending October 26, 1878.

Price 10 cents. For sale by all newsdealers.

FLOW OF WATER THROUGH PIPES.

Very frequently some one who has a pump, or cistern, or spring, wishes to know how much water will be discharged through a pipe of a stated size under a given head, or how large a pipe is necessary to fill a certain vessel or reservoir in a required time. Most of the calculations to this effect are made by rule of thumb; the rest are generally so buried in formulas that nobody can find out anything about them without first going to college, and then possibly going crazy. It may, then, be interesting to run over the following simple rules for determining the above-mentioned elements.

In the first place, this can never be known exactly, except by actual measurement; because all pipes are not equally smooth inside nor evenly laid to begin with, and some get crusted over with mud or scale. It is always best to allow 5 per cent margin, so as to be sure and have pipes large enough. It must be borne in mind that larger pipes cost less proportionately than smaller ones; as a very trifling increase in diameter counts up very rapidly in the amount of area and discharge.*

We want to make some very simple "sums" with the following elements: head or pressure, length of pipe, and diameter.

Head means vertical distance every time—vertical distance between the level of the water in the reservoir above and the center of gravity of the discharge orifice below. Some think that when pipes discharge under water the head is less than if they discharge into open air; but no one who is posted allows more than $\frac{1}{10}$ difference. Thus if a reservoir 120 feet above the standard level discharge 10 feet above this standard, through a pipe whose discharge orifice is 50 feet below water, the head is 110 feet all the same. Some parts of a pipe may have greater head than others.

Another thing worth noting: it does not make a particle of difference whether the pipe is level, inclined upward, or inclined downward, as far as the quantity of water discharged is concerned, the length and head remaining the same.

It is essential that the upper end of the pipe be sufficiently immerged to let it fill well; and there will be a certain amount of head lost in overcoming friction. The upper part of the head may be said to produce velocity, and the lower part to overcome friction; we may divide the whole into the "velocity head" and the "friction head."

A pipe might be so laid as not to have any bursting pressure upon it, by putting it all upon the "hydraulic grade" line—a line drawn from the true velocity head to center of gravity of the discharge end. In such case it would have on it only the weight of the water, upon its lower side. The bursting pressure on any point is determined by its vertical distance from this inclined grade line. It is curious that if a full flowing pipe be tapped at any point on its upper side, the water will rise to this inclined hydraulic grade line, and not to the level of the reservoir. If the discharge be stopped, the jet will rise above the grade line; or if there be an obstruction between the reservoir and the jet the latter will fall.

Wooden pipes have about $1\frac{3}{4}$ the frictional resistance that equally smooth cast iron ones have; corroded iron pipes double that of new smooth ones. Our formulas following are for smooth new cast iron pipes, more than four diameters long. (All dimensions must be in feet.)

We will multiply the head by the diameter. Add the length to 54 diameters, and divide this into the first found product, and take the square root of the quotient. Forty eight times this square root is the velocity in feet per second. If we multiply this by the area we get the discharge in cubic feet per second; and we can turn this into U. S. standard gallons by multiplying by 7·48.

Thus we have a 4 inch pipe 962 feet long, with a discharge 60 feet below the surface of the reservoir. How much water will flow through it?

$60\times\frac{1}{3}=20$; $962+\frac{54}{3}=980$; $\frac{20}{980}=\frac{1}{49}$; $\sqrt{\frac{1}{49}}\times48=\frac{48}{7}=6·857+$. $6·857\times·0873=·5916$ cubic foot per second. $·5916\times60=35·496$ cubic feet per minute. $35·496\times7·48=265·492+$ gallons per minute.

There is another rule which we will try, to see how nearly the results agree: Multiply the fifth power of the diameter by the head, and divide (as before) by the length plus 54 diameters. 37·6 times the square root of this will give the discharge in cubic feet per second.

$$37·6\sqrt{\frac{\frac{1}{243}\times60}{980}}=·5967 \text{ cubic foot per second} =35·802 \text{ cubic}$$

feet per minute $=267·172+$ gallons per minute.

Bends do not materially affect the discharge if they have radii longer than five diameters of the pipe.

To find either the area of pipe, or the mean velocity, or the quantity discharged, when the other two are given, we work out permutations of the formulas used above. Thus the area necessary for a given discharge and velocity = discharge divided by the velocity; the mean velocity equals the discharge divided by the area; the discharge equals the area multiplied by the velocity.

A COCKNEY PLAN TO BANISH SMOKE.

In a long article showing how London fogs are a purely local product, due to the heat, smoke, surface, emanations and sewer gas of that sadly afflicted city, the London *Medical Examiner* seriously proposes to get rid of the evil by collecting the smoke and sending it out to sea. It says:

"We shall perhaps be thought visionary in our views, but we hope the day will come when London smoke will be dealt with like London sewage—collected from each house and sent out to sea. The expense would be doubtless great, and the difficulties considerable, but the benefits would be still greater, smoky chimneys and dangerous and unsightly chimney pots being abolished forever. For every fire the requisite amount of draught might be secured by a simple arrangement and independently of length of flue or height of house. The smoke would necessarily have to be drawn away by steam fans, and discharged at different points on the sea coast, according to the direction of the wind. The laying of the street flues would not involve a quarter of the trouble or expense incurred in the main drainage works, and the alterations necessary in each house would be of less account than the annual taking up the drains, which is necessary in so many of our tenements. The only great difficulty when the pipes were once laid would be in the matter of sweeping, but we should imagine that this would be easily surmounted. The proposal we have made is certainly a bold one, and not likely to be seriously discussed for years to come. But let the mind dwell for a moment on its certain results. Think of the clear and pure atmosphere, of the final abolition of the London fog, of the flowers that would bloom at every window, and the creepers that would flourish on every wall. Think of the health that would be infused into all, whether dwelling in squares or alleys, of the clean faces, of the Paris-like houses, of the untarnished spoons. Why, the whole expense might be saved in a year or two out of washing bills and the cost of repairing the Houses of Parliament. But whether this great reform be ever adopted or not, this thing is certain, that without it there can never be any such thing as an 'Ideal London.'"

All very well, a Yankee would say, if London must be a great smoke factory; but wouldn't it be easier to stop making smoke? The pipes that would carry the smoke away might be put to a better use in bringing into the city the means of securing heat without smoke. The fuel now wasted by imperfect combustion and smoke-making would supply gas enough to heat the entire city, with a blazing fire in every room; and the saving of fuel would soon pay for the pipes.

It will be many years, however, before the conservative Londoner will be willing to give up his coal fire, no matter how offensive and wasteful; so that, if ever got rid of, London smoke will most likely be banished by improvements in household methods of coal burning. To a very large extent the smoke might be done away with by the adoption of existing American stoves and improved grates for fireplaces; yet there is large room for the improvement and adaptation of these for the special work there required of them. Hitherto it has been slow work for an American invention to win recognition in England; but the conditions are rapidly changing. American "notions" are making their way even in London. And we have no doubt that our American inventors could do a good thing for themselves, as well as for London, by turning their attention to the smoke problem there.

DECISION OF THE COURTS RELATING TO BARREL MACHINERY.

A very important decision concerning barrel making machinery has just been handed down by Hon. H. H. Wheeler, United States District Judge, who presided at the United States Circuit Court in the Southern District, several months since.

The case was entitled The American Barrel Machine Company *vs.* Lowell M. Palmer, but the real defendants were the well known barrel machine manufacturers, Messrs. E. & B. Holmes, of Buffalo, N. Y., whose patents were assailed in this action. The complainant is a Massachusetts corporation, and the suit has been pending about four years.

The patents owned by the complainants were originally granted to Wm. Trapp for "improvement in barrel machinery," and to John Tilley for "improvement in machines for chamfering barrels," the former being virtually for finishing the ends of barrels, ready for the heads, by placing the barrel in a revolving cylinder and applying by hand howeling and chamfering tools while the barrel is revolved; the latter patent is for two rotary truss rings for holding barrels during the same operation, in collars movable laterally to receive and release the cask, with peculiar shaped knives operating to cut the croze and chamfer in the barrel. Nearly all of this work is done by the Holmes patent automatically after the revolving cutter heads are adjusted, the knives for doweling and crozing the barrel being run very rapidly.

Judge Wheeler's decision is as follows:

The claims of the patent are in two parts, one for the truss rings, the other for their combination with the knives. Upon the evidence, it also satisfactorily appears that the truss rings were known and used before, and that Tilley was not the first inventor of them. The knives were probably new in form and mode of cutting, but the defendant does not make use of any knives, either of that form or that operate in that mode. The defendant's cutting machines cut in the same direction with reference to the staves, but that does not infringe the patent. Tilley did not, and probably could not, obtain a patent for the mere direction of cutting. The defendant appears to make use of the truss rings, but not of the tools. He would infringe the first claim, but that is not valid. He does not use the combina-

* Thus, an increase of $\frac{1}{15}$ in diameter gives nearly ¼ more discharge; $\frac{1}{5}$ more diameter, almost ½ more discharge, etc.

tion covered by the second claim, and does not infringe that. So the defendant appears to be entitled to a decree in his favor. Let a decree be entered accordingly, dismissing the bill of complaint, with costs.

THE MODULUS OF ELASTICITY.

Up to a certain limit a body lengthens, shortens, or bends equally under equal additions of load; beyond this point this is not true; if it were a rod could be doubled in length or shortened to nothing. This load in pounds, which would, at this rate, stretch to double length or compress to nothing a bar one inch square of any material, is the modulus of elasticity.

It is thus an imaginary load, bearing the same proportion to a load producing any given amount of stretch, as the original length of a uniform bar is to the length of this stretch.

And the use of this assumed weight or load is to render easy certain calculations. Thus, to find the load in pounds required to produce a given stretch within the elastic limits, is equal to the required stretch multiplied by the modulus of elasticity, and by the cross section, and divided by the original length. And to find the stretch produced by any load within the elastic limit, the product of the load by the length must be divided by the modulus times the cross section.

It may be interesting in this connection to enumerate some of the strengths of various materials in pounds per square inch. It should be borne in mind that large metal bars are weaker in proportion to area than small ones; and that cold-rolled iron bars, although not any denser, are from $\frac{1}{4}$ to $\frac{1}{2}$ stronger.

Cast brass stands about 18,000 lbs., while annealed brass wire is equal to 49,000, and hard or unannealed, 80,000. Copper sheet, 30,000; bolts, 36,000; wire, 60,000. Gun metal (copper and tin), from 22,000 to 39,000. There is a cast iron called gun metal that is good for 38,000. English cast iron, 18,000; American, very much higher, which must be taken in consideration when Englishmen and others call our machine framing light. Wrought iron rolled bars, 40,000 to 75,000; best American, 76,000; Low Moor, 6,000; plates, 50,000; hard wire, 75,000; wire ropes, 38,000; large forgings, 35,000. English steel plates, 65,000 to 103,000; Hussey, of Pittsburg, 95,000; Bessemer, 98,500; Bessemer tool steel, 112,000; wire, 200,000 to 250,000; rolled and hammered Bessemer ingots, 125,000; cherry red tempered, 214,400; chrome steel, 18,000. The strongest steel stretches the least.

THE NOISE OF RAPID TRANSIT.—A CHANCE FOR INVENTORS.

Our distant readers may not be aware that the system of rapid transit on high level roads now existing in New York city now embraces some fifteen miles of elevated roadway, traversing several of the principal streets and avenues of this city. Thirty or forty additional miles of similar works are also now in progress. The system has demonstrated rapid transit to be a great convenience, indeed a real necessity. It has also proved to be a very serious annoyance to such as dwell or conduct business in or near the streets traversed by the roads.

The roads may be described as iron bridges supported by iron columns, running lengthwise of the streets, either at the sides, as in the case of the New York Elevated Road, or over the middle of the street, as in the case of the Metropolitan Road. In the narrow business streets, down town, the structures overshadow the entire street; and even in the wider avenues the supporting columns greatly obstruct the groundways, and quite destroy their former openness and generous breadth.

But this is the least of the objections against elevated roads. Any one who has stood near an iron trestle bridge, over which a railway train was passing, can form some idea of the roar of trains along the elevated ways; and, running as they do at brief intervals, there is scarcely any intermission to the noise. The natural consequence has been a great depreciation in the value of property along the roads. This is particularly apparent along the avenues devoted to retail shops, dwellings, schools, and churches.

In many instances tradesmen have been driven to other and quieter streets; schools and families have had to seek other quarters; while those that remain subject to the noise are all but distracted by the incessant din, and the impossibility of getting restful sleep.

In addition to the noise, the obstruction of traffic on the ground, and of light and air above, the residents along the lines complain bitterly of easily removable nuisances attending the movement of the trains—the ceaseless outpouring of locomotive smoke, charged with stifling gases, the dropping of cinders and oil upon persons beneath, the shrieking of engine whistles, and the harsh noise of escaping steam.

The brunt of the opposition has been directed against the Sixth avenue road, which has at last been presented as a nuisance by the Grand Jury of the Court of General Sessions, who ask that the Attorney General and the Legislature shall take steps to redress an outrage which they, the members of the jury, "are confident would never have been sanctioned had its enormity been realized." This in response to a petition signed by a large number of citizens complaining of serious annoyances and discomforts to which they were subjected by the road, and asking that it might be indicted as a public nuisance.

These complaints have been investigated carefully and patiently, and the testimony of many witnesses has been taken; and the Grand Jury is of opinion that the road complained of is, in many respects, a grievous nuisance. They believe that the erection of such a structure in a thoroughfare like Sixth avenue was a most unfortunate mistake, and is a great calamity. They believe that if the Legislature of the State could have anticipated the results that have followed from their action in chartering the road, such charter would never have been granted.

In addition to the necessary evils attending a road of the sort over a street like Sixth avenue, the jury mention several unnecessary evils which might be and ought to be remedied at once. Among these are the dropping of oil and cinders; the generation of unwholesome and disagreeable gases by the engines; and, to a large extent, the noise of the trains.

The road was not indicted as a nuisance, because the Grand Jury were of the opinion that a criminal proceeding is not the best way to abate the nuisance, unless others fail, and they were confident that the rights of the people would be vindicated by the courts and the Legislature.

That the public at large will be willing to give up the advantages of rapid transit, even by an objectionable system now that it exists, is very doubtful. The real problem therefore is to reduce to the smallest possible quantity the evils inseparable from elevated roads. To a considerable extent the solution of this problem lies directly within the power of the directors of the roads. By using purer coal, and by improving the combustion of it, the greater part of the smoke, cinders, and noxious gases can be prevented and kept from poisoning the air. The noise of escaping steam can be largely abated by the use of existing inventions; and the shrieking of the engine whistle might easily be dispensed with. The dropping of oil, hot cinders, and the rest is the result of sheer carelessness.

The silencing of the running gear and the too resonant structure is not so easy; yet it is safe to say that a very large part of the rumble and clang and din can be abolished. Our inventors have not failed in any task yet presented to them; and surely they will not allow this resounding and intolerably urgent demand to go long unmet. There is money in it, as well as health and comfort to thousands.

We may add that perhaps the oldest of our great inventors now living, the venerable Peter Cooper, has undertaken the task of silencing the nuisance by invention, being driven to it in order that the efficiency of his great benefaction, the Cooper Union Free School of Science and Art, may not be permanently impaired by the noisy monster at its door. Even when the class rooms have been shifted to the opposite side of the building, it is with great difficulty that the work of the school can go on.

The problem is to secure high speed, at high levels, with the least noise. The problem is a complicated one, and many partial solutions are possible. Whoever diminishes the noise in any essential particular will do a good thing and meet with a sure reward.

It is noticeable that every departure from the simple round iron and wood structure of the first built portion of the Ninth avenue road has been attended by a large increase in noise. The substitution of flat iron for round in the supporting columns and braces, and the multiplication of pieces in the trestlework, seem to have multiplied the reverberating surfaces and raised the pitch of the sounds, more rapidly than it increased the strength and stability of the structure. Accordingly, instead of the original low rumble, we have now a multitudinous clang, sharp, discordant and irritating. Should it prove impossible to do away with any considerable portion of these loud and harsh noises, without making radical changes in the entire structure, it would seem that the only recourse would then be to sink the tracks below the level of the streets. This was done successfully in the case of the Fourth avenue improvement; and now we have through the upper part of the island a structure that will last for centuries and accommodate both local and through traffic, passenger and freight, with a capacity equal to any demands that may be made upon it, and with the least possible annoyance to the residents along the line. It will be no misfortune to the city if the system has to be extended.

AMERICAN AGRICULTURAL EXHIBITS AT PARIS.

Twelve prizes were placed at the disposal of the jury, namely, Sèvres vases, to be used in recognition of such exhibits as were proven to possess exceptional merit. Eleven awards were made; and of these eight were adjudged to American inventors, as follows:

C. H. McCormick's Reaping Binder.
Walter A. Wood's Reaping Binder.
Osborne's Reaping Binder.
Deere's Gang Plow.
Johnston's Harvester.
Whiteley's (Champion) Mower.
Dederick's Hay Press.
Chicago Hay Press.

The latter was exhibited by the French agent in Paris, the others by the parties themselves, being exposants in the American section. The English declined to enter the competition.

A Modern "Prehistoric" Instrument.

The discovery in the lacustrine houses of Switzerland and Savoy, and in the Lake of Bourget, of bronze rods surmounted with movable rings, has called forth explanations from all quarters. Carl Vogt, among others, has come forward in response to M. Mortillet's invitation to supply him with a clew to their use, and according to him we still have a similar instrument in the "Ringelstock" of the German herdsman, which is formed of a stout nut stick, terminating in a lateral branch, on which are hung several metal rings. If the noise is not successful in bringing back the animal, the instrument is thrown at its head with an alarming clatter of bells.

Remarkable Gas Wells in Ohio.

A correspondent of the Cleveland *Leader* says that the natural gas wells of East Liverpool, Ohio, form one of the seven wonders of the world. They are situated in and around the city, and give it a continual supply of the finest light. The gas is almost as free as the air. It costs practically nothing, and forms the illuminator and heater of the town. The city is lighted by it, and the street lamps blaze away at noonday as well as at midnight. It costs nothing to let them burn, and it takes trouble to put them out. Its light is not the flickering mockery of poorly manufactured gas, but a flame which proximates in its brilliancy that of the electric light. Almost the entire fuel used in the town is this gas. It is conducted into the grates and stoves in pipes, and by it all the cooking and heating are done. It is also used in furnishing steam power for many of the largest pottery and ironstone china manufacturing establishments, twenty-two of which are in operation and busily engaged, employing over two thousand hands, and which it is considered justly entitled East Liverpool to be designated as "the ceramic city" of America. Regarding the duration of the supply from these wells it is stated that the first well discovered now burns as brightly as when it was first opened, and for the last twenty years has never flagged in its brilliancy, and none of those now in operation have ever shown any signs of giving out. For years Liverpool used manufactured gas, never dreaming of the rich supply that was wasting away daily under its very feet. The poor quality of the manufactured product induced the opening of the first well in 1859. This well, which is four hundred and fifty feet deep, has been furnishing fuel and light to several houses, producing the steam for a large engine, and burning pottery kilns, every day for over twenty years.

Lighting Sea Beacons from the Shore.

A method devised by J. R. Wigham, and successfully tried by the Commissioners of Irish Lights, consists in extending pipes from the shore under water to the beacon lantern; in the daytime a very small jet of gas is kept burning in the lantern, but at night a full sized light is used, the regulation of the flame being accomplished simply by increasing or diminishing the gas pressure on shore. In the daytime a high pressure is maintained which lifts a valve near the burner and allows only a very small jet of gas to escape, while high pressure prevents the small flame from being easily extinguished by wind. At night, by lowering the gas pressure the valve falls and a large gaslight flame is the result. The labors of boatmen, and the dangers to which they are frequently exposed in stormy weather in lighting beacons, are by this plan saved.

Emigration from Canada.

The Department of State has received a dispatch from our Consul at Port Sarnia, in which the number of emigrants seeking homes in the United States, through that port, for the year ending June 30, 1878, is given as 30,610. Of this number, 16,183 were Canadians from the provinces of Ontario and Quebec. The Canadians were principally agriculturists, carrying with them to their new homes their horses, wagons, agricultural implements, household effects, and, in a majority of cases, money enough to purchase farms. "Hence," the Consul says, "they may be regarded as a very valuable acquisition to the ranks of American industry."

Alizarin Carmine, a New Tinctorial Substance.

This compound, recently introduced into the market as a dye for woolens, is the sodium salt of a sulpho-acid of alizarin. With the ordinary mordants it gives a variety of brown, chocolate, orange, red, and scarlet shades. The latter, though inferior in brightness to cochineal and eosin scarlets, are absolutely fast as against air and light, and are injured neither by soap lyes nor by perspiration. The new color will therefore be well adapted for carpets, hangings, military uniforms, etc.

Arsenic in Sulphuric Acid Pyrites.

In Spanish pyrites, M. E. Hjelt, using A. Smith's method, finds 0·91 per cent of arsenic; in Westphalian, 0·30; and in Norwegian, mere traces. In chamber acid he finds 0·202 of arsenic; in the acid from Glover's tower, 0·331; and in that from Gay-Lussac's condenser, 0·334. The bulk of this arsenic is present as arsenious acid. In the last chamber the acid contains merely 0·019 per cent of arsenic. The mud deposited in Glover's towers consists chiefly of arsenious acid.

THE Manchester *Guardian* says that the excessive heat—120° in the sun at Wigan—had a singular effect on the railway metals between Wigan and Manchester, on the London and Northwestern line. Near Plat Bridge station the up line to Manchester was found bulging for eight lengths in the shape of an S, the metals and sleepers having been bodily moved at one point nearly two feet. The rails appear to have been set too tightly, and on the heat expanding them they had been twisted out of their original course.