XXXVII. On the improvement of time-keepers

David Rittenhouse LL.D.

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mosaic represents a hunting party. *Observations sur la Mosaïque des Anciens, à l'Occasion de quelques Tableaux en Mosaïque, qui se trouvent à la Galerie des Peintres de l'Electeur Palatin*, par M. l'Abbé Hæfflin, in the *Comment. Histor. Academiæ Theodoro-Palatinae*, Vol. V. No. 3, p. 89: Mannheim 1783; 4to. M. Hæfflin compares mosaic in glass and in stone with the paintings executed by means of the feathers of birds by the Americans: *Explication de la Mosaïque de Palestrine*; par M. l'Abbe Barthelemy: Paris 1760; 4to. And in the *Memoirs of the Academy of Inscriptions*, Vol. XXX. Kircher in his *Latium*, and Montfaucon in the fourth volume of his *Supplément de l'Antiquité Expliquée*, had before attempted to give an explanation of this mosaic: *Observationi di Ennio-Quirino Visconti, su due Musaichi antichi istoriati*: Parm. 1788; 4to. These two mosaics, which, according to Visconti, relate to pyromancy, were found, in 1788, in the Campagna di Roma. They are now in the collection of the chevalier Azzara; *Description de la Mosaïque trouvée à Seville, et publiée par Ordre du Roi d'Espagne*. Alexander Laborde is about to publish a description of nine mosaics found in Spain.

XXXVII. *On the Improvement of Time-Keepers.* By DAVID RITTENHOUSE, LL.D. *President of the American Philosophical Society* *.

THE invention and construction of time-keepers may be reckoned among the most successful exertions of human genius. Pendulum clocks especially have been made to measure time with astonishing accuracy; and if there are still some causes of inequality in their motions, the united efforts of mechanism, philosophy, and mathematics, will probably in time remove them.

The last and least of those causes, which perhaps may be worthy of notice when all others of more importance are removed, is that rising from unequal density of the air, which by varying the actual weight of the pendulum will accelerate

* From the *Transactions of the American Philosophical Society*.

or retard its motion. The effects arising from this cause will indeed be found very small; for, if we suppose the greatest range of the barometer to be three inches, which indicates a change of density in the air of above one-tenth of the whole; and supposing lead, of which pendulums are generally made, to be 8,800 times heavier than air, the variations of the actual weight of a pendulum may be 1-88000th part of its whole weight, and consequently the change in its rate of going 1-176000th part. And, as there are 86,400 seconds in a day, the clock may vary in its rate of going, from this cause, about half a second in 24 hours. Mentioning the barometer, seems naturally to point out a remedy for this cause of irregularity by means of that instrument. But my design is at present to describe a very different and extremely simple method, which, though only a matter of curiosity at present, may at some future time, perhaps, be found useful; especially as the variation above mentioned is governed solely by the actual density of the surrounding air, and the barometer can only give the weight of an entire column, which does not strictly correspond with the density of its base; whereas the method I propose depends on the real density of the air surrounding the pendulum, and nothing else.

Let AB (Plate VII. fig. 1.) be a pendulum vibrating on the point A, and removed from the perpendicular line DE. Let the inflexible rod be continued from BA to C, and let a body C, of equal dimensions with the pendulum B, but hollow and light as possible, be fixed on the rod, making AC equal to AB. Now it is evident that B will be pressed upwards by a force equal to the weight of its bulk in air, and its descent retarded. But the body C will be equally pressed upwards, and consequently the motion of the pendulum towards the perpendicular will be as much accelerated. These two forces, therefore, will destroy each other, and the pendulum will perform its vibrations in equal times, whether the air be light or heavy, dense or rare.

I have, for greater perspicuity, described the most simple case, but perhaps not the most eligible; for, if we can enlarge

the vessel or body C in any proportion, the distance of its centre from A may be diminished at the same rate.

However plausible the above may appear in theory, no doubt difficulties will occur when we attempt to reduce it into practice. But I am persuaded they will not be found insuperable.

The only experiment I have hitherto made on this subject has been merely to show that a pendulum can be made in this manner which shall vibrate quicker in a dense medium than in one more rare, contrary to what takes place with common pendulums.

I made a compound pendulum, on the principles above mentioned, of about one foot in its whole length. This pendulum, on many trials, made in the air 57 vibrations in a minute. On immersing the whole in water it made 59 vibrations in the same time, showing evidently that its motion was quicker in so dense a medium as water than in the air. When the lower bob or pendulum only was plunged in water, it made no more than 44 vibrations in a minute; the remaining 15 being solely the effect of the pressure of the water against the upper vessel C.

XXXVIII. *Description of a new invented Steam-Engine, intended to give Motion to Water-Wheels in Places where there is no Fall, and but a very small Stream or Spring.*
By JOHN NANCARROW*.

A, Plate VII. fig. 2.) the receiver, which may be made either of wood or iron.

B, B, B, B, B, wooden or cast-iron pipes, for conveying the water to the receiver, and thence to the penstock.

C, the penstock or cistern.

D, the water-wheel.

E, the boiler, which may be either iron or copper.

F, the hot-well for supplying the boiler with water.

G, G, two cisterns under the level of the water, in which the small bores B, B, and the condenser are contained.

* From the *Transactions of the American Philosophical Society*.