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THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 147,

For the Week ending October 26, 1878.

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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 1¾ 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?

$60\times\frac{1}{3}=20$; $962+\frac{54}{3}=980$; $\frac{20}{980}=\frac{1}{49}$; $\sqrt{\frac{1}{49}}\times48=\frac{48}{7}=6\cdot857+$. $6\cdot857\times\cdot0873=\cdot5916$ cubic foot per second. $\cdot5916\times60=35\cdot496$ cubic feet per minute. $35\cdot496\times7\cdot48=265\cdot492+$ 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.

$$37\cdot6\sqrt{\frac{\frac{1}{243}\times60}{980}}=\cdot5967$$ cubic foot per second $=35\cdot802$ cubic feet per minute $=267\cdot172+$ 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 $\frac{1}{10}$ in diameter gives nearly ¼ more discharge; $\frac{1}{5}$ more diameter, almost ½ more discharge, etc.