

fore added this contrivance, to adjust the length of the wires ; but that, when he had done this, he found inequalities still remaining; and therefore justly concluded, that they arose from the difference in the friction of the different parts of the clockwork, occasioned by the differences in the fluidity of the oil, &c.

From what has been said above, it appears, that the improvement of clocks, by a contrivance to prevent their inequalities arising from the different lengths of the pendulum, in different seasons of the year, by the effects of heat and cold, was first thought of, and executed, by Mr. George Graham ; and that the application of wires or bars of two metals, which have different degrees of expansion or contraction, to prevent the same inequalities, was also first thought of by Mr. Graham, and first executed by Mr. John Harrison, without the least knowledge of what Mr. Graham had done before him.

LXXXIX. *A Letter from Mr. Henry Eeles, to the Royal Society, concerning the Cause of Thunder.*

Gentlemen,

Lismore, Ireland, June 18,
1752.

Read Nov. 7, 1752. **T**HE greatest men of most ages having thought it worth the while to inquire, what was the cause of thunder ; and the world seeming to acquiesce in an hypothesis subscrib'd by some great modern names, it must appear presumptuous in me, to offer you some thoughts for a theory intirely new .(at least it is so to me) unless I can shew, that the former hypotheses are ill-grounded,

grounded, and far from being satisfactory. In order to which I shall only object to the latest, (to avoid prolixity) which now has the general consent.

I think the basis, that this hypothesis stands on, is the authors assuming an analogy between thunder and fired gunpowder; and then proving, that there are sulphureous and nitrous particles in the air, they leave them to take fire by fermentation, or some other accident, and from thence to form thunder.

First, the analogy is not just; for there is not any thing similar to thunder in fired gunpowder, except the noise; which may be shewn from the different direction of their fire, and their very different effects. Fired gunpowder acts from a centre to a circumference, with equal force at equal distances every way, by propelling the circumambient air by the explosion it makes. The fire of thunder acts in rectilinear angles, (as I have often seen, and as any body may, who will observe it) with such subtil and distinct effects, as cannot be explain'd or imitated by the fire of gunpowder; the history of which effects is too well known to need a repetition here

I shall go on to shew some insuperable difficulties in the formation and firing of this supposed aerial gunpowder. And first, I think it inconceivable, that the sulphureous and nitrous particles should coalesce with some other unknown third body, in the place of charcoal, in such exact proportion, as is necessary to make gunpowder of any perfection, and to form a body compact enough to equal the noise of thunder, when fired in the open air. For such a body must necessarily descend by its own gravity, long before it arrives to a bulk sufficient for the purpose. And, secondly, I think it contradictory to all experience, that such a collision

collision of nitrous particles should ever happen in the common seat of thunder, which is in the most collected showers that descend: For there the nitrous particles must be absorb'd and dissipated in the water; in which state I think it impossible for them to take fire.

These, and many other considerations, too prolix for the compass of a letter, induced me to search for some other cause of thunder; which I think I have discover'd in that fire, which is made apparent in electrical experiments. This fire pervades and adheres to most bodies; while it flies, and cannot be brought to mix with some particular bodies. I shall here only mention two; air, which it flies and shuns, and water, which it more intimately pervades than almost any other body. I must also observe, that this fire does not only pervade bodies, but that it surrounds and covers them to a certain distance from their superficies, in proportion to the state of its activity, which is increased by heat: And that, when it is artificially or accidentally protruded upon any body beyond its natural affection, it will fly off to the next approaching body, which is not so much impregnated with this fire; and, when it departs in any considerable quantity, it makes a great noise or crack: All which is demonstrated by electrical experiments. Now, to shew, that this fire is the real cause of thunder, we need only consider it attending every vessel of humid vapour rising into the atmosphere, and covering its superficies to a certain depth; which I think it must certainly do. I shall not here speak my opinion how far this fire is the cause of vapours ascending, because I shall trouble you with
that

that hereafter. Having got the vapour aloft attended by this fire, without assigning any cause for its ascent, so, without assigning any cause for its descent, I shall let it come down as usual, which is in drops much larger than the vesicles, in which it ascended. Now, in the collision to form these drops, we must consider what becomes of our fire; for the surface of these larger drops increasing only as the squares, but their solids as the cubes of their diameters, the fire, which surrounded the superficies of the vesicles, must be protruded to a much greater distance from the superficies of the larger drops, and by that means made more in proportion to the larger drops, than its natural affection would have made it join them with; and, consequently, render'd more apt to fly off to the next approaching or approached body, not so fully impregnated by this fire.

I have observed before, that the constant seat of thunder is in those clouds, which are most compact of humid vapour, and which descend in the heaviest showers, and that generally in warm weather, when the adjacent atmosphere is serene; so that the humid vapours are almost all collected into this chain of clouds; where, according to the compaction, there will be a body of this fire collected, and ready to fly off, sufficient to perform the greatest effects of thunder. Which may be easily computed, from the force of electrical experiments, where the smallest portion of this fire, flying off from an electrified body, makes an audible crack, and is able to give a considerable shock. What then must be the force of this fire, when it is so collected, as to break from a cloud in a body of fire two or three hundred yards in length?

length? which I have often seen. Now some of these clouds coalescing in their descent, and the drops increasing in their magnitude, there is a vast body of this fire collected more than what would naturally adhere to those drops and their surfaces; which being render'd more active in its vibrations, by the heat of the lower part of the atmosphere, the sphere of its affections (pardon the word, for I have no other) is also increas'd in proportion to the body of fire, which enables it to fly off to clouds, not so much impregnated, at a considerable distance, with that violent crack so much taken notice of; tho' it is far from being the most wonderful of its effects; the dire influence of which we often happily escape, by this body's being dissipated by the heat of the lower atmosphere, before it comes within the sphere of its affection for bodies on the surface of the earth. There is a subsequent rumbling noise heard after the first crack or cracks of thunder, (for this fire does not all break off from one point) which has been taken notice of, and oddly accounted for; but I think it neither is nor can be more than echo's from adjacent clouds, which at this time are generally dense enough for that purpose; and the noise growing fainter in proportion to the times of its being return'd, I think sufficiently proves it.

As to the subtil effects of thunder, I shall leave you to compare them with those of electricity, only allowing for the different force of fire, which is so much greater in thunder than can possibly be procured from artificial experiments; and I believe, that the analogy will plainly appear. I shall only hint, that, where one body has been injured by thunder;
and

and another, tho' in contact with it, has remain'd untouch'd, the latter will be found to be of that kind, which electrical fire will not join with.

I must beg you will let me know, whether this theory is worth your acceptance; for I fear I am, like a fond mother, blind to the imperfections of my own child. I have dandled this opinion for eighteen months past; still fearing to lay it before you; and now, instead of seeing its defects, I begin to fancy, that it has the face of truth and demonstration. If you think this discovery worth the pursuit, I shall venture to trouble you hereafter with some farther attempts to shew, that this fire is a most considerable agent in nature. First, that the ascent of vapour and exhalation is principally owing to it, and that our atmosphere, by that means, is kept more homogeneal than is generally supposed, and fitter for respiration, vision, &c. and that clouds of heterogeneous matter are kept suspended at their usual height merely by this fire. Secondly, I shall prove, that this fire is the cause of reflexion, refraction, and inflexion of light. Thirdly, I shall endeavour to shew, that it is the cause of that secondary attraction and repulsion, which Sir Isaac Newton has taken notice of. Lastly, I shall give some hints of the great use of this fire in animal life, and in vegetation. What further I have thought of this fire, I shall not now trouble you with. I am,

Gentlemen,

Your most humble and
most obedient servant,

Henry Eeles.