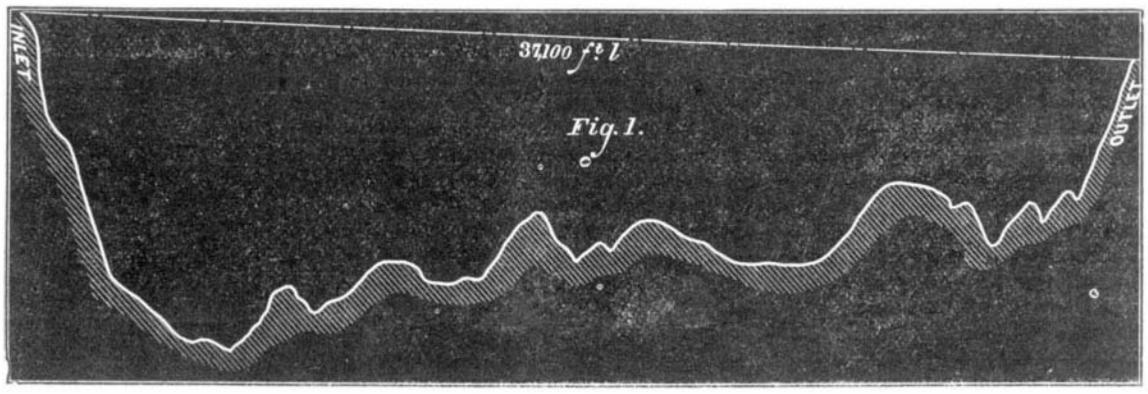
HYDRAULIC ENGINEERING EXTRAORDINARY.

An iron conduit has recently been constructed which, according to the *Mining and Scientific Press*, sustains the greatest water pressure in the world, namely, 1,720 feet, or 750 pounds to the square inch. It carries the water supply of Virginia City and Gold Hill, Nevada, from Marlette lake, situated at an elevation of about 1,500 feet above the former town, over a valley seven miles in width, the sides of which are steep and precipitous, and through a route presenting engineering difficulties of unusually troublesome nature. The most awkward feature of the undertaking begins at an elevation of 1,885 feet above the track of the Virginia and Truckee railroad, at a point about two miles west of Lake View Toll House, and thence follows by an easterly course the crest of the spur from which it starts: crosses the valley, at the toll house referred to, and gradually ascends to its outlet end, making the entire length 37,100 feet. The water at present is taken from Dall's Creek by an 18 inch flume four miles long, to the inlet, or western end of the pipe. From the outlet or eastern end of the pipe, the water is conveyed through a flume of the same size, nine miles long, into Virginia and Gold Hill, where it connects with the present city pipe system. In the future the water from Marlette lake will be conveyed to the inlet of the pipe, and be added to the supply from Dall's Creek.



HYDRAULIC ENGINEERING IN NEVADA.

All the iron pipe used is coated, inside and out, with a mixture of asphaltum and coal tar, thoroughly boiled together, each separate piece being plunged and rolled about in a bath of this mixture for from seven to ten minutes before being shipped to its destination. The average diameter of the pipe is 11½ inches, and its entire weight about 700 tuns. Nearly one million rivets were used to manufacture it, and some 35 tuns of lead were required in making the joints. At the point of heaviest pressure the iron is No. 0 thick, and is hot riveted with five eighths inch rivets, there being a double row on the straight seam and a single row on the round seam. The pressure gradually decreases as the ground rises to the east and west, and the iron decreases in thickness from five sixteenths to one sixteenth of an inch toward both inlet and outlet. But on its course to the outlet, it having to cross a great many spurs and sags, the iron varies of course according to the pressure.

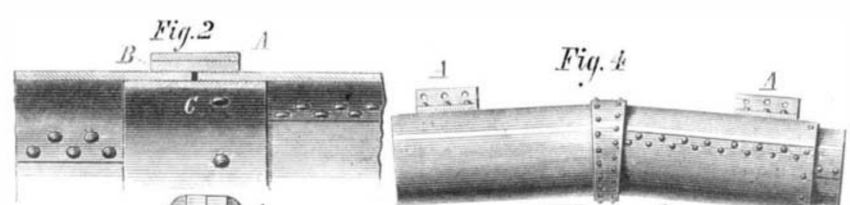
The inlet has a perpendicular elevation above the outlet of 465 feet, but just now only 300 feet is used, as this head will supply ten times as much as the two towns have heretofore had. This head carries into Virginia about 2,000,000 gallons every 24hours; and by increasing the head to its fullest capacity, the supply can be increased to 2,350,000 gallons per day.

Fig. 1 will convey an idea of the country over which this undertaking was carried out as it shows the profile of the pipe. The remaining engravings represent various ingenious plans adopted in the construction. Fig. 2 shows a lead joint in detail, said to be perfectly tight and safe. One of these joints is made between every two lengths of pipe of 26 feet 2 inches in length each; *a* is a wrought iron collar, always one sixteenth thicker than the thickness of iron in the respective pipe, leaving a play of three eighths of an inch between the inside of the collar and the outside of the pipe. The collar is five inches wide. *b* is the lead which is run in and caulked up tight from both sides three eighths inch thick; C is a nipple of No. 9 iron, riveted in one end of each pipe.

Fig. 3 shows the method of tightening leaky joints. At A is the clasp, the application of which, for forcing back the lead where it works out on account of the longitudinal expansion and contraction of the pipes, is clearly evident. A clamp is used to keep the lead afterwards in place. Fig. 4 is the elbow used for making short curves in the line of the pipe around rocky bluffs, through sharp cañons, etc. At B are angle irons riveted on the pipe on the outside of the curves which, by means of iron straps, are connected with the corresponding angle iron on the next pipe. Fig. 4 shows the manner in which the pipes and elbows were strapped together, wherever the curve was sufficiently short to require this precaution against an outward movement. The iron strap is put on the outside of the curve to strengthen the pipe. Fig. 5 shows the self-acting air or vacuum valve, used at each high point on the line of pipe. When the water is on, the valve, A, is kept wide open; the small valve, C, is shut, while the valve, B, is shut by the pressure. If any air accumulates in the pipe, on the elevation where this air cock is placed, it is occasionally blown off, by opening the cock, C. Should a break occur in the main pipe line at a point lower than the air cock, and within its district, the valve, B, falls down and admits the air into the main pipe so as to prevent a vacuum. Should the valve, B, get out of order, the valve, A, is shut, and the other valve, B, taken off and repaired. After a break on the main line is repaired, and the water let on again, the valve, B, being down or open, the air rushes out at B, its stem being weighted by the weight, D, so as only to close when the water begins to escape.

From the time of commencing the manufacture of the pipe until the water ran into Virginia City, only five months elapsed, ending in August last. The Risdon Iron and Locomotive Works constructed the pipe, and the credit of the accomplishment of the undertaking is due to the engineer, Mr. Herman Schussler.

It is difficult to say which characteristic of our Western engineers is the more remarkable, the courage with which they attack the most stupendous and difficult problems, or the promptitude and celerity with which they carry out their ideas. There is a great future for a country which produces such men and such achievements.



HYDRAULIC ENGINEERING IN NEVADA.

THE CANOPUS STONE.

Hitherto, almost the only guide for interpreting the hieroglyphics with which the monuments of Egypt are covered has been the Rosetta Stone, brought to England by the British army, after the expedition of 1801, and now in the British Museum.

But this is in every way inferior to the stone of Canopus. Half the lines it contains are incomplete, in consequence of the stone being broken and the fragments lost; and of the remaining lines many are defaced or illegible; whereas the stone of Canopus is almost as perfect as on the day it left the sculptor's hand. This inscription was accidentally discovered about seven years since at the southwest corner of Lake Menzaleh, one of the lagoons on the coast of Egypt; and on the old Tanitic branch of the Nile are the ruins of San, the Zoan of Scripture. It is a place very little visited, being remote and not easy to reach. But to judge from the numerous obelisks, statues, and remains of temples still existing there—especially that of Rameses II.—San must once have been a place of much importance. About five years ago a portion of the west wall of the temple of Rameses fell, and exposed the corner of a stone covered with Greek characters. in this state the inscription remained some time; at length its value was perceived, and it was removed to the Viceroy's museum at Boulac. It is of fine grained limestone, of light gray color, about seven feet high, two and a half feet broad, and the same deep, and bears three inscriptions, each on a separate side, in hieroglyphic, in Greek, and in the Hieratic (or Egyptian) characters.

It is a copy of a decree made in the ninth year of the reign of Ptolemy III. (Ptolemy Euergetes) by the priests of Egypt, assembled in solemn conclave at the great temple of Osiris, in Canopus. which is called, in the decree, the "Temple of the Euergetæ."

Of this magnificent temple not a fragment now remains; indeed, its very position can only be conjectured. As to the town of Canopus itself, the visitor may trace its site by the high mounds of rubbish over it. It was built on a high promontory (a little to the west of the bay of Aboukir), about fourteen miles to the east of Alexandria. For many years past, nothing of its buildings above ground could be seen, and lately the very foundations have been dug up to provide stone for the fortresses now building on the spot, by order of the viceroy, Ismail Pasha.

The position of Canopus, on one of the large canals or mouths of the Nile, and on the highest ground to be found for many leagues along the coast, must have made it healthy and pleasant; and it was a very flourishing, but, at the same time, a most dissolute, city. There was an open space, planted with trees, in front of the temple. On either side of it were altars belonging to the temples of the first order. After offering sacrifice upon these, and performing the necessary ceremonies for the apotheosis of Berenice, the assembled priests made the decree recorded on the stone.

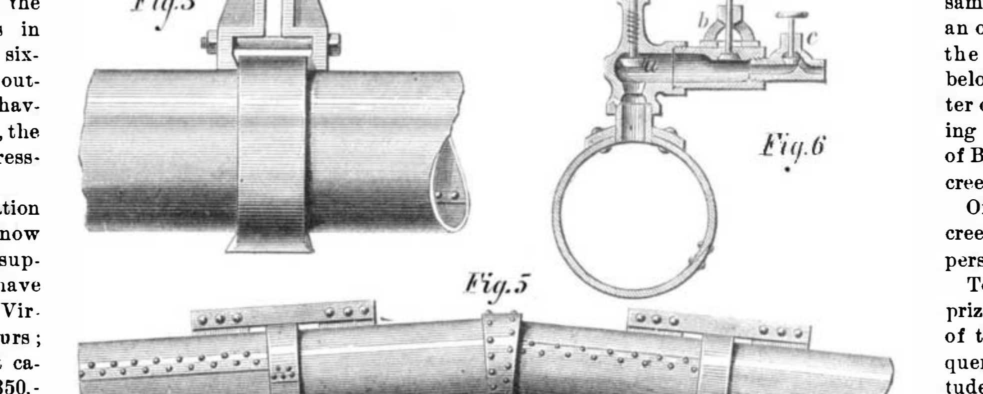
One of the most remarkable points in this decree is the assigning Divine honors to a living person.

To the Egyptians, not the least esteemed prizes of their King's victory. were the images of their gods, which Cambyses, the Persian conqueror of Egypt, had carried off; and in gratitude for their recovery, his subjects conferred upon Ptolemy the title of Euergetes (the benefactor).

It praises the King's great care for the sacred animals, especially for the worship of Apis and Mnevis.

After setting forth the merits of their rulers, and proclaiming the extraordinary honors to be offered to them, the priests established a fifth priestly tribe, for no other apparent reason than because the king's birthday was the fifth of the month Dios. And then they pass on to the real business of the meeting.

In addition to the three monthly festivals of the Euergetæ, on the 5th, 9th, and 25th days, "decreed in a former proclamation," they ordain that a general public festival for five days shall be held every year, in honor of the Euergetæ, commencing on the day "on which the star of Isis rises," "which in the sacred writings is considered New Year's day." Now in this 9th year of the reign of Euergetes, the rising of "Sirius" occurred on the 1st of Payni (July 19th) and they decided that this 1st Payni, reckoned according to the common computation, should be the first day of the Euergetan festival for four years. And that every fourth year, one additional day (besides the usual five intercalary days) should be kept as a public festival in honor of the rulers; thus introducing on every fourth year six instead of five intercalary days.



THE CANOPUS STONE.

By the former of these two provisions, the priests introduced the Sirius year of 365¼ days, in place of the common year of 365 days; and by the latter means, placing their reform under the protection of the monarch, they provided for the surplus six hours in every year, while by making the extra intercalary day a general festival, "both in the temples and throughout the whole country," they kept it in the people's memory.

The inscription does not inform us in what year this sixth intercalary day was first to be kept, but it is natural to suppose that the new arrangement would be brought into force as soon as possible, that is, in the then existing year.

It is probable that this reform of the calendar was not effected without much opposition. It lasted through the reign of Ptolemy III. But in B. C. 222-1 he died; his son Ptolemy Philopater succeeded him, and then this sixth intercalary day was no longer kept. There seems to have been a reaction Sirius the year was no longer observed, and the common year, of 365 days only, again prevailed. The old irregularities gradually became apparent: and the reform, which in consequence became necessary, was effected during the reign of Augustus in the year B. C. 26.

The latter part of the inscription recounts the honors decreed to the deified Princess Berenice. Her statue is to be placed in the great temple at Canopus, near the statue of Osiris. In all temples of the first and second orders, a statue of her, made of gold and adorned with jewels, is to be kept in the adytum; a four days' festival in all the temples is to be kept in memory of her, beginning on Tybi 17th (March 7th), the day on which the mourning for her ceased and her apotheosis was decreed. On the festivals of the other divinities her image is to be carried in the procession. Hymns are to be sung in her honor, and regular rations given to the maiden daughters of the priests who do service to her.

Lastly, the presiding high priest in each temple, and the temple scribes, are charged to set up in every temple of the first, second, and third order, and in the most conspicuous place, a copy of the decree, carved in Hieroglyphic, Egyptian and Greek characters, on a pillar of stone or brass.

Out of the many copies that must have existed, this is the only one hitherto discovered.

Correspondence.

The Ventilation of the United States Senate Chamber.

To the Editor of the Scientific American:

Allow me a few words of comment on the article on ventilating the Senate Chamber in your issue of December 13, 1873.

Ventilation is a very simple thing; and to secure it, it requires only to be not prevented or obstructed. Nature will ventilate any apartment if it is only allowed to do so. As easily as a man draws his breath, so will an apartment, crowded or not, ventilate itself if it be allowed a throat to do it with. To devise fans, steam engines, exhausts, or injectors to ventilate the senate or other house, is only foolishly trying to help Nature to do work which she can better do without help. It would be no more absurd to invent a whirligig to put into a man's mouth to help him to draw his breath than it is to devise an injector and an exhaust to force in pure and draw out impure air to and from a room. To help a river over a waterfall is not more preposterous than, by moving apparatus, to accelerate the entrance of fresh and the exit of foul air from a crowded hall. The same force which makes the water descend, gravity, forces cold air under hot air and makes it ascend. If the foul air of a crowded hall could be seen and handled, the nature of its movements would have been long ago as well understood as those of water. Supposing foul air were the color of dense smoke, it would be seen to accumulate at the ceiling. If it could be seen that it always tended upwards, a hole in the roof would be the natural result of the desire to get quit of it. The amount of haziness regarding this simple matter in the minds of scientific men is unaccountable. The thousands of pounds and the amount of abortive invention spent on the ventilation of our Parliament Houses might make the angels weep, and all for what? To force atmospheric air to obey a law of its nature, which it cannot of itself disobey. As the sparks fly upwards so will heated air, if it is not restrained; and herein consists the whole secret of ventilation. It needs no device to float a cork; neither does it need any machine, fan, steam engine, exhaust, or injector to purify the air of the Senate House. All that is strictly required is an entrance for fresh air below, and an exit for foul air above. These provided, ventilation will work in spite of all the wrong headed theories of the *savans* and without the well meant but useless inventions usually erected to assist Nature. If these holes are large enough, no hall need be either impure or oppressive. If the place be half filled, the supply of pure air will be enough. If crowded, it will be augmented to meet the larger demand. Every person who enters is a machine to make the current inwards and outwards work more vigorously; and every one who leaves deducts from the demand and the power to supply. The atmosphere is a nicer balance than ever man made, and vibrates to a counterpoise infinitesimal beyond his conception. It is a comfortable as well as an undeniable fact that the objects which require ventilation are the very means to create it. Fires, lights, and man himself, if they consume pure air, also heat it, causing it to ascend and give place to a new supply, which in turn is consumed, heated and pushed upwards. This process, which is never ending, is simple, admirable, exact, and complete. It requires no assistance, has worked from the beginning of time, and will work, though there be neither *savan* nor machinist in existence.

If our halls, like the ancient Greek, were without roofs, ventilation would cause us no thought. The foul air from our lungs and bodies would ascend right into the air, and a fresh supply would come down to us through the same opening. But our houses and halls are ceiled, and the currents are prevented taking their natural courses. Even in a ceiled chamber, if an open space be left large enough, the ascending and descending currents through it would supply all the ventilation required by a crowded assembly. But it is more convenient, as the modern fashion of buildings is and as our climates require, to admit our fresh air at the lower part of our houses instead of at the top. By this mode a smaller opening in the roof suffices. A very much smaller opening is needed than many would suppose. And here I beg to take exception to a statement in the article referred to. It is there said that the machinery injects 25 cubic feet of air per minute for every man of 1,200 assembled, or it is capable of doing so. This quantity is ridiculously overdone. A man does not consume even one foot of air per minute by breathing; 15 inhalations of 60 cubic inches each make only 900, and a cubic foot contains 1728. Take man by man in an assembly, half a foot per minute is all each will consume. One can inhale through a half inch tube more air than he requires. Even a quarter inch one will not oppress him much. I speak of a round tube, but, if you will, take a square one. Of this a square foot will represent 576 persons' breathing area, and will admit air sufficient to supply that number. It may be said the velocity of air into a crowded chamber is not so great as that of the air through the tube when one breathes by it. But it is to be remembered the air is passing into the lungs only half the time, while the inward rush to supply an assembly hall is constant. The fact is the current inwards and outwards in a chamber, ventilated in the natural way which I indicate, is quite as fast as the current in and out of a man's windpipe.

But in an assembly hall at night, the lights must be supplied with fresh air as well as the occupants. I need hardly mention fires, as it is not usual to have them in such places. If they be used, they also must have their supply of air, and they will take an amount of inlet for themselves, equal to the united areas of their chimneys. I suppose there are no fireplaces in the Senate Chamber; but a crowded hall gets heated, and an extra supply of air is demanded on that account. If such is the case, it calls in its own supply. The velocity both inwards and outwards increases and the temperature falls. If the air of a hall be pure, heat is not so oppressive. It is impure air that exhausts and makes people pant. Taking your estimate, 1,200, as the usual number in the Senate Chamber, a hole in the roof equal to two square feet, with an under inlet the same, are ample to supply all the breathing air required. The lights may be allowed as much, and the heat an equal space. As a large hole is about as cheaply made as a small one, and as plenty of outlet does not affect the people below, the openings may be made double or even treble the size mentioned without fear of inconvenience. These openings must be free to the atmosphere, but may be made with louvres to keep out the rain. A hinged skylight is as good as anything else. As a cistern of water will be emptied if any sort of hole be driven through the bottom, so will a crowded hall be refreshed if any sort of hole is driven through the roof.

I am sorry I did not get admission to the Senate House when I visited Washington, else I might be more precise in my suggestions. But I believe that there is a ceiling between the outer roof and the audience, and that this ceiling is pierced with ornamental fretwork, and that the piercing is equal in area to what I have indicated as necessary for outlet.

The inlet of fresh air is the next thing to be considered; and while it is equally simple in principle as the outlet, it is not exactly so in practice. The outlet may be anywhere in the roof. It may be far larger than really required. It may be one large opening, or it may be many small ones. The inlet must be a great many small openings, or a disagreeable current will blow in one place and inconvenience those near it. But even this is a simple matter. An opening in the masonry under the joists of the floor, communicating with the outer air, will allow a fresh current to rise through small gratings in the passages between seats. Or if the corridors have proper air holes, a supply to the main chamber may be got from them by slits above the doors. Or air may be let in along the channel where lie the heating pipes and allowed to find its way to the chamber through small grate work along the base of the wainscoating. The modes for small inlets are endless. And let me say the united areas of the divided inlets need not be so great as those of the outlets, because they are supplemented by chinks of windows, thresholds of doors, etc. I would impress on all objectors that no inconvenience from the currents will be felt, if an inlet area of 8 or 10 feet be properly scattered over a room of the size of the Senate Chamber.

Allow me a few words on the long pipe proposed, to suck the air from the park 220 feet off. I do not know what purer air people would wish than that at the Capitol. It blew on me as fresh as mountain breezes. It is all people have to breathe who are walking outside; and if those inside get the same, what else do they want? One undeviating law of air currents is that they always take the shortest available cut and depend upon it, the ventilating air of the Senate house will never run through a long pipe if it can get in at an open door nearer its work. The whole thing is of a piece with the London delusion, and indeed is a counterpart of it from beginning to end.

Paisley, Scotland. WM. MACKEAN.

To the Editor of the Scientific American:

I have read an article in your issue of December 13th, 1873, on the above subject, and I understood the difficulty (remedied by the charges described) to be the want of sufficient area, and the proper arrangement of the air passages from the old fan to the Senate Chamber. Unless there is some mistake in your explanation, there was, in my opinion, no necessity for the new fans, engine, and the two air shafts, which in all probability occasioned a large expenditure. I venture my opinion on these grounds: You say that the capacity of the old fan was 80 revolutions per minute, discharging 500 cubic feet of air at each revolution, making in all 40,000 cubic feet of air per minute; and that in consequence of the defect, it was producing but one fourth of the ventilation that it had the capacity to furnish. As you state the capacity of the new fans to be 30,000 cubic feet per minute, it appears there was at least no want of capacity in the old fan, and that in comparison with forced ventilation, there is no advantage in ventilating by exhaustion. In my opinion, Mr. Hayden selected a very indirect, as well as an extravagant, method of remedying a very simple matter.

CHICAGO.

Mental Arithmetic.

To the Editor of the Scientific American:

The young mechanic who hopes to excel in his chosen trade should endeavor to become skillful in mental arithmetic; and at the last analysis, all computation is strictly mental, the figures employed being only tallies to record results. I will give a table illustrating the theorem that the product of any two numbers is equal to the square of half their sum less the square of half their difference, that long practice proves to be a useful method of multiplication:

$$6 \times 6 = 36 = 6^2$$
$$7 \times 5 = 35 = 6^2 - 1^2$$
$$8 \times 4 = 32 = 6^2 - 2^2$$
$$9 \times 3 = 27 = 6^2 - 3^2$$
$$10 \times 2 = 20 = 6^2 - 4^2$$
$$11 \times 1 = 11 = 6^2 - 5^2$$

This theorem may be expressed algebraically, thus: $(a-x) \times (a+x) = a^2 - x^2$, and numerically as in the table.

Suppose it is required to multiply 53 by 47. Half their sum is 50, the square of 50 is 2,500, and the answer sought is that sum less $3^2 = 9 = 2{,}491$. In practice, such an example can be solved almost instantaneously. If 47 times 54 were required, proceed as in the example and add 47 to the product.

To use this method, considerable knowledge of square numbers and of some of their remarkable properties is required; and the careful study of difference series will be beneficial. This study has proved an excellent means of initiating pupils into the mysteries of square and other roots, enabling them to become proficient in a short time. There are many similar things in the curious and wonderful science of numbers that, like the magic squares given in your issue of December 20, 1873, are of far more value than is generally supposed. Let some one arrange them in a suitable form and put them into the hands of the Yankee boy.

New Britain, Conn. F. H. R.

The Relative Attraction of the Earth and the Sun

To the Editor of the Scientific American:

The semidiameter of the earth is, in round numbers, about 4,000 miles, and that of the sun 425,000 miles. An object situated on the surface of the earth will, therefore, when turned toward the sun, be 22,874 times farther from the center of solar attraction than it is from the center of terrestrial attraction; and when turned from the sun, it will be 22,876 times as far from the sun's center as from the earth's center. Now as the strength of attraction varies inversely as the squares of the distances, the pull of the earth's mass will be $22{,}874^2$ times as great (on a body on the surface of the earth turned toward the sun) as the pull of an equal solar mass will be; and when the object is away from the sun, the pull of the earth will be $22{,}876^2$ times as great as the pull of an equal solar mass. But, as the sun's mass is estimated to be 215,000 times as great as the earth's mass, the total pull of the sun on an object in the two supposed situations will be: $\frac{315{,}000}{22{,}874^2}$ and $\frac{315{,}000}{22{,}876^2}$ times that of the earth.

$$\frac{315{,}000}{22{,}874^2} = \frac{315{,}000}{523{,}176{,}276} \text{ and } \frac{315{,}000}{22{,}876^2} = \frac{315{,}000}{523{,}211{,}376} \text{ or } \frac{1}{1{,}660{,}877} \text{ and } \frac{1}{1{,}660{,}688}.$$

Now if the foregoing estimates be correct, there must be, in certain situations, a sensible difference between the weight of a given mass when on the surface of the earth in the direction of the sun, and the weight of the same mass when the earth has turned it away from the sun. This could be verified by experiment.

Let the place be at the equator, and the time of the experiment be one of the equinoxes. Suppose scales to be constructed of the capacity of several tuns and of the utmost possible delicacy. Now let us try our experiment with a weight of 10 tuns. Its weight at noon will be 10 T— $\frac{1}{1660877}$ of 10 T. and its weight at midnight will be 10 T. + $\frac{1}{1660688}$ of 10 T. or: Noon weight = 20,000 lbs.—12 lbs. 10 drams = 19,987 lbs. 15 ozs. 6 drams. Midnight weight = 20,000 + 12 lbs. 8 drams = 20,012 lbs. 0 ozs. 8 drams, making a difference between the noon weight and the midnight weight of 24 lbs. 1 oz. 2 drams.

If astronomers have miscalculated the relative masses of the sun and the earth, will not this experiment indicate the fact? And if we experiment in the same manner with the moon's attraction, may it not lead us to modify our statements of relative masses still further? And, moreover, may it not lead to a reconstruction of our tables of distances? If the principles set forth herein be correct, would not such an experiment be as worthy the interest of the great powers as are those expeditions of observation, so munificently aided, to