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 knowlege of what Mr. Graham had done before him.

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## 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. THE 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

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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

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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 fanſy, 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.