creditable to science to have erred by nearly four millions of miles in estimating the sun's distance. But such may be reminded that the error of 0·33″ (thirty-two hundredths of a second) in the sun's parallax, on which the correction turns, corresponds to the apparent breadth of a human hair at 125 feet, or of a sovereign at 8 miles off."

It is on such minute measurements that the approximate exactness of astronomy depends. The limit of probable error in the latest and most satisfactory determination of the sun's distance is somewhere about half a million miles, say one eighth part of the last correction. We may leave it to the reader to calculate how extremely delicate the observations of the coming transits must be to effect any considerable reduction in this apparently great but relatively minute inexactness.

EFFLUX OF STEAM.

If a fluid issues through an opening, without friction, the velocity of its flow will be the same as it would acquire in falling through a hight due to its pressure. For instance, suppose that steam at atmospheric pressure flows into a vacuum. Steam at atmospheric pressure, or 14·7 pounds per square inch, will have a pressure of 14·7×144=2116·8 pounds on the square foot. A cubic foot of steam, at this pressure, weighs about 0·0364 pounds, so that the hight of a column of steam, necessary to produce this pressure per square foot, would be 2116·3÷0·0364=58153 feet. The velocity acquired by a body in falling through this space is found by extracting the square root of 64·32×58153. This gives 1934 as the velocity in feet per second with which steam at atmospheric pressure will flow into a vacuum, if there be no frictional resistance. In practice, it is found that when a fluid is discharged through an orifice or tube, the actual velocity is less than the theoretical, so that a coefficient of correction is necessary in using the theoretical formula. Numerous experiments have been made upon the velocity of discharge of water, air and steam, those upon water being the most extended and reliable. It is difficult, when experimenting with steam, to maintain a constant pressure, and the velocity is so great that it is not easy to make an exact measurement. For these reasons, the results of different experimenters vary greatly. In this article, we shall endeavor to give the most accurate results that have been obtained.

There is one case, in the flow of water, in which the actual velocity of discharge varies but little from the theoretical. We refer to that in which the water flows through a mouth piece shaped to the form of the contracted vein. This mouthpiece has a length about equal to the diameter, and is constructed with a bell shaped mouth, its diameter being decreased at the middle of its length to about eight tenths of its original size. Experiments with this kind of mouth piece in the case of steam, however, show varying coefficients of velocity for discharges under different pressures. The table given below will illustrate this.

TABLE OF COEFFICIENTS OF THE VELOCITY OF DISCHARGE OF STEAM INTO THE ATMOSPHERE, THROUGH A MOUTHPIECE HAVING THE FORM OF THE CONTRACTED VEIN.

Pressure in pounds per square inch above atmosphere.	Weight per cubic foot.	Coefficient.
1	0·0396	0·93
5	0·0510	0·85
10	0·0598	0·78
20	0·0815	0·71
30	0·1025	0·69
40	0·1232	0·68
50	0·1436	0·67
60	0·1636	0·66
70	0·1833	0·65
80	0·2030	0·64
90	0·2224	0·63
100	0·2410	0·62

These coefficients have been determined experimentally for orifices varying from four tenths of an inch in diameter up to one and a half inches. We will now explain how to use them, illustrating by an example.

The expression for the theoretical velocity is $v=\sqrt{2gh}$, or the velocity of discharge in feet per second is equal to the square root of twice the acceleration due to gravity multiplied by the hight due to the effective pressure. The actual velocity is equal to the theoretical velocity multiplied by the proper coefficient.

EXAMPLE: With what velocity will steam at a pressure of 50 pounds by steam gage issue into the atmosphere through a mouthpiece having the form of the contracted vein? Answer: 50×144=7200 pounds pressure per square foot. 7200÷0·1436=50139 feet=hight due to pressure. $\sqrt{64\cdot32\times50139}\times0\cdot67\times1203$=velocity of efflux in feet per second. Corrections can be applied to the coefficients given in the preceding table, to adapt them to other cases than that in which the steam issues through a mouthpiece having the form of the contracted vein.

For a tube having rounded edges, and a length equal to once and a half the diameter, deduct 0·03 from the coefficient for any given pressure. For a tube with square edges, and a length from once and a quarter to twice and a half the diameter, deduct 0·13 from the coefficient. For a plain tube whose length is 12 times the diameter, deduct 0·24 from the coefficient. When the length of the tube is 24 times the diameter, deduct 0·28 from the coefficient.

To find the velocity of efflux through an orifice in a thin plate, the thickness of the plate being not more than one tenth the diameter of the orifice, correct the coefficients given in the table as follows: Deduct 0·36, when the pressure does not exceed half a pound per square inch. Deduct 0·21 when the pressure is equal to one atmosphere.

We will give an example in one of these cases, as it will illustrate the method of proceeding for all: Suppose steam of 40 pounds pressure per gage issues through a pipe one inch in diameter and twenty-four inches long, what is its velocity? Answer: 40×144=5760 pounds pressure per square foot, and 5760÷0·1232=46753 feet, hight due to pressure.

$\sqrt{62\cdot32\times46753}\times(0\cdot68-0\cdot28)=694$, velocity of efflux in feet per second. The preceding constants were determined experimentally by Mr. George Wilson, of England. It will be observed that they apply to orifices from four tenths of an inch to one and a half inches in diameter, and having lengths from one tenth to twenty-four times the diameter, the experiments having been made on the efflux of steam through orifices varying within these limits. Approximate formulas, for general use, have been established by the late Professor Rankine, and we will give these, illustrating them by examples.

Case 1: When the pressure of the medium into which the steam flows is less than three fifths of the pressure in the reservoir, the number of pounds of steam discharged through a pipe or orifice is found by multiplying the area of the pipe (in square inches) by the pressure of steam in the reservoir, and dividing the product by 70. Example: How much steam will be discharged from a boiler into the atmosphere, through a 3 inch pipe, the pressure per gage being 15 pounds? Answer: Here the absolute pressure in the boiler is 15+14·7=29·7 pounds per square inch, and the area of the pipe is 7·07 square inches. Hence the quantity of steam discharged per second will be (29·7×7·07)÷70=2·99 pounds. The volume of this steam will be 2·99÷0·0707=42·4 cubic feet, and the velocity of discharge in feet per second will be found by dividing the volume by the area of the pipe in square feet. This gives the velocity: 42·4÷0·0492=864 feet per second.

Case 2. When the pressure of the medium into which the steam is discharged is more than three fifths of the pressure in the reservoir, the number of pounds of steam discharged per second is found as follows: Multiply the area of the pipe (in square inches) by the product of the external pressure divided by 42 and the square root of the difference of the internal and external pressures divided by two thirds of the external pressure. Example: Steam of 5 pounds pressure, per gage, is discharged through a 2 inch pipe into the atmosphere. Absolute pressure of steam in boiler=5+14·7=19·7 pounds (absolute external pressure=14·7 pounds). Area of pipe=3·1416 square inches. Applying the rule, we find the quantity of steam discharged per second=3·1416×$(14\cdot7\div42)\times\sqrt{(19\cdot7-14\cdot7)\div(\frac{2}{3}\times14\cdot7)}=0\cdot785$ pounds. The volume of this steam is 0·785÷0·0487=16·1 cubic feet, and the velocity of discharge is 16·1÷0·0218=739 feet per second, 0·0218 being the area of the pipe in square feet.

With the formulas given above, our readers will be able to solve nearly any question that may arise regarding the efflux of steam, with sufficient accuracy for most practical purposes.

EZEKIEL PAGE.

We regret to hear of the demise of Ezekiel Page, formerly of Boston, Mass., inventor of the machine for turning oars. Mr. Page's name has been associated with this particular branch of industry for more than a generation; and at one time he possessed the only factory in the world wherein oars were made by machinery. Indeed at the present day the chief business connected with the oar trade in this country remains in the hands of the Page family. The manufacture has been so perfected that little chance remains for improvement. It is difficult to obtain a poor article from any concern where the Page machinery is used, because the mechanism never slights its work, but imparts true and exact proportions to every piece of lumber. Clumsy ill-shaped oars must be looked for in shops where the labor is done by hand.

Ezekiel Page's first improvement in this line was patented in 1842, for a new method of sawing out the oar lumber. The old method was to saw the logs into square sticks equal in size to the width of the oar blade, one oar being cut from one stick. By giving a peculiar movement to the carriage of the saw machinery, Page was enabled to get two oars out of the same block. He produced two blades where only one before was made. This gave him the oar monopoly and entitled him to rank as a benefactor of the race. His name will be for ever honored by every loyal boatman.

Page's next improvement, patented in 1845, was a mechanism for producing the swell on the oar handle. This he accomplished by means of a contrivance for moving the slide rest of the lathe, in such a manner as to compel the cutters to shape the wood to the exact form required.

Ezekiel Page, at the age of 62 years, rests from his labors. He never made much noise in the world, and yet he contributed, for the use of his fellow men, a discovery of immense economical importance. Think of the millions of oars now used in all parts of the world, and then remember that he taught us how to double the number out of the same piece of wood.

There is one other legacy that he has left us, more precious even than his useful inventions. It is the record of a generous, upright, amiable and well-spent life. Ezekiel Page was an honest man.

Friction of Water in Pipes.

In our article on this subject, on page 48 of the current volume, the formulas should have been printed as follows:

1. Prony's formula:

$$h=0\cdot00040085\times(L\div d)\times[(v+0\cdot15412)^2-0\cdot02375].$$

2. Brooklyn Water Commissioners' formula:

$$h=0\cdot00046749\times(L\div d)\times(v+0\cdot397)^2.$$

3. Lane's formula:

$$h=0\cdot000625\times(L\div d)\times v^2.$$

We republish them, as, separated from the verbal explanations given in the article, they might be misunderstood.

SCIENTIFIC AND PRACTICAL INFORMATION.

BLACK VARNISH FOR ZINC.

Professor Böttger prepares a black coating for zinc by dissolving 2 parts nitrate of copper and 3 parts crystallized chloride of copper in 64 parts of water, and adding 8 parts of nitric acid of specific gravity. This, however, is quite expensive; and in some places, the copper salts are difficult to obtain. On this account Puscher prepares black paint or varnish with the following simple ingredients: Equal parts of chlorate of potash and blue vitriol are dissolved in 36 times as much warm water, and the solution left to cool. If the sulphate of copper used contains iron, it is precipitated as a hydrated oxide and can be removed by decantation or filtration. The zinc castings are then immersed for a few seconds in the solution until quite black, rinsed off with water, and dried. Even before it is dry, the black coating adheres to the object so that it may be wiped dry with a cloth. A more economical method, since a much smaller quantity of the salt solution is required, is to apply it repeatedly with a sponge. If copper colored spots appear during the operation, the solution is applied to them a second time, and after a while they turn black. As soon as the object becomes equally black all over, it is washed with water and dried. On rubbing, the coating acquires a glittering appearance like indigo, which disappears on applying a few drops of linseed oil varnish or "wax milk," and the zinc then has a deep black color and gloss. The wax milk just mentioned is prepared by boiling 1 part of yellow soap and 3 parts Japanese wax in 21 parts of water, until the soap dissolves. When cold, it has the consistency of salve, and will keep in closed vessels as long as desired. It can be used for polishing carved wood work and for waxing ballroom floors, as it is cheaper than the solution of wax in turpentine, and does not stick or smell so disagreeable as the latter. A permanent black ink for zinc labels is prepared by dissolving equal parts of chlorate of potash and sulphate of copper in 18 parts of water, and adding some gum arabic solution. The black polish above described is recommended as permanent and capable of resisting quite a high temperature.

MANUFACTURE OF CHLORATE OF POTASH.

To manufacture chlorate of potash on a large scale, it has been recommended by W. Hunt to adopt the following method: Milk of lime is made to trickle down over bricks, placed in a tower where it comes in contact with a continuous current of chlorine gas. Chlorate of lime is the chief product, and, by treating this with chloride of potassium, chlorate of potash is formed, which can be purified by crystallization.

YELLOW GLASS FOR PHOTOGRAPHIC PURPOSES.

The following simple method of testing the actinic properties of yellow glass for dark rooms is by Le Neve Foster, and the only apparatus required is a cheap glass prism. When a strip of white paper is placed on a dull black surface and looked at, through the prism, by daylight, it has the appearance of the rainbow, showing a complete spectrum. On bringing the yellow glass in question between the prism and the strip of white paper, those colors which are absorbed by the colored glass disappear. If on looking through the prism any blue or violet rays are seen, it is certain that the glass transmits the chemical rays and hence is unfit for photographer's use. If only red and yellow be seen, it is non actinic.

TESTING SULPHATE OF ALUMINA.

Sulphate of alumina frequently contains an excess of acid which injures it for use in dyeing. Whether the sulphuric acid be present in excess is easily ascertained by stirring the pulverized salt into alcohol, which dissolves the free acid but not the salt. It is then only necessary to filter the solution and test for acid with litmus. The amount of sulphuric acid can also be obtained volumetrically. Pure sulphate of alumina produces with a decoction of campeachy wood a dark violet or purple color. If free acid be present, the color is browner.

PROGRESS OF THE HOOSAC TUNNEL DURING THE MONTH OF JULY, 1873.—East end section: Heading completed December 12, 1872. Central section: Heading advanced westward, 151 feet. West end section: Heading advanced eastward, 137 feet. Total advance of headings during month, 288 feet. Length opened from east end westward, 14,285 feet; length opened from west end eastward, 9,677 feet. Total lengths opened to August 1, 1873, 23,912 feet. Length remaining to be opened August 1, 1,119 feet.

ALBUMEN EXTRACTED FROM MILK.—Schwalbe has found that if oil of mustard be added to cow's milk in the proportion of one drop to 1·1 drams, the milk does not coagulate even after being kept for a considerable period: but that the caseine is transformed into albumen. If this discovery, says *Les Mondes*, is confirmed, it will be of considerable importance in the printed fabric industry.

SQUEAKING BOOTS AND SHOES.—To prevent the soles of boots or shoes from squeaking, says the *Shoe and Leather Chronicle*, rasp, with a coarse rasp, the outsole and insole, and every other piece of leather that comes in contact in friction by the action of the foot. Then apply freely good wheat or rye paste. If this is well attended to from heel to toe, the boot or shoe will not squeak.

COLT'S FIREARMS COMPANY has just received an order for 30,000 pistols. Smith & Wesson have commenced work upon 20,000 Russian pistols, and will make about 150 daily.