THE PROBLEM of squaring the circle may be described as changing circular into square measure. The mind being trained to estimate in squares, refuses to deal with circles. A plane has a length and breadth, but no thickness. We say a lot is 25 x 100, or a shadow is 10 feet wide by 20 long. We talk about superficial surface without substance. Thickness pertains to the third power and introduces a new dimension which the mind can grasp. A tank 20 x 20 gives no idea of its capacity until we learn that it is 10 feet deep. Then 20 x 20 x 10 shows that it will hold 4,000 cubic feet of water.

If our ancestors had estimated in spheres with the diameter of a small marble as the unit of measurement, we might all be talking in circles, with the mathematicians trying to circle the square.

For thousands of years they have sought to discover the ratio of the diameter to the circumference as the key to the great problem. Ingenious methods have been employed which produce answers approximately correct, but there is always an infinitesimally small fraction left over which is technically known as *pi*.

The ancients claimed the diameter to be one-third of the circumference, and had biblical authority for the same, as we read in the Book of Kings, VII, 23, that Solomon in making the vessels of the Temple "made a molten sea, ten cubits from one rim to the other, and a line of thirty cubits did compass it round about." This is but one of many references in the Bible to the ratio of the diameter of the circum. being one-third, this ratio gives a fairly good approximation, but for careful estimating we divide the circumference, or multiply the diameter by the decimal fraction 3,141592. From any given diameter we obtain an approximately correct answer to an infinistesimal degree by squaring the radius and multiplying it by *pi*. It may be said that calculations have been carried out to seven hundred decimal points in the vain hope of hitting upon a cycle of repeating decimals which would close the circuit so as to give a definite value to *pi*.

Here is the process worked out to seven hundred and seven points:

3.14159265358979323846264338327950288419716939937510582097494459230781640628620899862803482534211706798214808651328230664709384460955058223172535940812848111745028410270193852110555964462294895493038196442881097566593344612847564823378678316527120190914564856692346034861045432664821339360726024914127372458700660631558817488152092096282925409171536436789259036001133053054882046652138414695194151160943305727036575959195309218611738193261179310511854807446237983474956735188575272489122793818301194912983367336244193664308602139501609244807723094362855309662027556939798695022247499620607497030412366888619951100892023837702131416941190298858254468163979990465970008170029631237738134208413079145118398057098 5.

This stupendous calculation may be appreciated by explaining that you might imagine a sphere to be constructed with the earth as the central point and the orbit of the circle to extend to the star Sirius, distant a hundred million miles—but you may make it a billion times farther if you wish—then imagine this immense sphere packed with minute microbes, so small that a billion could stand on the point of a pin. Now multiply that radius of the great circle by those seven hundred and seven decimals and the error as to the space filled with microbes will be less than the billionth part of a microbe!

The interest in the squaring of the circle has been kept alive by the offer of 100,000 francs by the Paris Academie of Sciences, and by the claim that the secret was known at the time of the building of the pyramids. The Paris Academie has withdrawn its offer and says it "will examine no more squaring problems, no more trisections of the angle, no more duplications of the cube, and no more perpetual motion schemes."

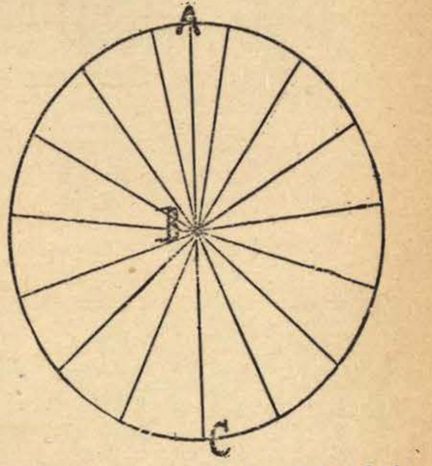
The offer was withdrawn because Prof. Gauss gave a rigid and positive demonstration of the impossibility of solving those problems mathematically. Prof. Gauss' proof is too profound and technical for the average student, but for the benefit of the thousand and one aspirants for fame who believe that they have new methods for solving the great problem we will put a new and interesting value to Mr. Shanks' seven hundred and seven point demonstration as a test wherewith to compare the new solutions. The greatest mathematicians of the world have indorsed his work as correct, and it has been approved by the Royal Society of London, Vol. XXI. All that is necessary to see how far the new methods compare with Mr. Shanks', and at what point they fail: It may be said that out of the hundreds of thousands of mathematicians, many of whom devoted their lives to the task—very, very few were correct as far as the fifth or sixth decimal, and here we have an absolutely correct standard up to seven hundred and seven points!

And now for a practical rule and explanation for the benefit of the engineer and mechanic, which when once learned will never be forgotten. To square a circle, multiply half the diameter (in inches) by half the circumference (in inches). The answer will be absolutely correct, and not merely approximately near, as many suppose. It is practical, because if you wish to know how many feet of sod will be required to cover a round grass plot, you take the tape and measure the circumference and the diameter, and multiply the half of one by half the other, and if your measurements are correct it will give the amount of sod required to less than the billionth part of an inch.

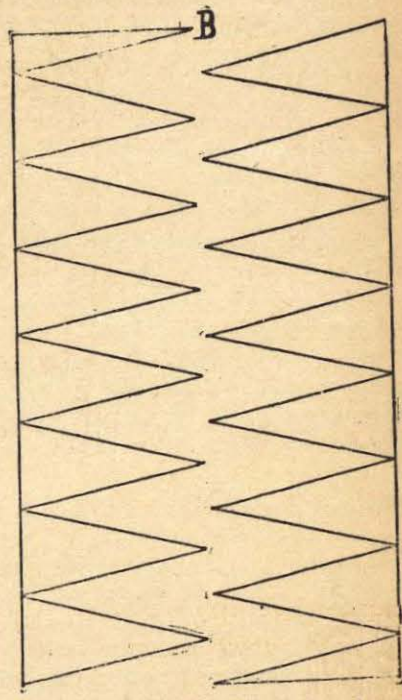
If the plumber wishes to know the contents of a circular boiler or cistern, let him measure the diameter and the circumference with the tape, then multiply the half of one by half of the other and the result by the depth, and he will have the capacity as close as a single drop of water. The correctness of the answer depends altogether on the accuracy of his measurements.

A tinsmith had to cover a circular roof 100 feet in diameter. Actual measurement made the circumference to be 3.1416 feet. By the use of this rule he found it required 7,854 feet of tin, which was not a square inch out of the way.

As the reason why has to be taught to impress it upon the mind, we will give a little kindergarten illustration which explains everything. If you halve an orange you will notice how the pulp of the fruit is divided into triangular looking segments of a circle converging to the center B, as shown in the following illustration.



Now let us square that circle of the orange by the rule. Suppose the circumference proves to be 9 3-7 inches, and the diameter 3 inches; the half of the one by the half of the other gives 7 and 1-14 square inches as the correct answer. But why? Suppose the circle was cut in half from A to B, as shown on the circle. Now take each of the pieces of orange and straighten out the peel as shown in the following cut. It is clear that each



piece is as long as half of the circumference, because two pieces formed the entire circumference. The pulp is broken or separated into segments which are evidently half as wide as the diameter because they reached from every point of the circumference to the center at B. As these triangles taper from the half of the circumference to nil at their points, we will bring the two pieces together so as to fit them into a solid oblong one and a half inches wide by 4 5-7 inches long, containing a surface of 7 and 1-14 inches as stated.

THE FIRE ESCAPE PUZZLE

BY Sam Loyd.

THIS PUZZLE IS BUILT upon common sense, and represents the Binks patent fire escape which the inventor says should be placed in every sleeping room in the world. It was tried at one of our hotels, but delinquent guests had such a way of decamping during the night with their worldly possessions that the scheme no longer finds favor with the landlords.

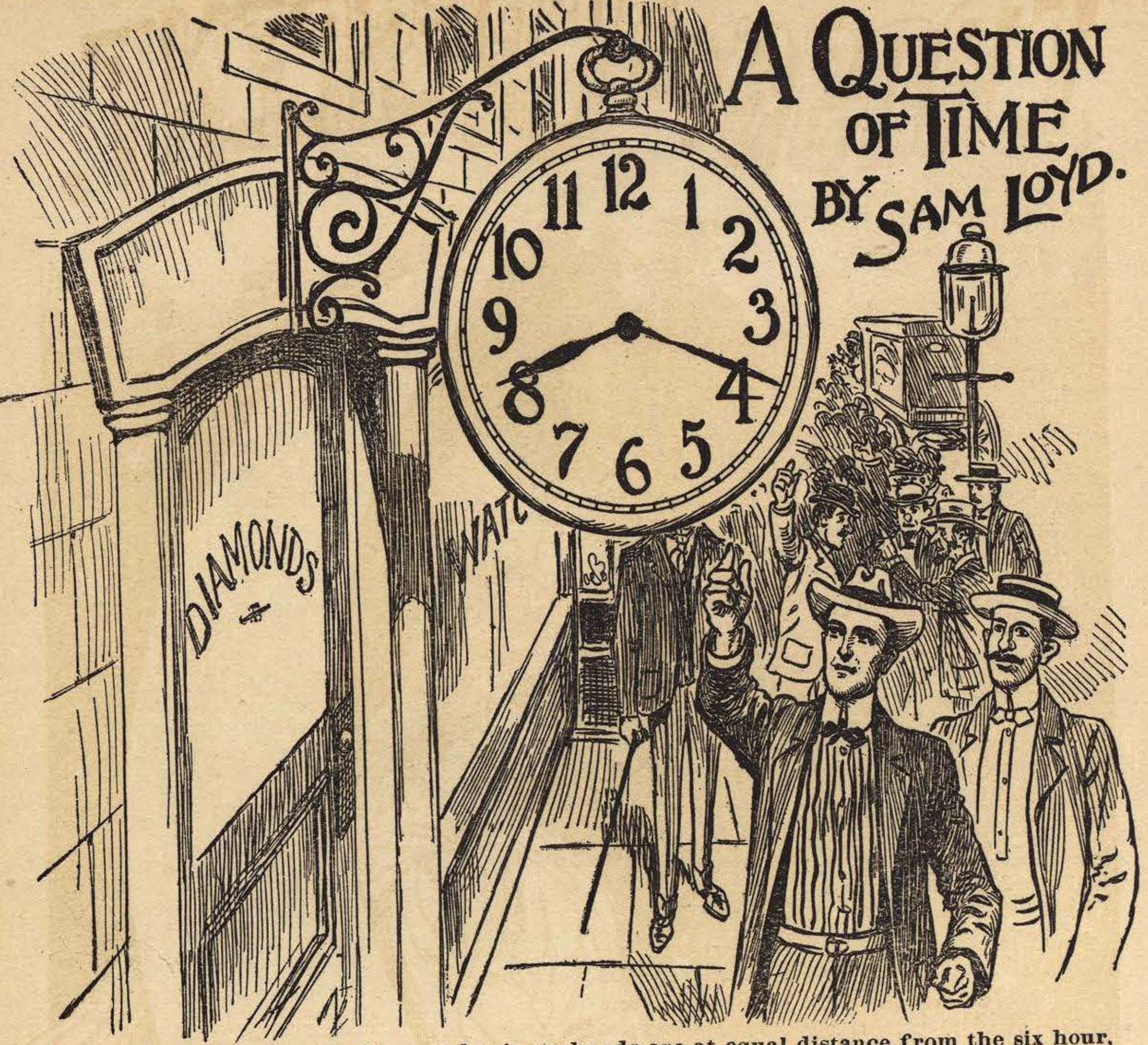
It is merely a rope with a large bucket at both ends running over a free pulley, so that when one bucket goes down the other comes up. The ingenuity of the scheme consists in putting some object in one bucket to act as a counter balance to a heavier article to be lowered in the other.

Now then, supposing that thirty pounds is the limit of difference which would not cause your feelings to be jarred, the following problem presents itself in a way to be readily understood:

A fire occurred one night at a fashionable summer hotel, and all of the people escaped in safety except the night watchman and his family who could not be aroused until all ways of escape were cut off except by the Binks elevator. Now, the combined weight of Mr. Watchman, Mrs. Watchman, baby and dog amounted to just 390 pounds, so the problem is simply to show the quickest way of lowering the family, thirty pounds at a time.

A Question of Time

By Sam Loyd.



PROPOSITION—When the hour and minute hands are at equal distance from the six hour, what time will it be?

A CURIOUS paragraph has been going the rounds of the press which attempts to explain why the signs of the big watches in front of jewelry stores are always alike. They are painted upon the dial, apparently in a hap-hazard sort of a way, and yet they invariably indicate a certain number of minutes past eight. It cannot be attributable to chance, for it would tax one's credulity to believe that such a coincidence could occur all over the civilized world.

There is no accepted rule or agreement established with the jewelers or sign painters, for careful inquiry proves that few of them are aware of the fact or ever noticed that any two are alike. It would be a marvelous case of unconscious imitation if it is looked upon as a mere custom, accidentally following a pattern set by the originator of the device of the sign of a big watch. In London, where they take pride in such things, I saw several big watches, looking as if they had hung in front of the stores for countless centuries, all indicating the same mysterious time, accompanied by the announcement that the firms were established a couple of hundred years ago. I do not doubt for a moment that some such similar sign can be found at Nuremberg, where the watch originated during the Fifteenth Century.

The discussion seems to have brought out a recognition of the fact that from an artistic point of view, symmetry requires that the hands should be evenly balanced, as it were, on both sides of the face of the watch.

If they are raised too much there is a certain "exasperating, declamatory effect" which is not altogether pleasing.

The time would be incorrect if the hands pointed at 9 and 3, and at other points would be too low, so, as a matter of fact, and from an artistic point of view, the position is well selected and is one of the points which, with the aid of a watch, can be shown to be possible. It is a fact however, that the mere puzzle of telling what time the watch indicates, has been held up to public gaze for all these centuries without being thought of or solved?

Take your watch and set it to the time indicated, with the hands at equal distances from the six hour, which shows it to be a possible position, and then tell what time of the day it is!

This is one of the many interesting puzzles which will be introduced to explain in a simple way several problems of the clock and divisions of time with which every one should be familiar.

How many boys know that a cord and stone will time a race more accurately than a $1,000 stop watch?

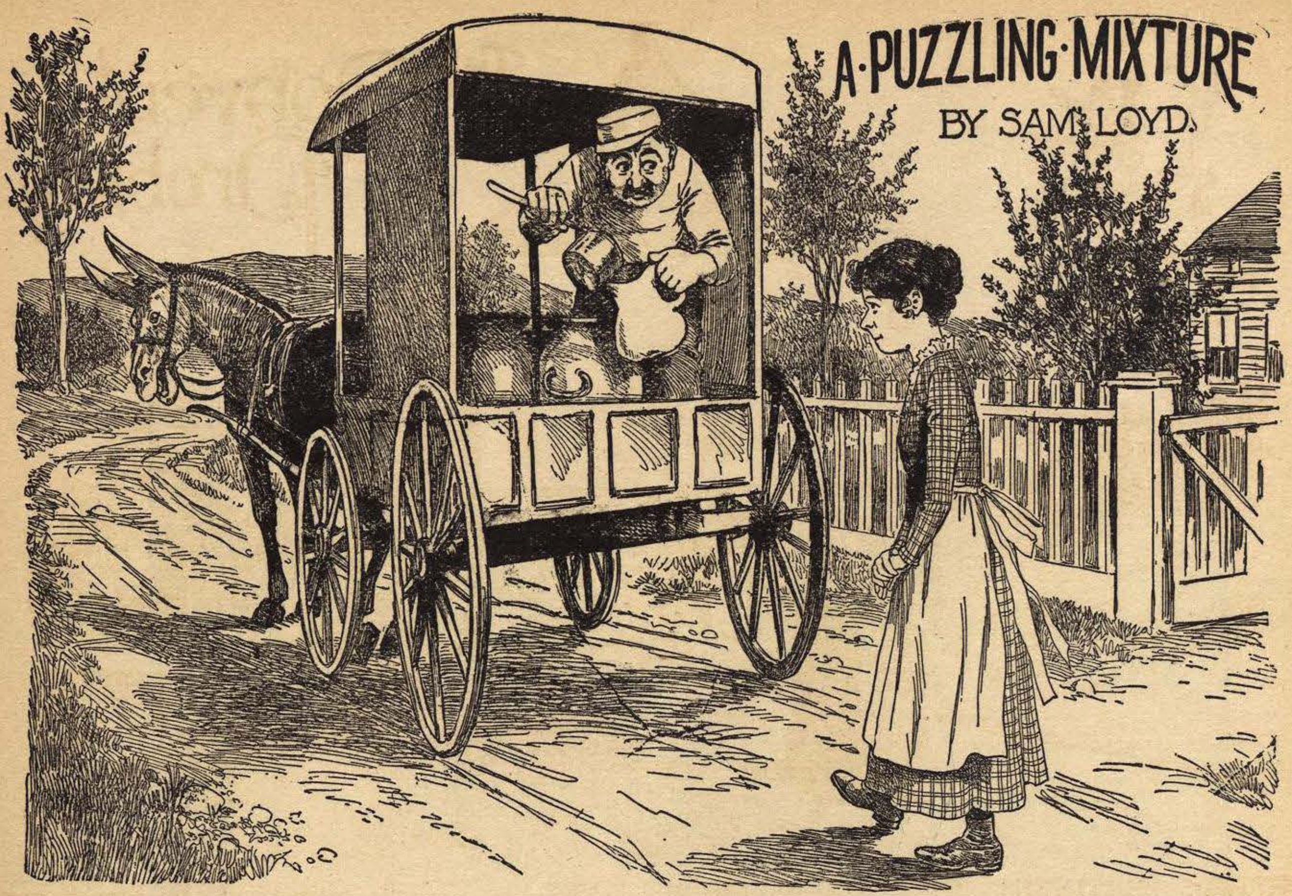
It is safe to say that few know that a watch can be used instead of a compass, or that with the aid of a compass you can set your watch correctly!

Cross and Crescent.

Here is a pretty and scientific puzzle closely allied to Hypocrates' famous mathematic problem of the relation of a square to a lune. The problem in this case being to discover how to convert the crescent into the form of a Greek cross, as shown upon the goddess' head, by cutting the moon into the fewest possible number of pieces which can be fitted together so as to form a cross.

A PUZZLING MIXTURE

BY SAM LOYD



IT IS TOLD THAT AN honest and unsophisticated milkman, who had boasted much about his conscientious dealings and the fact of his never having disappointed a customer, found to his dismay one morning that his supply of milk was inadequate to the demands of his patrons. In fact, his stock was much too short to serve his route, and there was no possibility of getting any more milk.

Realizing the serious consequences which might result to his business, to say nothing about the disappointment and inconvenience to his customers, he was at his wits' end to know what to do in his dilemma.

After turning the matter carefully over in his mind he determined that as he was too conscientious and fair-minded to show partiality by serving some and passing others, he would have to divide what he had among them all, but would dilute his milk with a sufficient quantity of water to make it meet all demands.

Having found, after diligent search, a well of exceedingly pure water which he could conscientiously employ for the purpose, he pumped into one of the cans as many gallons of water as would enable him to serve all of his customers.

Having been in the habit, however, of selling two qualities of milk, one for eight cents a quart and the other for ten, he proceeded to produce two mixtures, in the following ingenious manner, which is suggestive of a clever and interesting puzzle:

From Can No. 1, which contained only water, he poured sufficient to double the contents of Can No. 2, containing the milk. Then from No. 2 he poured back into No. 1 just as much of the mixture as he had left water in No. 1. Then, to secure the desired proportions, he proceed to pour back from No. 1 again just a sufficient quantity to double the contents of No. 2, which leaves an equal number of gallons in each of the cans, as may be readily shown, although there are three gallons more of water than milk in can No. 2.

Now, this is not as complicated a transaction as it looks, for it requires but three changes to equalize the contents of the two cans, but assuming that pure milk cost him two cents a quart, I wish to know how much money he received altogether if he sold out the entire stock at ten cents and eight cents a quart?

It is a pretty problem from the ordinary affairs of life well worth knowing, as it gives an idea of the profits of the milk trust, and explains the Farmers' Union formula for producing standard milk.

A Legal Problem.

A correspondent who wishes to lay claim to an estate in chancery asks if there is a law in any of our states which would have prohibited his grandfather from marrying the sister of his widow. He says that the entire proof of his right of inheritance to an old farm now covered with sky-scrapers and palatial residences turns upon the solution of this question.

The problem has gone the rounds of the puzzle world as a clever catch which turns upon the point that a man must be dead to make his wife a widow, so he could not marry his widow's sister. Nevertheless, there is a good catch within the catch question which fairly reverses the popular answer. From a legal, as well as a practical, standpoint we would inform our correspondent that there was neither law nor objection to his grandfather having married the sister of his widow. Suppose A and B are sisters. The man in question marries A.; she dies, leaving him a widower. He then marries B., who survives him and becomes his widow. Thus he may be said to have married his widow's sister (A.), though she was his first instead of his second wife. The grandson is therefore legally entitled to the old farm with its crop of sky-scrapers.

THE Convent Problem

BY SAM LOYD

AS PERTINENT TO A reference to unsolved, or ancient puzzles the true conditions of which seem never to have been correctly understood, I wish to call attention to one which is popularly known as the Problem of the Nuns. It appears in almost all collections of puzzles, but is very childish and the answer too weak to satisfy the expectations of solvers.

I remember that the answer was very disappointing when I first saw it many years ago, and I recall the accompanying statement about its being of Spanish origin and founded on an incident which occurred many centuries ago. Recently I came into possession of some very old Spanish histories, in one of which I find a brief allusion to the convent of Mt. Maladetta, situated on the mountain of that name, mentioned as being the highest peak of the Pyrenees. Reference is made to the occupancy of that part of the country by the French invaders who were finally defeated and driven out through that famous pass which was the scene of many contentions for over a century.

The direct allusion to the puzzle, however, occurs in the passage which says: "Many of the nuns were carried away by the 'Frank' soldiers, which without doubt gave rise to the familiar problem of the nuns of the convent of Mt. Maladetta."

As no explanation of the puzzle is vouchsafed, and the popular version is so susceptible of double solutions, I take the liberty of presenting it in a form which preserves the spirit of the problem and at the same time eliminates the many other answers.

The convent as shown in the picture, was a square three-story structure, with six windows on each side of the upper stories. It is plain to be seen that there are eight rooms on each of the upper floors, which agrees with the requirements of the old story. As the legend goes, the upper floors were used for sleeping apartments, of which the top floor, having more beds in each of the rooms, accommodated twice as many occupants as the second floor.

The mother Superior, in accordance with an old rule of the founders, insisted that the occupants must be so divided or arranged that every room should be occupied; there should be twice as many on the top floor as on the second, and that there must always be—neither more nor less—just eleven nuns in the six rooms on each of the four sides of the convent. Of course it is plain to be seen that the problem pertains to the two upper floors, so that the ground floor does not have to be considered at all.

Well, it so happened that after the retreat of the French army through the Pyrenees pass, that nine of the youngest and most comely nuns were found to have disappeared, and it was always believed that they had been captured by the soldiers. Not to distress the mother Superior, however, the nuns who discovered the loss found that it was just possible to conceal the fact, by a judicious manipulation or change of the occupants of the rooms, a maneuver with which they had long been familiar, as when at times it became necessary to conceal the absence of some of their more zealous workers.

So they managed to readjust themselves in such a way, that when the mother Superior made her nightly rounds, every room was found to be occupied; eleven nuns on each of the four sides of the convent; twice as many on the top floor as on the second, and yet the nine nuns were missing. How many nuns were there and how were they arranged?

The merit of the puzzle lies in the paradoxical conditions of the problem, which strikes us at the first blush to be absolutely impossible. Nevertheless it yields so readily to experimental puzzle methods, when one knows there is an answer, that our puzzlists will find it an amusing and instructive lesson.

The Office Boy's Puzzle

PROPOSITION—Can you decipher the rebus sign on the door of the directors' room?

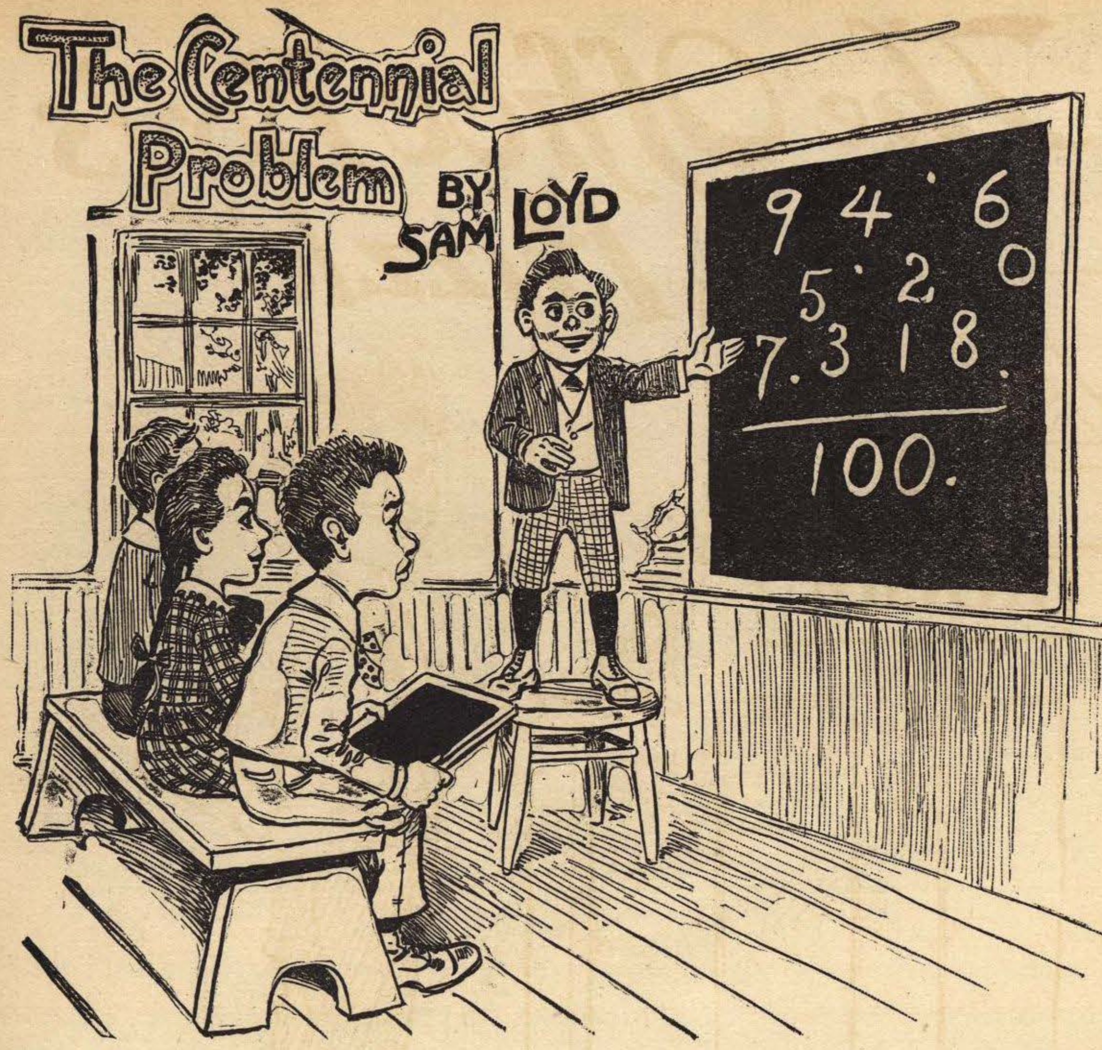
IT IS NOT GENERally known that in the bank, where I worked myself up to the presidency, and made that great financial coup, just before making a Candian tour, I first made my debut as office boy. It was due, it was said, to a phenomenal genius for making a puzzle out of every little thing that came under my notice that it was unanimously voted that some other position should be tendered me.

To illustrate my earnest desire to make everything clear by kindergarten methods, I recall that just before I was promoted, there was a meeting of the directors, and I took occasion to pin an explanatory sign on the door of their room, just to see which of them had brains enough to decipher it. I looked upon it as a sort of competitive test, as it were, to decide which of them was best qualified to fill the position of teller, which was vacant at the time; but, as none of them could tell, I thought that somebody about my own size was best qualified to fill the position, and therefore used it as a stepping stone to the presidency. Doubtless many of our puzzlists of an older growth will recall the incident and can furnish the answer to such as are ambitious to improve their positions by similar tactics.

What lesson of life can the small boy learn from the fire engine? It must work or it can't play.

The Centennial Problem

BY SAM LOYD



PROPOSITION—Arrange the ten figures, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0 and the four dots so they will add up exactly 100.

OVER A QUARTER OF a century ago, when the centennial of 1776 was duly celebrated in Philadelphia by a grand exposition, I designed a little arithmetical puzzle, which gave rise to considerable discussion. The conditions of the problem, correctly stated, were to arrange the figures 1 2 3 4 5 6 7 8 9 0 and the four dots in such a way that they would add up so as to make exactly 100. The puzzle was quoted and republished all over the world, accompanied by explanations or criticisms so different from those actually expressed and intended that the real answer was never published. Owing to the fact, therefore, that scores of solutions which were supposed to fill the bill, would not fairly satisfy the conditions, I am sure that it will interest such readers to discover wherein they were mistaken, for which reason the terms are again stated: Simply arrange the figures and dots so that by one addition, without the use of signs or numbers other than those shown on the black board, they will make the given answer of 100 correct.

Despite of its apparent simplicity this little puzzle embodies a most scientific mathematical principle which every one should know, and it is now given to introduce or pave the way for a new and interesting class of puzzles, which explains an important and interesting feature, which every teacher and lover of mathematics or even elementary arithmetic should understand.

A Poetical Perplexity.

Here is a clever potpourri of well-known lines to test a person's acquaintance with famous authors:

The curfew tolls the knell of parting day
In every clime, from Lapland to Japan;
To fix one spark of beauty's heavenly ray
The proper study of mankind is man.
Tell, for you can, what is it to be wise,
Sweet Auburn, loveliest village of the plain.
"The Man of Ross," each lisping babe replies,
And drags, at each remove, a lengthening chain.
Ah, who can tell how hard it is to climb
Far as the solar walk or milky way?
Procrastination is the thief of time,
Let Hercules himself do what he may.
'Tis education forms the common mind,
The feast of reason and the flow of soul;
I must be cruel only to be kind,
And waft a sigh from India to the pole.
Sphax! I joy to meet thee thus alone,
Where'er I roam, whatever lands I see;
A youth to fortune and to fame unknown,
In maiden meditation, fancy free.