THE WORKS

OF

BENJAMIN FRANKLIN.

VOL. V

BRONZE STATUE OF BENJAMIN FRANKLIN

INAUGURATED SEPTEMBER 17, 1856, IN BOSTON

THE WORKS OF

Benjamin Franklin

CONTAINING SEVERAL POLITICAL AND HISTORICAL

TRACTS NOT INCLUDED IN ANY FORMER EDITION,

AND MANY LETTERS OFFICIAL AND

PRIVATE NOT HITHERTO

PUBLISHED

WITH NOTES AND A LIFE OF THE AUTHOR

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AN ACCOUNT

OF

NEGOTIATIONS IN LONDON

FOR EFFECTING A RECONCILIATION BETWEEN

GREAT BRITAIN AND THE AMERICAN COLONIES.

Just before Dr. Franklin left England, after having resided there many years as agent for several of the colonies, an effort was made by eminent persons, friendly to America, to bring about, through his instrumentality, a reconciliation of the differences then subsisting between the two countries. Among those, who consulted him on this occasion, was the Earl of Chatham. That statesman, disapproving the measures of the British government in regard to the colonies, and foreseeing the fatal consequences of an American war, resolved to employ his talents and influence in endeavouring to carry through Parliament a plan, which should meet the views and receive the assent of both parties. He held conversations with Dr. Franklin on the subject at different times, and submitted to him the propositions he had drawn up, before they were presented to Parliament, requesting his opinion and remarks. These propositions were liberal and conciliatory, compared with the schemes of the ministry; but they did not satisfy Franklin, and he knew they would not be acceptable to his countrymen. Their fate in Parliament is well known. Though supported by the powerful eloquence of Chatham, and of other distinguished leaders of the opposition, yet they were rejected in the House of Lords by a very large majority.

Attempts were made in other quarters to draw from Franklin a statement of the terms, which he supposed the colonies would accept. He was thus led into a kind of informal negotiation, which continued for several weeks. It is probable, that some of the ministers were secretly at the bottom of this manœuvre, with the view of ascertaining, both what they had to expect from Franklin, and the full extent of the demands, which the colonists were determined to insist on; knowing that he was thoroughly acquainted with the prevailing sentiments in America, and that no man could do so much by the weight of his character, and by his abilities and efforts, for the restoration of harmony, if he could be brought to acquiesce in such plans as the ministry should approve. Whatever the aim may have been, the attempt was abortive. The claims he set up for his countrymen were deemed so extravagant, that even the best friends to the American cause told him they would never be admitted. Convinced of their justice, however, he adhered to them, and the negotiation came to an end without effecting the object proposed.

The following paper is a narrative of these transactions, and is not more interesting for the facts it contains, than for the characteristic ease and simplicity of its style. It was written immediately after the events, during the author's passage to America, in the form of a letter to his son. It was not published till many years after his death, having first appeared in William Temple Franklin's edition of his works. — EDITOR.

On board the Pennsylvania Packet, Captain Osborne,
bound to Philadelphia, March 22d, 1775.

DEAR SON,

Having now a little leisure for writing, I will endeavour, as I promised you, to recollect what particulars I can of the negotiations I have lately been concerned in, with regard to the *misunderstandings between Great Britain and America.*

During the recess of the last Parliament, which had passed the severe acts against the Province of the Massachusetts Bay, the minority having been sensible of their weakness, as an effect of their want of union among themselves, began to think seriously of a coalition. For they saw in the violence of these American measures, if persisted in, a hazard of dismembering, weakening, and perhaps ruining the British empire. This inclined some of them to propose such an union with each other, as might be more respectable in the ensuing session, have more weight in opposition, and be a body out of which a new ministry might easily be formed, should the ill success of the late measures, and the firmness of the colonies in resisting them, make a change appear necessary to the King.

I took some pains to promote this disposition, in conversations with several of the principal among the minority of both Houses, whom I besought and conjured most earnestly not to suffer, by their little misunderstandings, so glorious a fabric as the present British empire to be demolished by these blunderers; and for their encouragement assured them, as far as my opinions could give any assurance, of the *firmness* and *unanimity* of America, the continuance of which was what they had frequent doubts of, and appeared extremely apprehensive and anxious concerning it.

From the time of the affront given me at the Council Board, in January, 1774, I had never attended the levee of any minister. I made no justification of myself from the charges brought against me; I made no return of the injury by abusing my adversaries; but held a cool, sullen silence, reserving myself to some future opportunity; for which conduct I had several reasons not necessary here to specify. Now and then I heard it said, that the reasonable part of the administration was ashamed of the treatment they had given me. I suspected that some who told me this, did it to draw from me my sentiments concerning it, and perhaps my purposes; but I said little or nothing upon the subject. In the mean time, their measures with regard to New England failing of the success that had been confidently expected, and finding themselves more and more embarrassed, they began, as it seems, to think of making use of me, if they could, to assist in disengaging them. But it was too humiliating to think of applying to me openly and directly, and therefore it was contrived to obtain what they could of my sentiments through others.

The accounts from America during the recess all manifested, that the measures of administration had neither divided nor intimidated the people there; that, on the contrary, they were more and more united and determined; and that a non-importation agreement was likely to take place. The ministry thence apprehending that this, by distressing the trading and manufacturing towns, might influence votes against the court in the elections for a new Parliament (which were in course to come on the succeeding year), suddenly and unexpectedly dissolved the old one, and ordered the choice of a new one within the shortest time admitted by law, before the inconveniences of that agreement could begin to be felt, or produce any such effect.

When I came to England in 1757, you may remember I made several attempts to be introduced to Lord Chatham (at that time first minister), on account of my Pennsylvania business, but without success. He was then too great a man, or too much occupied in affairs of greater moment. I was therefore obliged to content myself with a kind of non-apparent and unacknowledged communication through Mr. Potter and Mr. Wood, his secretaries, who seemed to cultivate an acquaintance with me by their civilities, and drew from me what information I could give relative to the American war, with my sentiments occasionally on measures that were proposed or advised by others, which gave me the opportunity of recommending and enforcing the utility of conquering Canada. I afterwards considered Mr. Pitt as an *inaccessible*. I admired him at a distance, and made no more attempts for a nearer acquaintance. I had only once or twice the satisfaction of hearing through Lord Shelburne, and I think Lord Stanhope, that he did me the honor of mentioning me sometimes as a person of respectable character.

But towards the end of August last, returning from Brighthelmstone, I called to visit my friend Mr. Sargent, at his seat, Halsted in Kent, agreeable to a former engagement. He let me know, that he had promised to conduct me to Lord Stanhope's at Chevening, who expected I would call on him when I came into that neighbourhood. We accordingly waited on Lord Stanhope that evening, who told me Lord Chatham desired to see me, and that Mr. Sargent's house, where I was to lodge, being in the way, he would call for me there the next morning, and carry me to Hayes. This was done accordingly. That truly great man received me with abundance of civility, inquired particularly into the situation of affairs in America, spoke feelingly of the severity of the late laws against the Massachusetts, gave me some account of his speech in opposing them, and expressed great regard and esteem for the people of that country, who he hoped would continue firm and united in defending by all peaceable and legal means their constitutional rights. I assured him, that I made no doubt they would do so; which he said he was pleased to hear from me, as he was sensible I must be well acquainted with them.

I then took occasion to remark to him, that in former cases great empires had crumbled first at their extremities, from this cause; that countries remote from the seat and eye of government, which therefore could not well understand their affairs for want of full and true information, had never been well governed, but had been oppressed by bad governors, on presumption that complaint was difficult to be made and supported against them at such a distance. Hence, such governors had been encouraged to go on, till their oppressions became intolerable. But that this empire had happily found, and long been in the practice of, a method, whereby every province was well governed, being trusted in a great measure with the government of itself; and that hence had arisen such satisfaction in the subjects, and such encouragement to new settlements, that, had it not been for the late wrong politics, (which would have Parliament to be *omnipotent*, though it ought not to be so unless it could at the same time be *omniscient*,) we might have gone on extending our western empire, adding province to province, as far as the South Sea. That I lamented the ruin which seemed impending over so fine a plan, so well adapted to make all the subjects of the greatest empire happy; and I hoped that, if his Lordship, with the other great and wise men of the British nation, would unite and exert themselves, it might yet be rescued out of the mangling hands of the present set of blundering ministers; and that the union and harmony between Britain and her colonies, so necessary to the welfare of both, might be restored.

He replied, with great politeness, that my idea of extending our empire in that manner was a sound one, worthy of a great, benevolent, and comprehensive mind. He wished with me for a good understanding among the different parts of the opposition here, as a means of restoring the ancient harmony of the two countries, which he most earnestly desired; but he spoke of the coalition of our domestic parties, as attended with difficulty, and rather to be desired than expected. He mentioned an opinion prevailing here, that America aimed at setting up for itself as an *independent state;* or, at least, to get rid of the *Navigation Acts.* I assured him, that, having more than once travelled almost from one end of the continent to the other, and kept a great variety of company, eating, drinking, and conversing with them freely, I never had heard in any conversation from any person, drunk or sober, the least expression of a wish for a separation, or hint that such a thing would be advantageous to America. And as to the Navigation Act, the main, material part of it, that of carrying on trade in British or plantation bottoms, excluding foreign ships from our ports, and navigating with three quarters British seamen, was as acceptable to us as it could be to Britain. That we were even not against regulations of the general commerce by Parliament, provided such regulations were *bonâ fide* for the benefit of the *whole empire*, not for the small advantage of one part to the great injury of another, such as the obliging our ships to call in England with our wine and fruit, from Portugal or Spain; the restraints on our manufactures, in the woollen and hat-making branches, the prohibiting of slitting-mills, steel-works, &c. He allowed, that some amendment might be made in those acts; but said those relating to the slitting-mills, trip-hammers, and steel-works, were agreed to by our agents, in a compromise on the opposition made here to abating the duty.

In fine, he expressed much satisfaction in my having called upon him, and particularly in the assurances I had given him, that America did not aim at *independence;* adding, that he should be glad to see me again as often as might be. I said, I should not fail to avail myself of the permission he was pleased to give me of waiting upon his Lordship occasionally, being very sensible of the honor, and of the great advantages and improvement I should reap, from his instructive conversation; which indeed was not a mere compliment.

The new Parliament was to meet the 29th of November, 1774. About the beginning of that month, being at the Royal Society, Mr. Raper, one of our members, told me there was a certain lady who had a desire of playing with me at chess, fancying she could beat me, and had requested him to bring me to her. It was, he said, a lady with whose acquaintance he was sure I should be pleased, a sister of Lord Howe's, and he hoped I would not refuse the challenge. I said, I had been long out of practice, but would wait upon the lady when he and she should think fit. He told me where her house was, and would have me call soon, and without further introduction, which I undertook to do; but, thinking it a little awkward, I postponed it; and on the 30th, meeting him again at the feast of the Society election, being the day after the Parliament met, he put me in mind of my promise, and that I had not kept it, and would have me name a day when he said he would call for me, and conduct me. I named the Friday following. He called accordingly. I went with him, played a few games with the lady, whom I found of very sensible conversation and pleasing behaviour, which induced me to agree most readily to an appointment for another meeting a few days afterwards; though I had not the least apprehension that any political business could have any connexion with this new acquaintance.

On the Thursday preceding this chess party, Mr. David Barclay called on me to have some discourse concerning the meeting of merchants to petition Parliament. When that was over, he spoke of the dangerous situation of American affairs, the hazard that a civil war might be brought on by the present measures, and the great merit that person would have, who could contrive some means of preventing so terrible a calamity, and bring about a reconciliation. He was then pleased to add, that he was persuaded, from my knowledge of both countries, my character and influence in one of them, and my abilities in business, no man had it so much in his power as myself. I naturally answered, that I should be very happy if I could in any degree be instrumental in so good a work, but that I saw no prospect of it; for, though I was sure the Americans were always willing and ready to agree upon any equitable terms, yet I thought an accommodation impracticable, unless both sides wished it; and, by what I could judge from the proceedings of the ministry, I did not believe they had the least disposition towards it; that they rather wished to provoke the North American people into an open rebellion, which might justify a military execution, and thereby gratify a grounded malice, which I conceived to exist here against the Whigs and Dissenters of that country. Mr. Barclay apprehended I judged too hardly of the ministers; he was persuaded they were not all of that temper, and he fancied they would be very glad to get out of their present embarrassment on any terms, only saving the honor and dignity of government. He wished, therefore, that I would think of the matter, and he would call again and converse with me further upon it. I said I would do so, as he requested it, but I had no opinion of its answering any purpose. We parted upon this. But two days after I received a letter from him, enclosed in a note from Dr. Fothergill, both which follow.

"Youngsbury, near Ware, 3d 12th Month, 1774.

"Esteemed Friend,

"After we parted on Thursday last, I accidentally met our mutual friend, Dr. Fothergill, in my way home. and intimated to him the subject of our discourse; in consequence of which, I have received from him an invitation to a further conference on this momentous affair, and I intend to be in town to-morrow accordingly, to meet at his house between four and five o'clock; and we unite in the request of thy company. We are neither of us insensible, that the affair is of that *magnitude* as should almost deter private persons from meddling with it; at the same time we are respectively such well-wishers to the cause, that nothing in our power ought to be left undone, though the utmost of our efforts may be unavailable. I am thy respectful friend,

"David Barclay.

"Dr. Franklin, *Craven Street.*"

"Dr. Fothergill presents his respects to Dr. Franklin, and hopes for the favor of his company in Harpur Street to-morrow evening, to meet their mutual friend, David Barclay, to confer on American affairs As near five o'clock as may be convenient.

"*Harpur Street, 3d inst.*"

The time thus appointed was the evening of the day on which I was to have my second chess party with the agreeable Mrs. Howe, whom I met accordingly. After playing as long as we liked, we fell into a little chat, partly on a mathematical problem,* and partly about the new Parliament, then just met, when she said, "And what is to be done with this dispute between Great Britain and the colonies? I hope we are not to have a civil war." "They should kiss and be friends," said I; "what can they do better? Quarrelling can be of service to neither, but is ruin to both."

* This lady (which is a little unusual in ladies) has a good deal of mathematical knowledge.

"I have often said," replied she, "that I wished government would employ you to settle the dispute for them; I am sure nobody could do it so well. Do not you think that the thing is practicable?" "Undoubtedly, Madam, if the parties are disposed to reconciliation; for the two countries have really no clashing interests to differ about. It is rather a matter of punctilio, which two or three reasonable people might settle in half an hour. I thank you for the good opinion you are pleased to express of me; but the ministers will never think of employing me in that good work; they choose rather to abuse me." "Ay," said she, "they have behaved shamefully to you. And indeed some of them are now ashamed of it themselves." I looked upon this as accidental conversation, thought no more of it, and went in the evening to the appointed meeting at Dr. Fothergill's, where I found Mr. Barclay with him.

The Doctor expatiated feelingly on the mischiefs likely to ensue from the present difference, the necessity of accommodating it, and the great merit of being instrumental in so good a work; concluding with some compliments to me; that nobody understood the subject so thoroughly, and had a better head for business of the kind; that it seemed therefore a duty incumbent on me, to do every thing I could to accomplish a reconciliation; and that, as he had with pleasure heard from David Barclay, that I had promised to think of it, he hoped I had put pen to paper, and formed some plan for consideration, and brought it with me. I answered, that I had formed no plan; as, the more I thought of the proceedings against the colonies, the more satisfied I was, that there did not exist the least disposition in the ministry to an accommodation; that therefore all plans must be useless. He said, I might be mistaken; that, whatever was the violence of some, he had reason, *good reason*, to believe others were differently disposed; and that, if I would draw a plan, which we three upon considering should judge reasonable, it might be made use of, and answer some good purpose, since he believed that either himself or David Barclay could get it communicated to some of the most moderate among the ministers, who would consider it with attention; and what appeared reasonable to us, two of us being Englishmen, might appear so to them.

As they both urged this with great earnestness, and, when I mentioned the impropriety of my doing any thing of the kind at the time we were in daily expectation of hearing from the Congress, who undoubtedly would be explicit on the means of restoring a good understanding, they seemed impatient, alleging, that it was uncertain when we should receive the result of the Congress, and what it would be; that the least delay might be dangerous; that additional punishments for New England were in contemplation, and accidents might widen the breach, and make it irreparable; therefore, something preventive could not be too soon thought of and applied. I was therefore finally prevailed with to promise doing what they desired, and to meet them again on Tuesday evening at the same place, and bring with me something for their consideration.

Accordingly, at the time, I met with them, and produced the following paper.

"HINTS FOR CONVERSATION *upon the Subject of Terms that might probably produce a Durable Union between Britain and the Colonies.*

"1. The tea destroyed to be paid for.

"2. The Tea-duty Act to be repealed, and all the duties that have been received upon it to be repaid into the treasuries of the several provinces from which they have been collected.

"3. The Acts of Navigation to be all reënacted in the colonies.

"4. A naval officer, appointed by the crown, to reside in each colony, to see that those acts are observed.

"5. All the acts restraining manufactures in the colonies to be repealed.

"6. All duties arising on the acts for regulating trade with the colonies, to be for the public use of the respective colonies, and paid into their treasuries. The collectors and custom-house officers to be appointed by each governor, and not sent from England.

"7. In consideration of the Americans maintaining their own peace establishment, and the monopoly Britain is to have of their commerce, no requisition to be made from them in time of peace.

"8. No troops to enter and quarter in any colony, but with the consent of its legislature.

"9. In time of war, on requisition made by the King, with the consent of Parliament, every colony shall raise money by the following rules or proportions, viz. If Britain, on account of the war, raises three shillings in the pound to its land tax, then the colonies to add to their last general provincial peace tax a sum equal to one fourth thereof; and if Britain, on the same account, pays four shillings in the pound, then the colonies to add to their said last peace tax a sum equal to half thereof, which additional tax is to be granted to his Majesty, and to be employed in raising and paying men for land or sea service, furnishing provisions, transports, or for such other purposes as the King shall require and direct. And, though no colony may contribute less, each may add as much by voluntary grant as they shall think proper.

"10. Castle William to be restored to the province of the Massachusetts Bay, and no fortress built by the crown in any province, but with the consent of its legislature.

"11. The late Massachusetts and Quebec Acts to be repealed, and a free government granted to Canada.

"12. All judges to be appointed during good behaviour, with equally permanent salaries, to be paid out of the province revenues by appointment of the Assemblies. Or, if the judges are to be appointed during the pleasure of the crown, let the salaries be during the pleasure of the Assemblies, as heretofore.

"13. Governors to be supported by the Assemblies of each province.

"14. If Britain will give up its monopoly of the American commerce, then the aid above mentioned to be given by America in time of peace as well as in time of war.

"15. The extension of the act of Henry the Eighth, concerning treasons to the colonies, to be formally disowned by Parliament.

"16. The American admiralty courts reduced to the same powers they have in England, and the acts establishing them to be reënacted in America.

"17. All powers of internal legislation in the colonies to be disclaimed by Parliament."

In reading this paper a second time, I gave my reasons at length for each article.

On the *first* I observed, That, when the injury was done, Britain had a right to *reparation*, and would certainly have had it on demand, as was the case when injury was done by mobs in the time of the Stamp Act; or she might have a right to return an equal injury, if she rather chose to do that; but she could not have a right *both* to *reparation* and to return an *equal injury;* much less had she a right to return the injury ten or twenty fold, as she had done by blocking up the port of Boston. All which extra injury ought, in my judgment, to be repaired by Britain. That, therefore, if paying for the tea was agreed to by me, as an article fit to be proposed, it was merely from a desire of peace, and in compliance with their opinion expressed at our first meeting, that this was a *sine quâ non*, that the dignity of Britain required it, and that, if this was agreed to, every thing else would be easy. This reasoning was allowed to be just; but still the article was thought necessary to stand as it did.

On the *second*, That the act should be repealed, as having never answered any good purpose, as having been the cause of the present mischief, and never likely to be executed. That, the act being considered as unconstitutional by the Americans, and what the Parliament had no right to make, they must consider all the money *extorted* by it, as so much wrongfully taken, and of which therefore restitution ought to be made; and the rather, as it would furnish a fund out of which the payment for the tea destroyed might best be defrayed. The gentlemen were of opinion, that the first part of this article, viz. the repeal, might be obtained, but not the refunding part, and therefore advised striking that out; but, as I thought it just and right, I insisted on its standing.

On the *third* and *fourth* articles I observed, we were frequently charged with views of abolishing the Navigation Act. That, in truth, those parts of it which were of most importance to Britain, as tending to increase its naval strength, viz. those restraining the trade, to be carried on only in ships belonging to British subjects, navigated by at least three quarters British or colony seamen, &c., were as acceptable to us as they could be to Britain, since we wished to employ our own ships in preference to foreigners, and had no desire to see foreign ships enter our ports. That indeed the obliging us to land some of our commodities in England before we could carry them to foreign markets, and forbidding our importation of some goods directly from foreign countries, we thought a hardship, and a greater loss to us than gain to Britain, and therefore proper to be repealed. But, as Britain had deemed it an equivalent for her protection, we had never applied, or proposed to apply, for such a repeal. And, if they must be continued, I thought it best (since the power of Parliament to make them was now disputed), that they should be reënacted in all the colonies, which would demonstrate their consent to them. And then, if, as in the sixth article, all the duties arising on them were to be collected by officers appointed and salaried in the respective governments, and the produce paid into their treasuries, I was sure the acts would be better and more faithfully executed, and at much less expense, and one great source of misunderstanding removed between the two countries, viz. the calumnies of low officers appointed from home, who were for ever abusing the people of the country to government, to magnify their own zeal, and recommend themselves to promotion. That the extension of the admiralty jurisdiction, so much complained of, would then no longer be necessary; and that, besides its being the interest of the colonies to execute those acts, which is the best security, government might be satisfied of its being done, from accounts to be sent home by the naval officers of the fourth article. The gentlemen were satisfied with these reasons, and approved the third and fourth articles; so they were to stand.

The *fifth* they apprehended would meet with difficulty. They said, that restraining manufactures in the colonies was a favorite idea here; and therefore they wished that article to be omitted, as the proposing it would alarm and hinder perhaps the considering and granting others of more importance; but, as I insisted on the equity of allowing all subjects in every country to make the most of their natural advantages, they desired I would at least alter the last word from *repealed* to *reconsidered*, which I complied with.

In maintaining the *seventh* article (which was at first objected to, on the principle that all under the care of government should pay towards the support of it,) my reasons were, that, if every distinct part of the King's dominions supported its own government in time of peace, it was all that could justly be required of it; that all the old or confederated colonies had done so from their beginning; that their taxes for that purpose were very considerable; that new countries had many public expenses, which old ones were free from, the works being done to their hands by their ancestors, such as making roads and bridges, erecting churches, court-houses, forts, quays, and other public buildings, founding schools and places of education, hospitals and alms-houses, &c. &c.; that the voluntary and the legal subscriptions and taxes for such purposes, taken together, amounted to more than was paid by equal estates in Britain. That it would be best for Britain, on two accounts, not to take money from us, as contribution to its public expense, in time of peace; first, for that just so much less would be got from us in commerce, since all we could spare was already gained from us by Britain in that way; and, secondly, that, coming into the hands of British ministers, accustomed to prodigality of public money, it would be squandered and dissipated, answering no good general purpose. That, if we were to be taxed towards the support of government in Britain, as Scotland has been since the union, we ought then to be allowed the same privileges in trade as she has been allowed. That, if we are called upon to give to the sinking fund, or the national debt, Ireland ought be likewise called upon; and both they and we, if we gave, ought to have some means established of inquiring into the application, and securing a compliance with the terms on which we should grant. That British ministers would perhaps not like our meddling with such matters; and that hence might arise new causes of misunderstanding. That, upon the whole, therefore, I thought it best on all sides, that no aids shall be asked or expected from the colonies in time of peace; that it would then be their interest to grant bountifully and exert themselves vigorously in time of war, the sooner to put an end to it. That specie was not to be had to send to England in supplies, but the colonies could carry on war with their own paper money; which would pay troops, and for provisions, transports, carriages, clothing, arms, &c. So this seventh article was at length agreed to without further objection.

The *eighth* the gentlemen were confident would never be granted. For the whole world would be of opinion, that the King, who is to defend all parts of his dominions, should have of course a right to place his troops where they might best answer that purpose. I supported the article upon principles equally important, in my opinion, to Britain as to her colonies; for that, if the King could bring into one part of his dominions troops raised in any other part of them, without the consent of the legislatures of the part to which they were brought, he might bring armies raised in

America into England without consent of Parliament, which probably would not like it, as a few years since they had not liked the introduction of the Hessians and Hanoverians, though justified by the supposition of its being a time of danger. That, if there should be at any time real occasion for British troops in America, there was no doubt of obtaining the consent of the Assemblies there; and I was so far from being willing to drop this article, that I thought I ought to add another, requiring all the present troops to be withdrawn, before America could be expected to treat or agree upon any terms of accommodation; as what they should now do of that kind might be deemed the effect of compulsion, the appearance of which ought as much as possible to be avoided, since those reasonable things might be agreed to, where the parties seemed at least to act freely, which would be strongly refused under threats or the semblance of force. That the withdrawing the troops was therefore necessary to make any treaty durably binding on the part of the Americans, since proof of having acted under force would invalidate any agreement. And it could be no wonder, that we should insist on the crown's having no right to bring a standing army among us in time of peace, when we saw now before our eyes a striking instance of the ill use to be made of it, viz. to distress the King's subjects in different parts of his dominions, one part after the other, into a submission to arbitrary power, which was the avowed design of the army and fleet now placed at Boston. Finding me obstinate, the gentlemen consented to let this stand, but did not seem quite to approve of it. They wished, they said, to have this a paper or plan that they might show as containing the sentiments of considerate, impartial persons, and such as they might as Englishmen support, which they thought could not well be the case with this article.

The *ninth* article was so drawn, in compliance with an idea of Dr. Fothergill's, started at our first meeting, viz. that government here would probably not be satisfied with the promise of voluntary grants in time of war from the Assemblies, of which the quantity must be uncertain; that, therefore, it would be best to proportion them in some way to the shillings in the pound raised in England; but how such proportion could be ascertained he was at a loss to contrive. I was desired to consider it. It had been said, too, that Parliament was become jealous of the right claimed and heretofore used by the crown, of raising money in the colonies without Parliamentary consent; and, therefore, since we would not pay Parliamentary taxes, future requisitions must be made with consent of Parliament, and not otherwise. I wondered that the crown should be willing to give up that separate right, but had no objection to its limiting itself, if it thought proper; so I drew the article accordingly, and contrived to proportion the aid by the tax of the last year of peace. And since it was thought, that the method I should have liked best, would never be agreed to, viz. a Continental Congress to be called by the crown, for answering requisitions and proportioning aids, I chose to leave room for voluntary additions by the separate Assemblies, that the crown might have some motive for calling them together, and cultivating their good will, and they have some satisfaction in showing their loyalty and their zeal in the common cause, and an opportunity of manifesting their disapprobation of a war, if they did not think it a just one. This article therefore met with no objection *from them;* and I had another reason for liking it, viz. that the view of the proportion to be given in time of war, might make us the more frugal in time of peace.

For the *tenth* article, I urged the injustice of seizing that fortress, (which had been built at an immense charge by the province, for the defence of their port against national enemies,) and turning it into a citadel for awing the town, restraining their trade, blocking up their port, and depriving them of their privileges. That a great deal had been said of their injustice in destroying the tea; but here was a much greater injustice uncompensated, that castle having cost the province three hundred thousand pounds. And that such a use made of a fortress they had built, would not only effectually discourage every colony from ever building another, and thereby leave them more exposed to foreign enemies, but was a good reason for their insisting that the crown should never erect any hereafter in their limits, without the consent of the legislature. The gentlemen had not much to say against this article, but thought it would hardly be admitted.

The *eleventh* article, it was thought, would be strongly objected to; that it would be urged the old colonists could have nothing to do with the affairs of Canada, whatever we had with those of the Massachusetts; that it would be considered as an officious meddling merely to disturb government; and that some even of the Massachusetts acts were thought by administration to be improvements of that government, viz. those altering the appointment of counsellors, the choice of jurymen, and the forbidding of town meetings. I replied, that we, having assisted in the conquest of Canada, at a great expense of blood and treasure, had some right to be considered in the settlement of it. That the establishing an arbitrary government on the back of our settlements might be dangerous to us all; and that, loving liberty ourselves, we wished it to be extended among mankind, and to have no foundation for future slavery laid in America. That, as to amending the Massachusetts government, though it might be shown that every one of these pretended amendments were real mischiefs, yet that charters being compacts between two parties, the King and the people, no alteration could be made in them, even for the better, but by the consent of both parties. That the Parliament's claim and exercise of a power to alter our charters, which had always been deemed inviolable but for forfeiture, and to alter laws made in pursuance of these charters, which had received the royal approbation, and thenceforth deemed fixed and unchangeable, but by the powers that made them, had rendered all our constitutions uncertain, and set us quite afloat. That, as, by claiming a right to tax us *ad libitum*, they deprived us of all property; so, by this claim of altering our laws and charters at will, they deprived us of all privilege and right whatever, but what we should hold at their pleasure. That this was a situation we could not be in, and must risk life and every thing rather than submit to it. So this article remained.

The *twelfth* article I explained, by acquainting the gentlemen with the former situation of the judges in most colonies, viz. that they were appointed by the crown, and paid by the Assemblies. That, the appointment being during the pleasure of the crown, the salary had been during the pleasure of the Assembly. That, when it has been urged against the Assemblies, that their making judges dependent on them for their salaries, was aiming at an undue influence over the courts of justice; the Assemblies usually replied, that making them dependent on the crown for continuance in their places, was also retaining an undue influence over those courts; and that one undue influence was a proper balance for the other; but that whenever the crown would consent to acts making the judges during *good behaviour*, the Assemblies would at the same time grant their salaries to be permanent during their continuance in office. This the crown has however constantly refused. And this equitable offer is now again here proposed; the colonies not being able to conceive why their judges should not be rendered as independent as those in England. That, on the contrary, the crown now claimed to make the judges in the colonies dependent on its favor for both place and salary, both to be continued at its pleasure. This the colonies must oppose as inequitable, as putting both the weights into one of the scales of justice. If, therefore, the crown does not choose to commission the judges during good behaviour, with equally permanent salaries, the alternative proposed that the salaries continue to be paid during the pleasure of the Assemblies as heretofore. The gentlemen allowed this article to be reasonable.

The *thirteenth* was objected to, as nothing was generally thought more reasonable here, than that the King should pay his own governor, in order to render him independent of the people, who otherwise might aim at influencing him against his duty, by occasionally withholding his salary. To this I answered, that governors sent to the colonies were often men of no estate or principle, who came merely to make fortunes, and had no natural regard for the country they were to govern. That to make them quite independent of the people, was to make them careless of their conduct. whether it was beneficial or mischievous to the public, and giving a loose to their rapacious and oppressive dispositions. That the influence supposed could never extend to operate any thing prejudicial to the King's service, or the interest of Britain; since the governor was bound by a set of particular instructions, which he had given surety to observe; and all the laws he assented to were subject to be repealed by the crown, if found improper. That the payment of the salaries by the people was more satisfactory to them, as it was productive of a good understanding and mutual good offices between governor and governed, and therefore the innovation lately made in that respect at Boston and New York had, in my opinion, better be laid aside. So this article was suffered to remain.

But the *fourteenth* was thought totally inadmissible. The monopoly of the American commerce could never be given up, and the proposing it would only give offence without answering any good purpose. I was therefore prevailed on to strike it wholly out.

The *fifteenth* was readily agreed to.

The *sixteenth* it was thought would be of little consequence, if the duties were given to the colony treasuries.

The *seventeenth* it was thought could hardly be obtained, but might be tried.

Thus having gone through the whole, I was desired to make a fair copy for Dr. Fothergill, who now informed us, that, having an opportunity of seeing daily Lord Dartmouth, of whose good disposition he had a high opinion, he would communicate the paper to him, as the sentiments of considerate persons, who wished the welfare of both countries. "Suppose," said Mr. Barclay, "I were to show this paper to Lord Hyde; would there be any thing amiss in so doing? He is a very knowing man; and, though not in the ministry, properly speaking, he is a good deal attended to by them. I have some acquaintance with him; we converse freely sometimes; and perhaps, if he and I were to talk these articles over, and I should communicate to him our conversation upon them, some good might arise out of it." Dr. Fothergill had no objection, and I said I could have none. I knew Lord Hyde a little, and had an esteem for him. I had drawn the paper at their request, and it was now theirs to do with it what they pleased. Mr. Barclay then proposed that I should send the fair copy to him, which, after making one for Dr. Fothergill and one for himself, he would return to me. Another question then arose, whether I had any objection to their mentioning that I had been consulted. I said, none that related to myself; but it was my opinion, if they wished any attention paid to the propositions, it would be better not to mention me; the ministry having, as I conceived, a prejudice against me, and every thing that came from me. They said, on that consideration it might be best not to mention me; and so it was concluded. For my own part, I kept this whole proceeding a profound secret; but I soon after discovered, that it had taken air by some means or other.

Being much interrupted the day following, I did not copy and send the paper. The next morning I received a note from Mr. Barclay, pressing to have it before twelve o'clock. I accordingly sent it to him. Three days after, I received the following note from him.

"D. Barclay presents his respects, and acquaints Dr. Franklin, that, being informed a pamphlet, entitled 'A Friendly Address,' has been dispersed to the *disadvantage* of America, (in particular by the Dean of Norwich,) he desires Dr. Franklin will peruse the enclosed, just come to hand from America; and, if he approves of it, republish it, as D. Barclay wishes something might be properly spread at Norwich. D. Barclay saw to-day a person, with whom he had been yesterday (before he called on Dr. Franklin), and had the satisfaction of walking part of the way with him to another noble person's house, to meet on the *business*, and he told him, that he could say, that he saw some *light*.

"*Cheapside*, 11*th instant*."

The person so met and accompanied by Mr. Barclay, I understood to be Lord Hyde, going either to Lord Dartmouth's or Lord North's; I knew not which.

In the following week arrived the proceedings of the Congress, which had been long and anxiously expected, both by the friends and adversaries of America.

The petition of Congress to the King was enclosed to me, and accompanied by the following letter from their president, addressed to the American agents in London, as follows.

"To Paul Wentworth, Esquire, Dr. Benjamin Franklin, William Bollan, Esquire, Dr. Arthur Lee, Thomas Life, Esquire, Edmund Burke, Esquire, Charles Garth, Esquire.

"Philadelphia, October 26th, 1774.

"Gentlemen,

"We give you the strongest proof of our reliance on your zeal and attachment to the happiness of America, and the cause of liberty, when we commit the enclosed papers to your care.

"We desire you will deliver the Petition into the hands of his Majesty; and, after it has been presented, we wish it may be made public through the press, together with the list of grievances. And as we hope for great assistance from the spirit, virtue, and justice of the nation, it is our earnest desire, that the most effectual care be taken, as early as possible, to furnish the trading cities and manufacturing towns throughout the united kingdom with our Memorial to the People of Great Britain.

"We doubt not but that your good sense and discernment will lead you to avail yourselves of every assistance, that may be derived from the advice and friendship of all great and good men, who may incline to aid the cause of liberty and mankind.

"The gratitude of America, expressed in the enclosed vote of thanks, we desire may be conveyed to the deserving objects of it, in the manner that you think will be most acceptable to them.*

"It is proposed that another Congress be held on the 10th of May next, at this place; but in the mean time we beg the favor of you, Gentlemen, to transmit to the Speakers of the several Assemblies, the earliest information of the most authentic accounts you can collect, of all such conduct and designs of ministry or Parliament, as it may concern America to know. We are, with unfeigned esteem and regard, Gentlemen, &c.

By order of the Congress.

"HENRY MIDDLETON, *President.*"

The first impression made by the proceedings of the American Congress on people in general, was greatly in our favor. Administration seemed to be staggered, were impatient to know whether the *Petition* mentioned in the proceedings was come to my hands, and took a roundabout method of obtaining that information, by getting a ministerial merchant, a known intimate of the Solicitor-General, to write me a letter, importing that he heard I had received such a petition, that I was to be

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* This vote of thanks was as follows. "*October* 25*th*, 1774. Resolved, That this Congress, in their own names, and in the behalf of all those whom they represent, do present their most grateful acknowledgments to those truly noble, honorable, and patriotic advocates of civil and religious liberty, who have so generously and powerfully, though unsuccessfully, espoused and defended the cause of America, both in and out of Parliament." — EDITOR.

attended in presenting it by the merchants, and begging to know the time, that he might attend "on so important an occasion, and give his testimony to so good a work." Before these proceedings arrived, it had been given out, that no petition from the Congress could be received, as they were an illegal body; but the Secretary of State, after a day's perusal (during which a council was held), told us it was a decent and proper petition, and cheerfully undertook to present it to his Majesty, who, he afterwards assured us, was pleased to receive it very graciously, and to promise to lay it, as soon as they met, before his two Houses of Parliament; and we had reason to believe, that, at that time, the petition was intended to be made the foundation of some change of measures; but that purpose, if such there was, did not long continue.

About this time, I received a letter from Mr. Barclay, then at Norwich, dated December 18th, expressing his opinion, that it might be best to postpone taking any further steps in the affair of procuring a meeting and petition of the merchants, (on which we had had several consultations,) till after the holidays, thereby to give the proceedings of Congress more time to work upon men's minds; adding, "I likewise consider, that our superiors will have some little time for reflection, and perhaps may contemplate on the propriety of the 'Hints' in their possession. By a few lines I have received from Lord Hyde, he intimates his hearty wish that they may be productive of what may be practicable and advantageous for the mother country and the colonies."

On the 22d, Mr. Barclay was come to town, when I dined with him, and learnt that Lord Hyde thought the propositions too hard.

On the 24th, I received the following note from a considerable merchant in the city, viz.

"Mr. William Neate presents his most respectful compliments to Dr. Franklin, and, as a report prevailed yesterday evening, that all the disputes between Great Britain and the American colonies were, through his application and influence with Lord North, amicably settled, conformable to the wish and desire of the late Congress, W. N. desires the favor of Dr. Franklin to inform him by a line, per the bearer, whether there is any credit to be given to the report.

"*St. Mary Hill, 24th December,* 1774."

My answer was to this effect; that I should be very happy to be able to inform him, that the report he had heard had some truth in it; but I could only assure him, that I knew nothing of the matter. Such reports, however, were confidently circulated, and had some effect in recovering the stocks, which had fallen three or four per cent.

On Christmas-day evening, visiting Mrs. Howe, she told me as soon as I went in, that her brother, Lord Howe, wished to be acquainted with me; that he was a very good man, and she was sure we should like each other. I said, I had always heard a good character of Lord Howe, and should be proud of the honor of being known to him. "He is but just by," said she; "will you give me leave to send for him?" "By all means, Madam, if you think proper." She rang for a servant, wrote a note, and Lord Howe came in a few minutes.

After some extremely polite compliments, as to the general motives for his desiring an acquaintance with me, he said he had a particular one at this time, which was the alarming situation of our affairs with America, which no one, he was persuaded, understood better than myself; that it was the opinion of some friends of his, that no man could do more towards reconciling our differences than I could, if I would undertake it; that he was sensible I had been very ill treated by the ministry, but he hoped that would not be considered by me in the present case; that he himself, though not in opposition, had much disapproved of their conduct towards me; that some of them, he was sure, were ashamed of it, and sorry it had happened; which he supposed must be sufficient to abate resentment in a great and generous mind; that, if he were himself in administration, he should be ready to make me ample satisfaction, which, he was persuaded, would one day or other be done; that he was unconnected with the ministry, except by some personal friendships, wished well however to government, was anxious for the general welfare of the whole empire, and had a particular regard for New England, which had shown a very endearing respect to his family; that he was merely an independent member of Parliament, desirous of doing what good he could, agreeably to his duty in that station; that he therefore had wished for an opportunity of obtaining my sentiments on the means of reconciling our differences, which he saw must be attended with the most mischievous consequences, if not speedily accommodated; that he hoped his zeal for the public welfare would, with me, excuse the impertinence of a mere stranger, who could have otherwise no reason to expect, or right to request, me to open my mind to him on these topics; but he did conceive, that, if I would indulge him with my ideas of the means proper to bring about a reconciliation, it might be of some use; that perhaps I might not be willing myself to have any *direct* communication with this ministry on this occasion; that I might likewise not care to have it known, that I had any *indirect* communication with them, till I could be well assured of their good dispositions; that, being himself upon no ill terms with them, he thought it not impossible that he might, by conveying my sentiments to them and theirs to me, be a means of bringing on a good understanding, without committing either them or me, if his negotiation should not succeed; and that I might rely on his keeping perfectly secret every thing I should wish to remain so.

Mrs. Howe here offering to withdraw, whether of herself, or from any sign from him, I know not, I begged she might stay, as I should have no secret in a business of this nature, that I could not freely confide to her prudence; which was truth; for I had never conceived a higher opinion of the discretion and excellent understanding of any woman on so short an acquaintance. I added, that, though I had never before the honor of being in his Lordship's company, his manner was such as had already engaged my confidence, and would make me perfectly easy and free in communicating myself to him.

I begged him, in the first place, to give me credit for a sincere desire of healing the breach between the two countries; that I would cheerfully and heartily do every thing in my small power to accomplish it; but that I apprehended from the King's speech, and from the measures talked of, as well as those already determined on, no intention or disposition of the kind existed in the present ministry, and therefore no accommodation could be expected till we saw a change. That, as to what his Lordship mentioned of the *personal injuries* done me, those done my country were so much greater, that I did not think the other, at this time, worth mentioning; that, besides, it was a fixed rule with me, not to mix my private affairs with those of the public; that I could join with my personal enemy in serving the public, or, when it was for its interest, with the public in serving that enemy; these being my sentiments, his Lordship might be assured, that no private considerations of the kind should prevent my being as useful in the present case as my small ability would permit.

He appeared satisfied and pleased with these declarations, and gave it me as his sincere opinion, that some of the ministry were extremely well disposed to any reasonable accommodation, preserving only the dignity of government; and he wished me to draw up in writing some propositions containing the terms on which I conceived a good understanding might be obtained and established, and the mode of proceeding to accomplish it; which propositions, as soon as prepared, we might meet to consider, either at his house, or at mine, or where I pleased; but, as his being seen at my house, or me at his, might, he thought, occasion some speculation, it was concluded to be best to meet at his sister's, who readily offered her house for the purpose, and where there was a good pretence with her family and friends for my being often seen, as it was known we played together at chess. I undertook, accordingly, to draw up something of the kind; and so for that time we parted, agreeing to meet at the same place again on the Wednesday following.

I dined about this time by invitation with Governor Pownall. There was no company but the family; and after dinner we had a *tête-à-tête*. He had been in the opposition; but was now about making his peace, in order to come into Parliament upon ministerial interest, which I did not then know. He told me, what I had before been told by several of Lord North's friends, that the American measures were not the measures of that minister, nor approved by him; that, on the contrary, he was well disposed to promote a reconciliation upon any terms honorable to government; that I had been looked upon as the great fomenter of the opposition in America, and as a great adversary to any accommodation; that he, Governor Pownall, had given a different account of me, and had told his Lordship that I was certainly much misunderstood. From the Governor's further discourse I collected, that he wished to be employed as an envoy or commissioner to America, to settle the differences, and to have me with him; but, as I apprehended there was little likelihood that either of us would be so employed by government, I did not give much attention to that part of his discourse.

I should have mentioned in its place (but one cannot recollect every thing in order), that, declining at first to draw up the propositions desired by Lord Howe, I alleged its being unnecessary, since the Congress in their petition to the King, just then received and presented through Lord Dartmouth, had stated their grievances, and pointed out very explicitly what would restore the ancient harmony; and I read a part of the petition to show their good dispositions, which, being very pathetically expressed, seemed to affect both the brother and sister. But still I was desired to give my ideas of the steps to be taken, in case some of the propositions in the petition should not be thought admissible. And this, as I said before, I undertook to do.

I had promised Lord Chatham to communicate to him the first important news I should receive from America. I therefore sent him the proceedings of the Congress as soon as I received them; but a whole week passed after I received the petition, before I could, as I wished to do, wait upon him with it, in order to obtain his sentiments on the *whole;* for my time was taken up in meetings with the other agents to consult about presenting the petition, in waiting three different days with them on Lord Dartmouth, in consulting upon and writing letters to the Speakers of Assemblies, and other business, which did not allow me a day to go to Hayes.

At last, on Monday the 26th, I got out, and was there about one o'clock. He received me with an affectionate kind of respect, that from so great a man was extremely engaging; but the opinion he expressed of the Congress was still more so. They had acted, he said, with so much temper, moderation, and wisdom, that he thought it the most honorable assembly of statesmen since those of the ancient Greeks and Romans, in the most virtuous times. That there were not in their whole proceedings above one or two things he could have wished otherwise; perhaps but one, and that was their assertion, that the keeping up a standing army in the colonies in time of peace, without consent of their legislatures, was against law. He doubted that was not well founded, and that the law alluded to did not extend to the colonies. The rest he admired and honored. He thought the petition decent, manly, and properly expressed. He inquired much and particularly concerning the state of America, the probability of their perseverance, the difficulties they must meet with in adhering for any long time to their resolutions, the resources they might have to supply the deficiency of commerce; to all which I gave him answers with which he seemed well satisfied. He expressed a great regard and warm affection for that country, with hearty wishes for their prosperity; and that government here might soon come to see its mistakes, and rectify them; and intimated that possibly he might, if his health permitted, prepare something for its consideration, when the Parliament should meet after the holidays; on which he should wish to have previously my sentiments.

I mentioned to him the very hazardous state I conceived we were in, by the continuance of the army in Boston; that, whatever disposition there might be in the inhabitants to give no just cause of offence to the troops, or in the general to preserve order among them, an unpremeditated, unforeseen quarrel might happen between perhaps a drunken porter and a soldier, that might bring on a riot, tumult, and bloodshed, and in its consequences produce a breach impossible to be healed; that the army could not possibly answer any good purpose *there*, and might be infinitely mischievous; that no accommodation could properly be proposed and entered into by the Americans, while the bayonet was at their breasts; that, to have any agreement binding, all force should be withdrawn. His Lordship seemed to think these sentiments had something in them that was reasonable.

From Hayes I went to Halsted, Mr. Sargent's place, to dine, intending thence a visit to Lord Stanhope at Chevening; but, hearing that his Lordship and the family were in town, I stayed at Halsted all night, and the next morning went to Chislehurst to call upon Lord Camden, it being in my way to town. I met his Lordship and family in two carriages just without his gate, going on a visit of congratulation to Lord Chatham and his lady, on the late marriage of their daughter to Lord Mahon, son of Lord Stanhope. They were to be back at dinner; so I agreed to go in, stay dinner, and spend the evening there, and not return to town till next morning. We had that afternoon and evening a great deal of conversation on American affairs, concerning which he was very inquisitive, and I gave him the best information in my power. I was charmed with his generous and noble sentiments; and had the great pleasure of hearing his full approbation of the proceedings of the Congress, the petition, &c. &c., of which, at his request, I afterwards sent him a copy. He seemed anxious that the Americans should continue to act with the same temper, coolness, and wisdom, with which they had hitherto proceeded in most of their public assemblies, in which case he did not doubt they would succeed in establishing their rights, and obtain a solid and durable agreement with the mother country; of the necessity and great importance of which agreement, he seemed to have the strongest impressions.

I returned to town the next morning, in time to meet at the hour appointed by Lord Howe. I apologized for my not being ready with the paper I had promised, by my having been kept longer than I intended in the country. We had, however, a good deal of conversation on the subject, and his Lordship told me he could now assure me, of a certainty, that there was a sincere disposition in Lord North and Lord Dartmouth to accommodate the differences with America, and to listen favorably to any proposition that might have a probable tendency to answer that salutary purpose. He then asked me what I thought of sending some person or persons over, commissioned to inquire into the grievances of America upon the spot, converse with the leading people, and endeavour with them to agree upon some means of composing our differences. I said, that a person of rank and dignity, who had a character of candor, integrity, and wisdom, might possibly, if employed in that service, be of great use.

He seemed to be of the same opinion, and that whoever was employed should go with a hearty desire of promoting a sincere reconciliation, on the foundation of mutual interests and mutual good-will; that he should endeavour, not only to remove their prejudices against government, but equally the prejudices of government against them, and bring on a perfect good understanding, &c. Mrs. Howe said, "I wish, brother, you were to be sent thither on such a service; I should like that much better than General Howe's going to command the army there." "I think, Madam," said I, "they ought to provide for General Howe some more honorable employment." Lord Howe here took out of his pocket a paper, and offering it to me said, smiling, "If it is not an unfair question, may I ask whether you know any thing of this paper?" Upon looking at it, I saw it was a copy, in David Barclay's hand, of the "HINTS" before recited; and said, that I had seen it; adding a little after, that, since I perceived his Lordship was acquainted with a transaction, my concern in which I had understood was to have been kept a secret, I should make no difficulty in owning to him, that I had been consulted on the subject, and had drawn up that paper. He said, he was rather sorry to find that the sentiments expressed in it were mine, as it gave him less hopes of promoting, by my assistance, the wished-for reconciliation; since he had reason to think there was no likelihood of the admission of those propositions. He hoped, however, that I would reconsider the subject, and form some plan that would be acceptable here. He expatiated on the infinite service it would be to the nation, and the great merit in being instrumental in so good a work; that he should not think of influencing me by any selfish motive, but certainly I might with reason expect any reward in the power of government to bestow.

This to me was what the French vulgarly call *spitting in the soup.* However, I promised to draw some sketch of a plan, at his request, though I much doubted, I said, whether it would be thought preferable to that he had in his hand. But he was willing to hope that it would; and, as he considered my situation, that I had friends here and constituents in America to keep well with, that I might possibly propose something improper to be seen in my handwriting; therefore, it would be better to send it to Mrs. Howe, who would copy it, send the copy to him to be communicated to the ministry, and return me the original. This I agreed to, though I did not apprehend the inconvenience he mentioned. In general, I liked much his manner, and found myself disposed to place great confidence in him on occasion; but in this particular the secrecy he proposed seemed not of much importance.

In a day or two, I sent the following paper, enclosed in a cover, directed to the Honorable Mrs. Howe.

"It is supposed to be the wish on both sides, not merely to put a stop to the mischief at present threatening the general welfare, but to cement a *cordial union*, and remove, not only every real grievance, but every cause of jealousy and suspicion.

"With this view, the first thing necessary is, to know what is, by the different parties in the dispute, thought essentially necessary for the obtaining such a union.

"The American Congress, in their petition to the King, have been explicit, declaring, that by a repeal of the oppressive acts therein complained of, '*the harmony between Great Britain and the colonies, so necessary to the happiness of both, and so ardently desired of them, will, with the usual intercourse, be immediately restored.*'

"If it has been thought reasonable here, to expect that, previous to an alteration of measures, the colonies should make some declaration respecting their future conduct, they have also done that, by adding, '*That, when the causes of their apprehensions are removed, their* *future conduct will prove them not unworthy of the regard they have been accustomed in their happier days to enjoy.'*

"For their sincerity in these declarations, they solemnly call to witness the Searcher of all hearts.

"If Britain can have any reliance on these declarations, (and perhaps none to be extorted by force can be more relied on than these, which are thus freely made,) she may, without hazard to herself, try the expedient proposed, since, if it fails, she has it in her power at any time to resume her present measures.

"It is then proposed; That Britain should show some confidence in these declarations, by repealing all the laws or parts of laws, that are requested to be repealed in the Petition of the Congress to the King;

"And that, at the same time, orders should be given to withdraw the fleet from Boston, and remove all the troops to Quebec, or the Floridas, that the colonies may be left at perfect liberty in their future stipulations.

"That this may, for the honor of Britain, appear not the effect of any apprehension from the measures entered into and recommended to the people by the Congress, but from good-will, and a change of disposition towards the colonies, with a sincere desire of reconciliation; let some of their other grievances, which in their petition they have left to the magnanimity and justice of the King and Parliament, be at the same time removed, such as those relating to the payment of governors' and judges' salaries, and the instructions for dissolving Assemblies, &c., with the declarations concerning the statute of Henry the Eighth.

"And to give the colonies an immediate opportunity of demonstrating the reality of their professions, let their proposed ensuing Congress be authorized by government, (as was that held at Albany, in 1754,) and a person of weight and dignity of character be appointed to preside at it on behalf of the crown.

"And then let requisition be made to the Congress, of such points as government wishes to obtain for its future security, for aids, for the advantage of general commerce, for reparation to the India Company, &c. &c.

"A generous confidence thus placed in the colonies, will give ground to the friends of government there, in their endeavours to procure from America every reasonable concession, or engagement, and every substantial aid, that can fairly be desired."

On the Saturday evening, I saw Mrs. Howe, who informed me she had transcribed and sent the paper to Lord Howe in the country, and she returned me the original. On the following Tuesday, January 3d, I received a note from her, (enclosing a letter she had received from Lord Howe the last night,) as follows.

"Mrs. Howe's compliments to Dr. Franklin; she encloses him a letter she received last night, and returns him many thanks for his very obliging present,* which has already given her great entertainment. If the Doctor has any spare time for chess, she will be exceedingly glad to see him any morning this week, and as often as will be agreeable to him, and rejoices in having so good an excuse for asking the favor of his company.

"*Tuesday.*"

"TO THE HONORABLE MRS. HOWE, GRAFTON STREET.

"Porter's Lodge, January 2d, 1775.

"I have received your packet; and it is with much concern that I collect, from sentiments of such authority as those of our worthy friend, that the desired accom-

* His Philosophical Writings. W. T. F.

modation threatens to be attended with much greater difficulty than I had flattered myself, in the progress of our intercourse, there would be reason to apprehend.

"I shall forward the propositions as intended, not desirous of trespassing further on our friend's indulgence; but retaining sentiments of regard, which his candid and obliging attention to my troublesome inquiries will render ever permanent in the memory of your affectionate, &c.

"Howe.

"I ought to make excuses likewise to you."

His Lordship had, in his last conversation with me, acknowledged a communication between him and the ministry, to whom he wished to make my sentiments known. In this letter from the country he owns the receipt of them, and mentions his intention of forwarding them, that is, as I understood it, to the ministers; but expresses his apprehensions, that such propositions were not likely to produce any good effect. Some time after, perhaps a week, I received a note from Mrs. Howe, desiring to see me. I waited upon her immediately, when she showed me a letter from her brother, of which having no copy, I can only give from the best of my recollection the purport of it, which I think was this; that he desired to know from their friend, meaning me, through her means, whether it might not be expected, that if that friend would engage for their payment of the tea as a preliminary, relying on a promised redress of their grievances on future petitions from their Assembly, they would approve of his making such engagement; and whether the proposition in the former paper, (the "Hints,") relating to aids, was still in contemplation of the author. As Mrs. Howe proposed sending to her brother that evening, I wrote immediately the following answer, which she transcribed and forwarded.

"The proposition in the former paper relating to aids, is still in contemplation of the author, and, as he thinks, is included in the last article of the present paper.

"The people of America, conceiving that Parliament has no right to tax them, and that therefore all that has been extorted from them by the operation of the duty acts, with the assistance of an armed force, *preceding* the destruction of the tea, is so much injury, which ought in order of time to be first repaired, before a demand on the tea account can be justly made of them, are not, he thinks, likely to approve of the measure proposed, and pay *in the first place* the value demanded, especially as twenty times as much injury has since been done them by blocking up their port; and their castle also, seized before by the crown, has not been restored, nor any satisfaction offered them for the same."

At the meeting of Parliament after the holidays, which was on the 19th of January, 1775, Lord Howe returned to town, when we had another meeting, at which he lamented, that my propositions were not such as probably could be accepted; intimated, that it was thought I had powers or instructions from the Congress to make concessions on occasion, that would be more satisfactory. I disclaimed the having any of any kind, but what related to the presenting of their petition. We talked over all the particulars in my paper, which I supported with reasons; and finally said, that, if what I had proposed would not do, I should be glad to hear what would do; I wished to see some propositions from the ministers themselves. His Lordship was not, he said, as yet fully acquainted with their sentiments, but should learn more in a few days. It was, however, some weeks before I heard any thing further from him.

In the mean while, Mr. Barclay and I were frequently together on the affair of preparing the merchants' petition, which took up so much of his time that he could not conveniently see Lord Hyde; so he had no information to give me concerning the "HINTS," and I wondered I heard nothing of them from Dr. Fothergill At length, however, but I cannot recollect about what time, the Doctor called on me, and told me he had communicated them, and with them had verbally given my arguments in support of them, to Lord Dartmouth, who, after consideration, had told him, some of them appeared reasonable, but others were inadmissible or impracticable. That having occasion to see frequently the Speaker,* he had also communicated them to him, as he found him very anxious for a reconciliation. That the Speaker had said it would be very humiliating to Britain to be obliged to submit to such terms; but the Doctor told him she had been unjust, and ought to bear the consequences, and alter her conduct; that the pill might be bitter, but it would be salutary, and must be swallowed. That these were the sentiments of impartial men, after thorough consideration and full information of all circumstances; and that sooner or later these or similar measures must be followed, or the empire would be divided and ruined. The Doctor, on the whole, hoped some good would be effected by our endeavours.

On the 19th of January, I received a card from Lord Stanhope, acquainting me, that Lord Chatham, having a motion to make on the morrow in the House of Lords,

* Sir Fletcher Norton

concerning America, greatly desired that I might be in the House, into which Lord Stanhope would endeavour to procure me admittance. At this time it was a rule of the House, that no person could introduce more than one friend. The next morning his Lordship let me know by another card, that, if I attended at two o'clock in the lobby, Lord Chatham would be there about that time, and would himself introduce me. I attended, and met him there accordingly. On my mentioning to him what Lord Stanhope had written to me, he said, "Certainly; and I shall do it with the more pleasure, as I am sure your being present at this day's debate will be of more service to America than mine;" and so taking me by the arm was leading me along the passage to the door that enters near the throne, when one of the door-keepers followed, and acquainted him that, by the order, none were to be carried in at that door but the eldest sons or brothers of peers; on which he limped back with me to the door near the bar, where were standing a number of gentlemen, waiting for the peers who were to introduce them, and some peers waiting for friends they expected to introduce; among whom he delivered me to the door-keepers, saying aloud, "This is Dr. Franklin, whom I would have admitted into the House;" when they readily opened the door for me accordingly.

As it had not been publicly known, that there was any communication between his Lordship and me, this I found occasioned some speculation. His appearance in the House, I observed, caused a kind of bustle among the officers, who were hurried in sending messengers for members, I suppose those in connexion with the ministry, something of importance being expected when that great man appears; it being but seldom that his infirmities permit his attendance. I had great satisfaction in hearing his motion and the debate upon it, which I shall not attempt to give here an account of, as you may find a better in the papers of the time. It was his motion for withdrawing the troops from Boston, as the first step towards an accommodation.

The day following, I received a note from Lord Stanhope expressing, that, "at the desire of Lord Chatham, was sent me inclosed the motion he made in the House of Lords, that I might be possessed of it in the most authentic manner, by the communication of the individual paper, which was read to the House by the mover himself." I sent copies of this motion to America, and was the more pleased with it, as I conceived it had partly taken its rise from a hint I had given his Lordship in a former conversation. It follows in these words.

LORD CHATHAM'S MOTION, JANUARY 20TH, 1775.

"That an humble address be presented to his Majesty, most humbly to advise and beseech his Majesty, that, in order to open the way towards a happy settlement of the dangerous troubles in America, by beginning to allay ferments and soften animosities there; and above all, for preventing in the mean time any sudden and fatal catastrophe at Boston, now suffering under the daily irritation of an army before their eyes, posted in their town; it may graciously please his Majesty, that immediate orders may be despatched to General Gage for removing his Majesty's forces from the town of Boston, as soon as the rigor of the season and other circumstances, indispensable to the safety and accommodation of the said troops, may render the same practicable."

I was quite charmed with Lord Chatham's speech in support of his motion. He impressed me with the highest idea of him, as a great and most able statesman.* Lord Camden, another wonderfully good speaker and close reasoner, joined him in the same argument, as did several other Lords, who spoke excellently well; but all availed no more than the whistling of the winds. The motion was rejected. Sixteen Scotch peers, and twenty-four bishops, with all the lords in possession or expectation of places, when they vote together unanimously, as they generally do for ministerial measures, make a dead majority, that renders all debating ridiculous in itself, since it can answer no end. Full of the high esteem I had imbibed for Lord Chatham, I wrote back to Lord Stanhope the following note, viz.

"Dr. Franklin presents his best respects to Lord Stanhope, with many thanks to his Lordship and Lord Chatham for the communication of so authentic a copy of the motion. Dr. F. is filled with admiration of that truly great man. He has seen, in the course of life, sometimes eloquence without wisdom, and often wisdom without eloquence; in the present instance he sees both united, and both, as he thinks, in the highest degree possible.

"*Craven Street, January 23d*, 1775."

As in the course of the debate some Lords in the administration had observed, that it was common and easy to censure their measures, but those who did so proposed nothing better, Lord Chatham mentioned, that

* It was reported at the time, that his Lordship had concluded his speech with the following remarkable words; "If the ministers thus persevere in *misadvising* and *misleading* the King, I will not say, that they can alienate the affections of his subjects from his crown, but I will affirm, that they will make the crown *not worth his wearing*. I will not say, that the King is betrayed, but I will pronounce that *the kingdom is undone*." — W. T. F.

he should not be one of those idle censurers; that he had thought long and closely upon the subject, and proposed soon to lay before their Lordships the result of his meditation, in a plan for healing our differences, and restoring peace to the empire, to which his present motion was preparatory. I much desired to know what his plan was, and intended waiting on him to see if he would communicate it to me; but he went the next morning to Hayes, and I was so much taken up with daily business and company, that I could not easily get out to him. A few days after, however, Lord Mahon called on me, and told me Lord Chatham was very desirous of seeing me; when I promised to be with him the Friday following, several engagements preventing my going sooner.

On Friday the 27th, I took a post-chaise about nine o'clock, and got to Hayes about eleven; but, my attention being engaged in reading a new pamphlet, the post-boy drove me a mile or two beyond the gate. His Lordship, being out on an airing in his chariot, had met me before I reached Hayes, unobserved by me, turned and followed me, and not finding me there, concluded, as he had seen me reading, that I had passed by mistake, and sent a servant after me. He expressed great pleasure at my coming, and acquainted me in a long conversation with the outlines of his plan, parts of which he read to me. He said he had communicated it only to Lord Camden, whose advice he much relied on, particularly in the law part; and that he would, as soon as he could, get it transcribed, put it into my hands for my opinion and advice, but should show it to no other person before he presented it to the House; and he requested me to make no mention of it, otherwise parts might be misunderstood and blown upon beforehand, and others perhaps adopted and produced by ministers as their own. I promised the closest secrecy, and kept my word, not even mentioning to any one that I had seen him. I dined with him, his family only present, and returned to town in the evening.

On the Sunday following, being the 29th, his Lordship came to town, and called upon me in Craven Street. He brought with him his plan transcribed, in the form of an act of Parliament, which he put into my hands, requesting me to consider it carefully, and communicate to him such remarks upon it as should occur to me. His reason for desiring to give me that trouble was, as he was pleased to say, that he knew no man so thoroughly acquainted with the subject, or so capable of giving advice upon it; that he thought the errors of ministers in American affairs had been often owing to their not obtaining the best information; that, therefore, though he had considered the business thoroughly in all its parts, he was not so confident of his own judgment, but that he came to set it right by mine, as men set their watches by a regulator. He had not determined when he should produce it in the House of Lords; but in the course of our conversation, considering the precarious situation of his health, and that if presenting it was delayed, some intelligence might arrive which would make it seem less seasonable, or in all parts not so proper; or the ministry might engage in different measures, and then say, "If you had produced your plan sooner, we might have attended to it;" he concluded to offer it the Wednesday following; and therefore wished to see me upon it the preceding Tuesday, when he would again call upon me, unless I could conveniently come to Hayes. I chose the latter, in respect to his Lordship, and because there was less likelihood of interruptions; and I promised to be with him early, that we might have more time. He stayed with me near two hours, his equipage waiting at the door; and being there while people were coming from church, it was much taken notice of, and talked of, as at that time was every little circumstance that men thought might possibly any way affect American affairs. Such a visit from so great a man, on so important a business, flattered not a little my vanity; and the honor of it gave me the more pleasure, as it happened on the very day twelve months that the ministry had taken so much pains to disgrace me before the Privy Council.*

I applied myself immediately to the reading and considering the plan, of which, when it was afterwards published, I sent you a copy, and therefore need not insert it here. I put down upon paper, as I went along, some short memorandums for my future discourse with him upon it, which follow, that you may, if you please, compare them with the plan; and, if you do so, you will see their drift and purpose, which otherwise would take me much writing to explain.

"Tuesday, January 31st, 1775.

"NOTES *for Discourse with Lord Chatham on his Plan.*

"Voluntary grants and forced taxes not to be expected of the same people at the same time.

"Permanent revenue will be objected to. Would not a temporary agreement be best, suppose for one hundred years?

"Does the whole of the rights claimed in the Petition of Rights relate to England only?

"The American Naturalization Act gives all the rights of natural-born subjects to foreigners residing there seven years. Can it be supposed, that the natives there have them not?

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* In the affair of Hutchinson's Letters.—EDITOR

"If the King should raise armies in America, would Britain like their being brought hither? as the King might bring them when he pleased.

"An act of Parliament requires the colonies to furnish sundry articles of provision and accommodation to troops quartered among them; this may be made very burdensome to colonies that are out of favor.

"If a permanent revenue, why not the same privileges in trade with Scotland?

"Should not the lands, conquered by Britain and the colonies in conjunction, be given them, (reserving a quit-rent,) whence they might form funds to enable them to pay?

"Instructions about agents to be withdrawn.

"Grants to be for three years, at the end of which a new Congress; and so from three to three years.

"Congress to have the general defence of the frontiers, making and regulating new settlements.

"Protection mutual.

"We go into all your wars.

"Our settlements cost you nothing.

"Take the plan of union.

"'Defence, extension, and prosperity of.' The late Canada Act prevents their extension, and may check their prosperity.

"Laws should be secure as well as charters.

"Perhaps if the legislative power of Parliament is owned in the colonies, they may make a law to forbid the meeting of any Congress, &c."

I was at Hayes early on Tuesday, agreeably to my promise, when we entered into consideration of the plan; but, though I stayed near four hours, his Lordship, in the manner of, I think, all eloquent persons, was so full and diffuse in supporting every particular I questioned, that there was not time to go through half my memorandums. He is not easily interrupted; and I had such pleasure in hearing him, that I found little inclination to interrupt him. Therefore, considering that neither of us had much expectation, that the plan would be adopted entirely as it stood; that, in the course of its consideration, if it should be received, proper alterations might be introduced; that, before it would be settled, America should have opportunity to make her objections and propositions of amendment; that, to have it received at all here, it must seem to comply a little with some of the prevailing prejudices of the legislature; that, if it was not so perfect as might be wished, it would at least serve as a basis for treaty, and in the mean time prevent mischiefs; and that, as his Lordship had determined to offer it the next day, there was not time to make changes and another fair copy; I therefore ceased my querying; and, though afterwards many people were pleased to do me the honor of supposing I had a considerable share in composing it, I assure you, that the addition of a single word only was made at my instance, viz. "*constitutions*" after "charters"; for my filling up, at his request, a blank with the titles of acts proper to be repealed, which I took from the proceedings of the Congress, was no more than might have been done by any copying clerk.

On Wednesday, Lord Stanhope, at Lord Chatham's request, called upon me, and carried me down to the House of Lords, which was soon very full. Lord Chatham, in a most excellent speech, introduced, explained, and supported his plan. When he sat down, Lord Dartmouth rose, and very properly said, it contained matter of such weight and magnitude, as to require much consideration; and he therefore hoped the noble Earl did not expect their Lordships to decide upon it by an immediate vote, but would be willing it should lie upon the table for consideration. Lord Chatham answered readily, that he expected nothing more.

But Lord Sandwich rose, and in a petulant, vehement speech, opposed its being received at all, and gave his opinion, that it ought to be immediately *rejected*, with the contempt it deserved. That he could never believe it to be the production of any British Peer. That it appeared to him rather the work of some American; and, turning his face towards me, who was leaning on the bar, said, he fancied he had in his eye the person who drew it up, one of the bitterest and most mischievous enemies this country had ever known. This drew the eyes of many Lords upon me; but, as I had no inducement to take it to myself, I kept my countenance as immovable as if my features had been made of wood. Then several other Lords of the administration gave their sentiments also for rejecting it, of which opinion also was strongly the *wise* Lord Hillsborough. But the Dukes of Richmond and Manchester, Lord Shelburne, Lord Camden, Lord Temple, Lord Lyttleton, and others, were for receiving it, some through approbation, and others for the character and dignity of the House. One Lord mentioning with applause, the candid proposal of one of the ministers, Lord Dartmouth, his Lordship rose again, and said, that having since heard the opinions of so many Lords against receiving it, to lie upon the table for consideration, he had altered his mind, could not accept the praise offered him for a candor of which he was now ashamed, and should therefore give his voice for rejecting the plan immediately.

I am the more particular in this, as it is a trait of that nobleman's character, who from his office is supposed to have so great a share in American affairs, but who has in reality no will or judgment of his own, being, with dispositions for the best measures, easily prevailed with to join in the worst.

Lord Chatham, in his reply to Lord Sandwich, took notice of his illiberal insinuation, that the plan was not the person's who proposed it; declared that it was entirely his own; a declaration he thought himself the more obliged to make, as many of their Lordships appeared to have so mean an opinion of it; for if it was so weak or so bad a thing, it was proper in him to take care that no other person should unjustly share in the censure it deserved. That it had been heretofore reckoned his vice, not to be apt to take advice; but he made no scruple to declare, that, if he were the first minister of this country, and had the care of settling this momentous business, he should not be ashamed of publicly calling to his assistance a person so perfectly acquainted with the whole of American affairs as the gentleman alluded to, and so injuriously reflected on; one, he was pleased to say, whom all Europe held in high estimation for his knowledge and wisdom, and ranked with our Boyles and Newtons; who was an honor, not to the English nation only, but to human nature! I found it harder to stand this extravagant compliment than the preceding equally extravagant abuse; but kept as well as I could an unconcerned countenance, as not conceiving it to relate to me.

To hear so many of these *hereditary* legislators declaiming so vehemently against, not the adopting merely, but even the *consideration* of a proposal so important in its nature, offered by a person of so weighty a character, one of the first statesmen of the age, who had taken up this country when in the lowest despondency, and conducted it to victory and glory, through a war with two of the mightiest kingdoms in Europe; to here them censuring his plan, not only for their own misunderstandings of what was in it, but for their imaginations of what was not in it, which they would not give themselves an opportunity of rectifying by a second reading; to perceive the total ignorance of the subject in some, the prejudice and passion of others, and the wilful perversion of plain truth in several of the ministers; and, upon the whole, to see it so ignominiously rejected by so great a majority, and so hastily too, in breach of all decency, and prudent regard to the character and dignity of their body, as a third part of the national legislature, gave me an exceeding mean opinion of their abilities, and made their claim of sovereignty over three millions of virtuous, sensible people in America seem the greatest of absurdities, since they appeared to have scarce discretion enough to govern a herd of swine. *Hereditary legislators!* thought I. There would be more propriety, because less hazard of mischief, in having (as in some university of Germany) *hereditary professors of mathematics!* But this was a hasty reflection; for the *elected* House of Commons is no better, nor ever will be while the electors receive money for their votes, and pay money wherewith ministers may bribe their representatives when chosen.

After this proceeding I expected to hear no more of any negotiation for settling our difference amicably; yet, in a day or two, I had a note from Mr. Barclay, requesting a meeting at Dr. Fothergill's, the 4th of February, in the evening. I attended accordingly, and was surprised by being told, that a very good disposition appeared in administration; that the "HINTS" had been considered, and several of them thought reasonable, and that others might be admitted with small amendments. The good Doctor, with his usual philanthropy, expatiated on the miseries of war; that even a bad peace was preferable to the most successful war; that

America was growing in strength; and, whatever she might be obliged to submit to at present, she would in a few years be in a condition to make her own terms.

Mr. Barclay hinted how much it was in my power to promote an agreement; how much it would be to my honor to effect it; and that I might expect, not only restoration of my old place, but almost any other I could wish for, &c. I need not tell you, who know me so well, how improper and disgusting this language was to me. The Doctor's was more suitable. Him I answered, that we did not wish for war, and desired nothing but what was reasonable and necessary for our security and well-being. To Mr. Barclay I replied, that the ministry, I was sure, would rather give me a place in a cart to Tyburn, than any other place whatever; and to both, that I sincerely wished to be serviceable; that I needed no other inducement than to be shown how I might be so; but saw they imagined more to be in my power than really was. I was then told again, that conferences had been held upon the "HINTS"; and the paper being produced was read, that I might hear the observations that had been made upon them separately, which were as follows.

1. The first article was approved.

2. The second agreed to, so far as related to the repeal of the Tea Act. But repayment of the duties that had been collected was refused.

3. The third not approved, as it implied a deficiency of power in the Parliament that made those acts.

4. The fourth approved.

5. The fifth agreed to, but with a reserve, that no change prejudicial to Britain was to be expected.

6. The sixth agreed to, so far as related to the appropriation of the duties; but the appointment of the officers and their salaries to remain as at present.

7. The seventh, relating to aids in time of peace, agreed to.

8. The eighth, relating to the troops, was inadmissible.

9. The ninth could be agreed to, with this difference, that no proportion should be observed with regard to preceding taxes, but each colony should give at pleasure.

10. The tenth agreed to, as to the restitution of Castle William; but the restriction on the crown in building fortresses refused.

11. The eleventh refused absolutely, except as to the Boston Port Bill, which would be repealed; and the Quebec Act might be so far amended, as to reduce that province to its ancient limits. The other Massachusetts acts, being real amendments of their constitution, must for that reason be continued, as well as to be a standing example of the power of Parliament.

12. The twelfth agreed to, that the judges should be appointed during good behaviour, on the Assemblies providing permanent salaries, such as the crown should approve of.

13. The thirteenth agreed to, provided the Assemblies make provision as in the preceding article.

15. The fifteenth agreed to.

16. The sixteenth agreed to, supposing the duties paid to the colony treasuries.

17. The seventeenth inadmissible.

We had not at this time a great deal of conversation upon these points; for I shortened it by observing, that, while the Parliament claimed and exercised a power of altering our constitutions at pleasure, there could be no agreement; for we were rendered unsafe in every privilege we had a right to, and were secure in nothing. And, it being hinted how necessary an agreement was for America, since it was so easy for Britain to burn all our seaport towns, I grew warm, said that the chief part of my little property consisted of houses in those towns; that they might make bonfires of them whenever they pleased; that the fear of losing them would never alter my resolution to resist to the last that claim of Parliament; and that it behoved this country to take care what mischief it did us; for that sooner or later it would certainly be obliged to make good all damages with interest! The Doctor smiled, as I thought, with some approbation of my discourse, passionate as it was, and said, he would certainly repeat it to-morrow to Lord Dartmouth.

In the discourse concerning the "HINTS," Mr. Barclay happened to mention, that, going to Lord Hyde's he found Lord Howe with him; and that Lord Hyde had said to him, "You may speak any thing before Lord Howe, that you have to say to me, for he is a friend in whom I confide;" upon which he accordingly had spoken with the same freedom as usual. By this I collected how Lord Howe came by the paper of "HINTS," which he had shown me. And, it being mentioned as a measure thought of, to send over a commissioner with powers to inquire into grievances, and give redress on certain conditions, but that it was difficult to find a proper person, I said, "Why not Lord Hyde? He is a man of prudence and temper, a person of dignity, and, I should think, very suitable for such an employment; or, if he would not go, there is the other person you just mentioned, Lord Howe, who would, in my opinion, do excellently well." This passed as mere conversation, and we parted.

Lord Chatham's rejected plan being printed, for the public judgment, I received six copies from Lord Mahon, his son-in-law, which I sent to different persons in America.

A week and more passed, in which I heard nothing further of any negotiation, and my time was much taken up among the members of Parliament, when Mr. Barclay sent me a note to say, that he was indisposed, but desirous of seeing me, and should be glad if I would call on him. I waited upon him the next morning, when he told me, that he had seen Lord Hyde, and had some further discourse with him on the ARTICLES; that he thought himself now fully possessed of what would do in this business; that he therefore wished another meeting with me and Dr. Fothergill, when he would endeavour to bring prepared a draft conformable chiefly to what had been proposed and conceded on both sides, with some propositions of his own. I readily agreed to the meeting, which was to be on Thursday evening, February 16th.

We met accordingly, when Mr. Barclay produced the following paper, viz.

"A PLAN, which, it is believed, would produce a *permanent union* between Great Britain and her Colonies

"1. The tea destroyed to be paid for; and. in order that no time may be lost, to begin the desirable work of conciliation, it is proposed, that the agent or agents, in a petition to the King, should engage that the tea destroyed shall be paid for; and, in consequence of that engagement, a commissioner to have authority, by a clause in an act of Parliament, to open the port (by a suspension of the Boston Port Act) when that engagement shall be complied with.

"2. The Tea-duty Act to be repealed, as well for the advantage of Great Britain as the colonies

"3. Castle William to be restored to the province of Massachusetts Bay, as formerly, before it was delivered up by Governor Hutchinson.

"4. As it is believed, that the *commencement* of conciliatory measures will, in a considerable degree, quiet the minds of the subjects in America, it is proposed, that the inhabitants of the province of the Massachusetts Bay should petition the King, and state their objections to the said act.* And it is to be *understood*, that the said act shall be repealed. *Interim*, the commissioner to have power to suspend the act, in order to enable the inhabitants to petition.

"5. The several provinces, who may think themselves aggrieved by the Quebec Bill, to petition in their legislative capacities; and it is to be *understood*, that so far of the act, as extends the limits of Quebec beyond its ancient bounds, is to be repealed.

"6. The act of Henry the Eighth to be formally disclaimed by Parliament.

"7. In time of *peace*, the Americans to raise, within their respective provinces, by acts of their own legislatures, a certain sum or sums, such as *may be thought* necessary for a peace establishment, to pay governors, judges, &c. Vide *Laws of Jamaica*.

"8. In time of *war*, on requisition made by the King, with consent of Parliament, every colony shall raise such sums of money as their legislatures may think suitable to their abilities and the public exigency, to be laid out in raising and paying men for land or sea service, furnishing provisions, transports, or such other purposes as the King shall require and direct.

"9. The acts of navigation to be reëxamined, in order to see whether some alterations might not be

* Supposed to mean the Boston Port Act.

made therein, as much for the advantage of Great Britain as the ease of the colonies.

"10. A naval officer to be appointed by the crown to reside in each colony, to see those acts observed.

"N. B. In some colonies they are *not* appointed by the crown.

"11. All duties arising on the acts for regulating trade with the colonies to be for the public use of the respective colonies, and paid into their treasuries, and an officer of the crown to see it done.

"12. The admiralty courts to be reduced to the same powers as they have in England.

"13. All judges in the King's colony governments to be appointed during good behaviour, and to be paid by the province, agreeable to article seventh.

"N. B. If the King chooses to add to their salaries, the same to be sent from England.

"14. The governors to be supported in the same manner."

Our conversation turned chiefly upon the *first* article. It was said, that the ministry only wanted some opening to be given them, some ground on which to found the commencement of conciliating measures; that a petition containing such an engagement as mentioned in this article would answer that purpose; that preparations were making to send over more troops and ships; that such a petition might prevent their going, especially if a commissioner were proposed. I was therefore urged to engage the colony agents to join with me in such a petition. My answer was, that no agent had any thing to do with the tea business, but those for Massachusetts Bay, who were Mr. Bollan for the Council, myself for the Assembly, and Mr. Lee, appointed to succeed me when I should leave England;

that the latter, therefore, could hardly yet be considered as an agent; and that the former was a cautious, exact man, and not easily persuaded to take steps of such importance without instructions or authority; that, therefore, if such a step were to be taken, it would lie chiefly on me to take it; that, indeed, if there were, as they supposed, a clear probability of good to be done by it, I should make no scruple of hazarding myself in it; but I thought the empowering a commissioner to suspend the Boston Port Act was a method too dilatory, and a mere suspension would not be satisfactory; that, if such an engagement were entered into, all the Massachusetts acts should be immediately repealed.

They laid hold of the readiness I had expressed to petition on a probability of doing good, applauded it, and urged me to draw up a petition immediately. I said it was a matter of importance, and with their leave I would take home the paper, consider the propositions as they now stood, and give them my opinion to-morrow evening. This was agreed to, and for that time we parted.

Weighing now the present dangerous situation of affairs in America, and the daily hazard of widening the breach there irreparably, I embraced the idea proposed in the paper of sending over a commissioner, as it might be a means of suspending military operations, and bring on a treaty, whereby mischief would be prevented, and an agreement by degrees be formed and established. I also concluded to do what had been desired of me as to the engagement, and essayed a draft of a memorial to Lord Dartmouth for that purpose simply, to be signed only by myself. As to the sending of a commissioner, a measure which I was desired likewise to propose, and express my sentiments of its utility, I apprehended my colleagues in the agency might be justly displeased if I took a step of such importance without consulting them, and therefore I sketched a joint petition to that purpose, for them to sign with me, if they pleased; but, apprehending that would meet with difficulty, I drew up a letter to Lord Dartmouth, containing the same proposition, with the reasons for it, to be sent from me only. I made also upon paper some remarks on the propositions; with some hints, on a separate paper, of further remarks to be made in conversation, when we should meet in the evening of the 17th. Copies of these papers (except the first, which I do not find with me on shipboard,) are here placed as follows, viz.

"TO THE KING'S MOST EXCELLENT MAJESTY,

"The PETITION and MEMORIAL of W. Bollan, B. Franklin, and Arthur Lee,

"Most humbly showeth;

"That your petitioners, being agents for several colonies, and deeply affected with the apprehension of impending calamities, that now threaten your Majesty's subjects in America, beg leave to approach your throne, and to suggest with all humility their opinion, formed on much attentive consideration, that, if it should please your Majesty to permit and authorize a meeting of delegates from the different provinces, and appoint some person or persons of dignity and wisdom from this country to preside in that meeting, or to confer with the said delegates, acquaint themselves fully with the true grievances of the colonies, and settle the means of composing all dissensions, such means to be afterwards ratified by your Majesty, if found just and suitable; your petitioners are persuaded, from their thorough knowledge of that country and people, that such a measure might be attended with the most salutary effects, prevent much mischief, and restore the harmony which so long subsisted, and is so necessary to the prosperity and happiness of all your Majesty's subjects in every part of your extensive dominions; which, that Heaven may preserve entire to your Majesty and your descendants, is the sincere prayer of your Majesty's most dutiful subjects and servants."

"TO THE RIGHT HONORABLE LORD DARTMOUTH.

"My Lord,

"Being deeply apprehensive of the impending calamities, that threaten the nation and its colonies through the present unhappy dissensions, I have attentively considered by what possible means those calamities may be prevented. The great importance of a business which concerns us all, will, I hope, in some degree excuse me to your Lordship, if I presume unasked to offer my humble opinion, that, should his Majesty think fit to authorize delegates from the several provinces to meet at such convenient time and place, as in his wisdom shall seem meet, then and there to confer with a commissioner or commissioners to be appointed and empowered by his Majesty, on the means of establishing a firm and lasting union between Britain and the American provinces, such a measure might be effectual for that purpose. I cannot therefore but wish it may be adopted, as no one can more ardently and sincerely desire the general prosperity of the British dominions, than, my Lord, your Lordship's most obedient, &c.

"B. Franklin."

"REMARKS ON THE PROPOSITIONS.

"Art. 1. In consequence of that engagement, all the Boston and Massachusetts acts to be suspended, and, in compliance with that engagement, to be totally repealed.

"By this amendment article fourth will become unnecessary.

"Art. 4 and 5. The numerous petitions heretofore sent home by the colony Assemblies, and either refused to be received, or received and neglected, or answered harshly, and the petitioners rebuked for making them, have, I conceive, totally discouraged that method of application; and, if even their friends were now to propose to them the recurring again to petitioning, such friends would be thought to trifle with them. Besides, *all* they desire is now before government in the petition of the Congress, and the whole or parts may be granted or refused at pleasure. The sense of the colonies cannot be better obtained by petition from different colonies, than it is by that general petition.

"Art. 7. Read, *such as they may think necessary*

"Art. 11. As it stands, of little importance. The first proposition was, that they should be repealed as unjust. But they may remain, for they will probably not be executed.

"Even with the amendment proposed above to article first, I cannot think it stands as it should do. If the object be merely the preventing present bloodshed, and the other mischiefs to fall on that country in war, it may possibly answer that end; but, if a thorough, hearty reconciliation is wished for, all cause of heart-burning should be removed, and strict justice be done on both sides. Thus the tea should not only be paid for on the side of Boston, but the damage done to Boston by the Port Act should be repaired, because it was done contrary to the custom of all nations, savage as well as civilized, of first demanding satisfaction.

"Art. 14. The judges should receive nothing from the King.

"As to the other two acts, the Massachusetts must suffer all the hazards and mischiefs of war, rather than admit the alteration of their charters and laws by Parliament. 'They, who can give up essential liberty to obtain a little temporary safety, deserve neither liberty nor safety.'

"B. FRANKLIN."

"HINTS.

"I doubt the regulating duties will not be accepted, without enacting them, and having the power of appointing the collectors, in the colonies.

"If we mean a hearty reconciliation, we must deal candidly, and use no tricks.

"The Assemblies are many of them in a state of dissolution. It will require time to make new elections; then to meet and choose delegates, supposing all could meet. But the Assembly of the Massachusetts Bay cannot act under the new constitution, or meet the new Council for that purpose, without acknowledging the power of Parliament to alter their charter, which they never will do. The language of the proposal is, *Try on your fetters first, and then, if you don't like them, petition and we will consider.*

"Establishing salaries for judges may be a general law. For governors not so, the constitution of colonies differing. It is possible troops may be sent to *particular* provinces, to burden them when they are out of favor.

"Canada. We cannot endure despotism over any of our fellow subjects. We must all be free, or none."

That afternoon I received the following note from Mrs. Howe, enclosing another from Lord Howe, viz.

"MRS. HOWE'S compliments to Dr. Franklin; she has just received the enclosed note from Lord Howe, and hopes it will be convenient to him to come to her, either to-morrow or Sunday, at any hour most convenient to him, which she begs he will be so good to name.

"*Grafton Street, Friday, February* 17*th*, 1775."

[*Enclosed in the foregoing.*]

"TO THE HONORABLE MRS. HOWE.

"I wish you to procure me an opportunity to see Dr. Franklin at your house to-morrow, or on Sunday morning, for an essential purpose.

"*Grafton Street, Friday, four o'clock.*"

I had not heard from his Lordship for some time, and readily answered, that I would do myself the honor of waiting upon him at her house to-morrow at eleven o'clock.

Mr. Barclay, Dr. Fothergill, and myself, met according to appointment at the Doctor's house. I delivered to them the "REMARKS" I had made on the paper, and we talked them over. I read also the sketches I had made of the petitions and memorials; but, they being of opinion, that the repeal of none of the Massachusetts acts could be obtained by my engaging to pay for the tea, the Boston Port Act excepted, and I insisting on a repeal of *all*, otherwise declining to make the offer, that measure was deferred for the present, and I pocketed my drafts. They concluded, however, to report my sentiments, and see if any further concession could be obtained. They observed, too, that I had signed my "Remarks"; on which I said, that understanding by other means, as well as from them, that the ministers had been acquainted with my being consulted in this business, I saw no occasion for further mystery; and, since conveying and receiving through second hands their sentiments and mine occasioned delay, and might be attended with misapprehension, something being lost or changed by mistake in the conveyance, I did not see why we should not meet and discuss the points together at once; that, if this was thought proper, I should be willing and ready to attend them to the ministerial persons they conferred with. They seemed to approve the proposal, and said they would mention it.

The next morning I met Lord Howe, according to appointment. He seemed very cheerful, having, as I imagine, heard from Lord Hyde what that Lord might have heard from Mr. Barclay the evening of the 16th, viz. that I had consented to petition, and engage payment for the tea; whence it was hoped, the ministerial terms of accommodation might take place. He let me know, that he was thought of to be sent commissioner for settling the differences in America; adding, with an excess of politeness, that, sensible of his own unacquaintedness with the business, and of my knowledge and abilities, he could not think of undertaking it without me; but, with me, he should do it most readily; for he should found his expectation of success on my assistance. He therefore had desired this meeting, to know my mind upon a proposition of my going with him in some shape or other, as a friend, an assistant, or secretary; that he was very sensible, if he should be so happy as to effect any thing valuable, it must be wholly owing to the advice and assistance I should afford him; that he should therefore make no scruple of giving me upon all occasions the full honor of it; that he had declared to the ministers his opinion of my good dispositions towards peace, and what he now wished was to be authorized by me to say, that I consented to accompany him, and would coöperate with him in the great work of reconciliation. That the influence I had over the minds of people in America was known to be very extensive; and that I could, if any man could, prevail with them to comply with reasonable propositions.

I replied, that I was obliged to his Lordship for the favorable opinion he had of me, and for the honor he did me in proposing to make use of my assistance; that I wished to know what propositions were intended for America; that, if they were reasonable ones in themselves, possibly I might be able to make them appear such to my countrymen; but, if they were otherwise, I doubted whether that could be done by any man, and certainly I should not undertake it. His Lordship then said, that he should not expect my *assistance* without a *proper consideration*. That the business was of great importance; and, if he undertook it, he should insist on being enabled to make *generous* and *ample* appointments for those he took with him, particularly for me; as well as a firm promise of *subsequent rewards*. "And," said he, "that the ministry may have an opportunity of showing their good disposition towards yourself, will you give me leave, Mr. Franklin, to procure for you previously some mark of it; suppose the payment here of the arrears of your salary, as agent for New England, which I understand they have stopped for some time past?" "My Lord," said I, "I shall deem it a great honor to be in any shape joined with your Lordship in so good a work; but, if you hope service from any influence I may be supposed to have, drop all thoughts of procuring me any previous favors from ministers; my accepting them would destroy the very influence you propose to make use of; they would be considered as so many bribes to betray the interest of my country; but only let me see the *propositions*, and, if I approve of them, I shall not hesitate a moment, but will hold myself ready to accompany your Lordship at an hour's warning." He then said, he wished I would discourse with Lord Hyde upon the business, and asked if I had any objection to meet his Lordship. I answered, none, not the least; that I had a great respect for Lord Hyde, and would wait upon him whenever he should please to permit it. He said he would speak to Lord Hyde, and send me word.

On the Monday following, I received a letter from Lord Howe. To understand it better, it is necessary to reflect, that in the mean time there was opportunity for Mr. Barclay to communicate to that nobleman the "REMARKS" I had made on the Plan, the sight of which had probably changed the purpose of making any use of me on the occasion. The letter follows.

"Grafton Street, February 20th, 1775.

"Not having had a convenient opportunity to talk with Lord Hyde until this morning, on the subject I mentioned when I had, my worthy friend, the pleasure to see you last, I now give you the earliest information of his Lordship's sentiments upon my proposition.

"He declares he has no personal objection, and that he is always desirous of the conversation of men of knowledge, consequently, in that respect, would have a pleasure in yours. But he apprehends, that on the present American contest your principles and his, or rather those of Parliament, are as yet so wide from each other, that a meeting merely to discuss them might give you unnecessary trouble. Should you think otherwise, or should any propitious circumstances approximate such distant sentiments, he would be happy to be used as a channel to convey what might tend to harmony from a person of credit to those in power. And

I will venture to advance, from my knowledge of his Lordship's opinion of men and things, that nothing of that nature would suffer in the passage.

"I am, with sincere regard, your most obedient servant,

"HOWE.

"To DR. FRANKLIN."

As I had no desire of obtruding myself upon Lord Hyde, though a little piqued at his declining to see me, I thought it best to show a decent indifference, which I endeavoured in the following answer.

"Craven Street, February 20th, 1775.

"Having nothing to offer on the American business in addition to what Lord Hyde is already acquainted with from the papers that have passed, it seems most respectful not to give his Lordship the trouble of a visit; since a mere discussion of the sentiments contained in those papers is not, in his opinion, likely to produce any good effect. I am thankful, however, to his Lordship for the permission of waiting on him, which I shall use if any thing occurs, that may give a chance of utility in such an interview.

"With sincere esteem and respect, I have the honor to be, my Lord, your Lordship's most obedient humble servant,

"B. FRANKLIN.

"To LORD HOWE."

On the morning of the same day, February 20th, it was currently and industriously reported all over the town, that Lord North would that day make a pacific motion in the House of Commons for healing all differences between Britain and America. The House was accordingly very full, and the members full of expectation. The Bedford party, inimical to America, and who had urged severe measures, were alarmed, and began to exclaim against the minister for his timidity, and the fluctuation of his *politics;* they even began to count voices, to see if they could not, by negativing his motion, at once unhorse him, and throw him out of administration. His friends were therefore alarmed for him, and there was much caballing and whispering. At length a motion, as one had been promised, was made, but whether that originally intended, is with me very doubtful. I suspect, from its imperfect composition, from its inadequateness to answer the purpose previously professed, and from some other circumstances, that, when first drawn, it contained more of Mr. Barclay's plan, but was curtailed by advice, just before it was delivered. My old proposition of giving up the regulating duties to the colonies was in part to be found in it; and many, who knew nothing of that transaction, said it was the best part of the motion. It was as follows.

LORD NORTH'S MOTION, FEBRUARY 20TH, 1775.

"That it is the opinion of this committee, that, when the Governor, Council, and Assembly, or General Court of his Majesty's provinces or colonies shall propose to make provision according to their respective conditions, circumstances, and situations, for contributing their proportion to the common defence, such proportion to be raised under the authority of the General Court or General Assembly of such province or colony, and disposable by Parliament, and shall engage to make provision also for the support of the civil government and the administration of justice in such province or colony, it will be proper, if such proposal shall be approved by his Majesty in Parliament, and for so long as such provision shall be made accordingly, to forbear, in respect of such province or colony, to levy any duties, tax, or assessment, or to impose any further duty, tax, or assessment, except only such duties as it may be expedient to impose for the regulation of commerce; the net produce of the duties last mentioned to be carried to the account of such province, colony, or plantation, exclusively."

After a good deal of wild debate, in which this motion was supported upon various and inconsistent principles by the ministerial people, and even met with an opposition from some of them, which showed a want of concert, probably from the suddenness of the alterations above supposed, they all agreed at length, as usual, in voting it by a large majority.

Hearing nothing during all the following week from Messrs. Barclay and Fothergill, (except that Lord Hyde, when acquainted with my willingness to engage for the payment of the tea, had said it gave him *new life*,) nor any thing from Lord Howe, I mentioned his silence occasionally to his sister, adding, that I supposed it owing to his finding what he had proposed to me was not likely to take place; and I wished her to desire him, if that was the case, to let me know it by a line, that I might be at liberty to take other measures. She did so as soon as he returned from the country, where he had been for a day or two; and I received from her the following note.

"MRS. HOWE's compliments to Dr. Franklin; Lord Howe not quite understanding the message received from her, will be very glad to have the pleasure of seeing him, either between twelve and one this morning, (the only hour he is at liberty this day,) at her house, or at any hour to-morrow most convenient to him.

"*Grafton Street, Tuesday.*"

I met his Lordship at the hour appointed. He said, that he had not seen me lately, as he expected daily to have something more material to say to me than had yet occurred; and hoped that I would have called on Lord Hyde, as I had intimated I should do when I apprehended it might be useful, which he was sorry to find I had not done. That there was something in my verbal message by Mrs. Howe, which perhaps she had apprehended imperfectly; it was the hint of my purpose to take other measures. I answered, that having, since I had last seen his Lordship, heard of the death of my wife at Philadelphia, in whose hands I had left the care of my affairs there, it was become necessary for me to return thither as soon as conveniently might be; that what his Lordship had proposed of my accompanying him to America might, if likely to take place, postpone my voyage to suit his conveniency; otherwise, I should proceed by the first ship; that I did suppose by not hearing from him, and by Lord North's motion, all thoughts of that kind were laid aside, which was what I only desired to know from him.

He said, my last paper of "REMARKS" by Mr. Barclay, wherein I had made the indemnification of Boston, for the injury of stopping its port, a condition of my engaging to pay for the tea (a condition impossible to be complied with), had discouraged further proceeding on that idea. Having a copy of that paper in my pocket, I showed his Lordship, that I had proposed no such condition of my engagement, nor any other than the repeal of all the Massachusetts acts. That what followed relating to the indemnification was only expressing my private opinion, that it would be just, but by no means insisting upon it. He said the arrangements were not yet determined on; that, as I now explained myself, it appeared I had been much misapprehended; and he wished of all things I would see Lord Hyde, and asked if I would choose to meet him there (at Mrs. Howe's), or that he should call upon me. I said, that I would by no means give Lord Hyde that trouble. That, since he (Lord Howe) seemed to think it might be of use, and wished it done soon, I would wait upon Lord Hyde. I knew him to be an early riser, and would be with him at eight o'clock the next morning; which Lord Howe undertook to acquaint him with. But I added, that, from what circumstances I could collect of the disposition of ministry, I apprehended my visit would answer no material purpose. He was of a different opinion; to which I submitted.

The next morning, March 1st, I accordingly was early with Lord Hyde, who received me with his usual politeness. We talked over a great part of the dispute between the countries. I found him ready with all the newspaper and pamphlet topics; of the expense of settling our colonies, the protection afforded them, the heavy debt under which Britain labored, the equity of our contributing to its alleviation; that many people in England were no more represented than we were, yet all were taxed and governed by Parliament, &c. &c. I answered all, but with little effect; for, though his Lordship seemed civilly to hear what I said, I had reason to believe he attended very little to the purport of it, his mind being employed the while in thinking on what he himself purposed to say next.

He had hoped, he said, that Lord North's motion would have been satisfactory; and asked what could be objected to it. I replied, the terms of it were, that we should grant money till Parliament had agreed we had given enough, without having the least share in judging of the propriety of the measure for which it was to be granted, or of our own abilities to grant; that these grants were also to be made under a threat of exercising a claimed right of taxing us at pleasure, and compelling such taxes by an armed force, if we did not give till it should be thought we had given enough; that the proposition was similar to no mode of obtaining aids that ever existed, except that of a highwayman, who presents his pistol and hat at a coach window, demanding no specific sum, but, if you will give all your money, or what he is pleased to think sufficient, he will civilly omit putting his own hand into your pockets; if not, there is his pistol. That the mode of raising contributions in an enemy's country was fairer than this, since there an explicit sum was demanded, and the people who were raising it knew what they were about, and when they should have done; and that, in short, no free people could ever think of beginning to grant upon such terms. That, besides, a new dispute had now been raised, by the Parliament's pretending to a power of altering our charters and established laws, which was of still more importance to us than their claim of taxation, as it set us all adrift, and left us without a privilege we could depend upon, but at their pleasure; this was a situation we could not possibly be in; and, as Lord North's proposition had no relation to this matter, if the other had been such as we could have agreed to, we should still be far from a reconciliation.

His Lordship thought I misunderstood the proposition; on which I took it out and read it. He then waved that point, and said he should be glad to know from me, what would produce a reconciliation. I said, that his Lordship, I imagined, had seen several proposals of mine for that purpose. He said he had; but some of my articles were such as would never be agreed to. That it was apprehended I had several instructions and powers to offer more acceptable terms, but was extremely reserved, and perhaps from a desire he did not blame, of doing better for my constituents; but my expectations might deceive me; and he did think I might be assured I should never obtain better terms than what were now offered by Lord North. That administration had a sincere desire of restoring harmony with America; and it was thought, if I would coöperate with them, the business would be easy. That he hoped I was above retaining resentment against them, for what nobody now approved, and for which satisfaction might be made me; that I was, as he understood, in high esteem among the Americans; that, if I would bring about a reconciliation on terms suitable to the dignity of government, I might be as highly and generally esteemed here, and be honored and *rewarded*, perhaps, *beyond my expectation.*

I replied, that I thought I had given a convincing proof of my sincere desire of promoting peace, when, on being informed that all wanted for the honor of government was, to obtain payment for the tea, I offered, without any instruction to warrant my so doing, or assurance that I should be reimbursed, or my conduct approved, to engage for that payment, if the Massachusetts acts were to be repealed; an engagement in which I must have risked my whole fortune, which I thought few besides me would have done. That, in truth, private resentments had no weight with me in public business; that I was not the reserved man imagined, having really no secret instructions to act upon. That I was certainly willing to do every thing that could reasonably be expected of me. But, if any supposed I could prevail with my countrymen to take black for white, and wrong for right, it was not knowing either them or me; they were not capable of being so imposed on, nor was I capable of attempting it.

He then asked my opinion of sending over a commissioner, for the purpose mentioned in a preceding part of this account, and my answer was to the same effect. By the way, I apprehend, that to give me an opportunity of discoursing with Lord Hyde on that point, was a principal motive with Lord Howe for urging me to make this visit. His Lordship did not express his own sentiments upon it. And thus ended this conversation.

Three or four days after, I received the following note from Mrs. Howe.

"Mrs. Howe's compliments to Dr. Franklin; Lord Howe begs to have the pleasure of meeting him once more before he goes, at her house; he is at present out of town, but returns on Monday; and any day or hour after that, that the Doctor will name, he will be very glad to attend him.

"*Grafton Street, Saturday, March 4th.*"

I answered, that I would do myself the honor of waiting on Lord Howe, at her house, the Tuesday following, at eleven o'clock. We met accordingly. He began by saying, that I had been a better prophet than himself, in foreseeing that my interview with Lord Hyde would be of no great use; and then said, that he hoped I would excuse the trouble he had given me, as his intentions had been good both towards me and the public. He was sorry, that at present there was no appearance of things going into the train he had wished, but that possibly they might yet take a more favorable turn; and, as he understood I was going soon to America, if he should chance to be sent thither on that important business, he hoped he might still expect my assistance. I assured him of my readiness at all times of coöperating with him in so good a work; and so, taking my leave, and receiving his good wishes, ended the negotiation with Lord Howe. And I heard no more of that with Messrs. Fothergill and Barclay. I could only gather, from some hints in their conversation, that neither of them were well pleased with the conduct of the ministers respecting these transactions. And, a few days before I left London, I met them by their desire, at the Doctor's house, when they desired me to assure their friends from them, that it was now their fixed opinion, that nothing could secure the privileges of America, but a firm, sober adherence to the terms of the association made at the Congress, and that the salvation of English liberty depended now on the perseverance and virtue of America.

During the whole, my time was otherwise much taken up, by friends calling continually to inquire news from America; members of both Houses of Parliament, to inform me what passed in the Houses, and discourse with me on the debates, and on motions made, or to be made; merchants of London and of the manufacturing and port towns, on their petitions; the Quakers, upon theirs, &c. &c.; so that I had no time to take notes of almost any thing. This account is therefore chiefly from recollection, in which doubtless much must have been omitted, from deficiency of memory; but what there is, I believe to be pretty exact; except that, discoursing with so many different persons about the same time, on the same subject, I may possibly have put down some things as said by or to one person, which passed in conversation with another.

A little before I left London, being at the House of Lords, during a debate in which Lord Camden was to speak, and who indeed spoke admirably on American affairs, I was much disgusted, from the ministerial side, by many base reflections on American courage, religion, understanding, &c., in which we were treated with the utmost contempt, as the lowest of mankind, and almost of a different species from the English of Britain; but particularly the American honesty was abused by some of the Lords, who asserted that we were all knaves, and wanted only by this dispute to avoid paying our debts; that, if we had any sense of equity or justice, we should offer payment of the tea, &c. I went home somewhat irritated and heated; and, partly to retort upon this nation, on the article of *equity*, drew up a memorial to present to Lord Dartmouth before my departure; but, consulting my friend, Mr. Thomas Walpole, upon it, who is a member of the House of Commons, he looked at it and at me several times alternately, as if he apprehended me a little out of my senses. As I was in the hurry of packing up, I requested him to take the trouble of showing it to his neighbour, Lord Camden, and ask his advice upon it, which he kindly undertook to do; and returned it me with a note, which here follows the proposed memorial.

"To the Right Honorable the Earl of Dartmouth, one of his Majesty's principal Secretaries of State;

"A Memorial of Benjamin Franklin, Agent of the Province of Massachusetts Bay.

"Whereas an injury done can only give the party injured a right to full reparation; or, in case that be refused, a right to return an equal injury; and whereas the blockade of Boston, now continued nine months, hath every week of its continuance done damage to that town, equal to what was suffered there by the India Company; it follows that such *exceeding* damage is an *injury* done by this government, for which reparation ought to be made; and whereas reparation of injuries ought always (agreeably to the custom of all nations, savage as well as civilized,) to be first required, before satisfaction is taken by a return of damage to the aggressors; which was not done by Great Britain in the instance above mentioned; I the underwritten do therefore, as their agent, in the behalf of my country and the said town of Boston, protest against the continuance of the said blockade; and I do hereby solemnly demand satisfaction for the accumulated injury done them, beyond the value of the India Company's tea destroyed.

"And whereas the conquest of the Gulf of St. Lawrence, the coasts of Labrador and Nova Scotia, and the fisheries possessed by the French there and on the Banks of Newfoundland, so far as they were more extended than at present, was made by the *joint forces* of Britain and the colonies, the latter having nearly an equal number of men in that service with the former; it follows, that the colonies have an equitable and just right to participate in the advantage of those fisheries; I do, therefore, in the behalf of the colony of the Massachusetts Bay, protest against the act now under consideration in Parliament, for depriving that province, with others, of that fishery, (on pretence of their refusing to purchase British commodities,) as an act highly unjust and injurious; and I give notice, that satisfaction will probably one day be demanded for all the injury that may be done and suffered in the execution of such act; and that the injustice of the proceeding is likely to give such umbrage to *all the colonies*, that in no future war, wherein other conquests may be meditated, either a man or a shilling will be obtained from any of them to aid such conquests, till full satisfaction be made as aforesaid.

"B. FRANKLIN.

"*Given in London, this* 16*th day of March*, 1775."

"TO DR. FRANKLIN.

"DEAR SIR,

"I return you the memorial, which it is thought might be attended with dangerous consequences to your person, and contribute to exasperate the nation.

"I heartily wish you a prosperous voyage, a long health, and am, with the sincerest regard, your most faithful and obedient servant,

"THOMAS WALPOLE.

"*Lincoln's Inn Fields*, 16*th March*, 1775."

Mr. Walpole called at my house the next day, and, hearing I was gone to the House of Lords, came there to me, and repeated more fully what was in his note; adding, that it was thought my having no instructions directing me to deliver such a protest, would make it appear still more unjustifiable, and be deemed a national affront. I had no desire to make matters worse, and, being grown cooler, took the advice so kindly given me.

The evening before I left London, I received a note from Dr. Fothergill, with some letters to his friends in Philadelphia. In that note he desires me to get those friends "and two or three more together, and inform them, that, whatever specious pretences are offered, they are all hollow; and that to get a larger field on which to fatten a herd of worthless parasites is all that is regarded. Perhaps it may be proper to acquaint them with David Barclay's and our united endeavours, and the effects. They will stun at least, if not convince, the most worthy, that nothing very favorable is intended, if more unfavorable articles cannot be obtained." The Doctor, in the course of his daily visits among the great, in the practice of his profession, had full opportunity of being acquainted with their sentiments, the conversation everywhere turning upon the subject of America.

VINDICATION AND OFFER

FROM CONGRESS TO PARLIAMENT.

Immediately after Dr. Franklin's return to America, he was chosen one of the delegates in Congress from Pennsylvania, and was present at the opening of the Congress in May, 1775. Mr. Vaughan says of the following paper; "It was drawn up in a Committee of Congress, June 25th, 1775, but does not appear on their Minutes; a severe act of Parliament, which arrived about that time, having determined them not to give the sum proposed It was first printed in the *Public Advertiser* for July 18th, 1777.' At the time mentioned above, that is, June 25th, 1775, Dr. Franklin was on a Committee for reporting to Congress a declaration to be published by General Washington, on his arrival in camp at Cambridge. The discussion of that subject in the Committee may have suggested these remarks. — EDITOR.

FORASMUCH as the enemies of America in the Parliament of Great Britain, to render us odious to the nation, and give an ill impression of us in the minds of other European powers, have represented us as unjust and ungrateful in the highest degree; asserting, on every occasion, that the colonies were settled at the expense of Britain; that they were, at the expense of the same, protected in their infancy; that they now ungratefully and unjustly refuse to contribute to their own protection, and the common defence of the nation; that they aim at independence; that they intend an abolition of the Navigation Acts; and that they are fraudulent in their commercial dealings, and purpose to cheat their creditors in Britain, by avoiding the payment of their just debts;

And, as by frequent repetition these groundless assertions and malicious calumnies may, if not contradicted and refuted, obtain further credit, and be injurious throughout Europe to the reputation and interest of the confederate colonies, it seems proper and necessary to examine them in our own just vindication.

With regard to the first, *that the colonies were settled at the expense of Britain*, it is a known fact, that none of the twelve united colonies were settled, or even discovered, at the expense of England. Henry the Seventh, indeed, granted a commission to Sebastian Cabot, a Venetian, and his sons, to sail into the western seas for the discovery of new countries; but it was to be "*suis eorum propriis sumptibus et expensis*," at their *own* costs and charges.* They discovered, but soon slighted and neglected these northern territories; which were, after more than a hundred years' dereliction, purchased of the natives, and settled at the charge and by the labor of private men and bodies of men, our ancestors, who came over hither for that purpose. But our adversaries have never been able to produce any record, that ever the Parliament or government of England was at the smallest expense on these accounts; on the contrary, there exists on the journals of Parliament a solemn declaration in 1642, (only twenty-two years after the first settlement of the Massachusetts, when, if such expense had ever been incurred, some of the members must have known and remembered it,)

* See the Commission in the Appendix to POWNALL'S *Administration of the Colonies*. Edition 1775.

"That these colonies had been planted and established *without any expense to the state.*" *

New York is the only colony in the founding of which England can pretend to have been at any expense; and that was only the charge of a small armament to take it from the Dutch, who planted it. But to retain this colony at the peace, another at that time full as valuable, planted by private countrymen of *ours*, was given up by the crown to the Dutch in exchange, viz. Surinam, now a wealthy sugar colony in Guiana, and which, but for that cession, might still have remained in our possession. Of late, indeed, Britain has been at some expense in planting two colonies, Georgia and Nova Scotia; but those are not in our confederacy; † and the expense she has been at in their name has chiefly been in grants of sums unnecessarily large, by way of salaries to officers sent from England, and in jobs to friends, whereby dependants might be provided for; those excessive grants not being requisite to the welfare and good government of the colonies, which good government (as experience in many instances of other colonies has taught us) may be much more frugally, and full as effectually, provided for and supported.

With regard to the second assertion, *that these colonies were protected in their infant state by England*, it

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* "*Veneris, March 10th*, 1642. Whereas, the plantations in New England have, by the blessing of the Almighty, had good and prosperous success, *without any public charge to this state*, and are now likely to prove very happy for the propagation of the Gospel in those parts, and very beneficial and commodious to this kingdom and nation; the Commons now assembled in Parliament, &c &c. &c."

† Georgia joined the other colonies soon afterwards. On the 20th of July, 1775, a letter was read in Congress from the convention of Georgia, giving notice that delegates had been appointed in that colony to attend the Continental Congress. — EDITOR.

is a notorious fact, that, in none of the many wars with the Indian natives, sustained by our infant settlements for a century after our first arrival, were ever any troops or forces of any kind sent from England to assist us; nor were any forts built at her expense, to secure our seaports from foreign invaders; nor any ships of war sent to protect our trade, till many years after our first settlement, when our commerce became an object of revenue, or of advantage to British merchants; and then it was thought necessary to have a frigate in some of our ports, during peace, to give weight to the authority of custom-house officers, who were to restrain that commerce for the benefit of England. Our own arms, with our poverty, and the care of a kind Providence, were all this time our only protection; while we were neglected by the English government; which either thought us not worth its care, or, having no good will to some of us, on account of our different sentiments in religion and politics, was indifferent what became of us.

On the other hand, the colonies have not been wanting to do what they could in every war for annoying the enemies of Britain. They formerly assisted her in the conquest of Nova Scotia. In the war before last they took Louisburg, and put it into her hands. She made her peace with that strong fortress, by restoring it to France, greatly to their detriment. In the last war, it is true, Britain sent a fleet and army, who acted with an equal army of ours, in the reduction of Canada; and perhaps thereby did more for us, than we in the preceding wars had done for her. Let it be remembered, however, that she rejected the plan we formed in the Congress at Albany, in 1754, for our own defence, by a union of the colonies; a union she was jealous of, and therefore chose to send her own forces;

otherwise her aid to protect us was not wanted. And from our first settlement to that time, her military operations in our favor were small, compared with the advantages she drew from her exclusive commerce with us. We are, however, willing to give full weight to this obligation; and, as we are daily growing stronger, and our assistance to her becomes of more importance, we should with pleasure embrace the first opportunity of showing our gratitude by returning the favor in kind.

But, when Britain values herself as affording us protection, we desire it may be considered, that we have followed her in all her wars, and joined with her at our own expense against all she thought fit to quarrel with. This she has required of us; and would never permit us to keep peace with any power she declared her enemy; though by separate treaties we might well have done it. Under such circumstances, when at her instance we made nations our enemies, whom we might otherwise have retained our friends, we submit it to the common sense of mankind, whether her protection of us in these wars was not our *just due*, and to be claimed of *right*, instead of being received as a *favor*? And whether, when all the parts of an empire exert themselves to the utmost in their common defence, and in annoying the common enemy, it is not as well the *parts* that protect the *whole*, as the *whole* that protects the *parts*? The protection then has been proportionably mutual. And, whenever the time shall come, that our abilities may as far exceed hers, as hers have exceeded ours, we hope we shall be reasonable enough to rest satisfied with her proportionable exertions, and not think we do too much for a part of the empire, when that part does as much as it can for the whole.

The charge against us, *that we refuse to contribute to our own protection*, appears from the above to be groundless; but we farther declare it to be absolutely false; for it is well known, that we ever held it as our duty to grant aids to the crown, upon requisition, towards carrying on its wars; which duty we have cheerfully complied with, to the utmost of our abilities; insomuch that frequent and grateful acknowledgments thereof, by King and Parliament, appear on the records.* But, as Britain has enjoyed a most gainful monopoly of our commerce; the same, with our maintaining the dignity of the King's representative in each colony, and all our own separate establishments of government, civil and military; has ever hitherto been deemed an equivalent for such aids as might otherwise be expected from us in time of peace. And we hereby declare, that on a reconciliation with Britain, we shall not only continue to grant aids in time of war, as aforesaid; but, whenever she shall think fit to abolish her monopoly, and give us the same privileges of trade as Scotland received at the union, and allow us a free commerce with all the rest of the world; we shall willingly agree (and we doubt not it will be ratified by our constituents) to *give and pay* into the sinking fund [one hundred thousand pounds] sterling per annum for the term of one hundred years; which duly, faithfully, and inviolably applied to that purpose, is demonstrably more than sufficient to extinguish *all her present national* debt; since it will in that time amount, at legal British interest, to more than [two hundred and thirty millions of pounds.] †

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* Supposed to allude to certain passages in the journals of the House of Commons on the 4th of April, 1748; 28th of January, 1756; 3d of February, 1756; 16th and 19th of May, 1757; 1st of June, 1758; 26th and 30th of April, 1759; 26th and 31st of March, and 28th of April 1760; 9th and 20th of January, 1761; 22d and 26th of January, 1762; and 14th and 17th of March, 1763. — B. V.

† See Dr. Price's *Appeal on the National Debt.* — B. V.

But if Britain does not think fit to accept this proposition, we, in order to remove her groundless jealousies, *that we aim at independence, and an abolition of the Navigation Act*, (which hath in truth never been our intention,) and to avoid all future disputes about the right of making that and other acts for regulating our commerce, do hereby declare ourselves ready and willing to enter into a *covenant with Britain*, that she shall fully possess, enjoy, and exercise that right, for an hundred years to come; the same being *bonâ fide* used for the common benefit; and, in case of such agreement, that every Assembly be advised by us to confirm it solemnly by laws of their own, which, once made, cannot be repealed without the assent of the crown.

The last charge, *that we are dishonest traders, and aim at defrauding our creditors in Britain*, is sufficiently and authentically refuted by the solemn declarations of the British merchants to Parliament, (both at the time of the Stamp Act and in the last session,) who bore ample testimony to the general good faith and fair dealing of the Americans, and declared their confidence in our integrity; for which we refer to their petitions on the journals of the House of Commons. And we presume we may safely call on the body of the British tradesmen, who have had experience of both, to say, whether they have not received much more punctual payment from us, than they generally have from the members of their own two Houses of Parliament.

On the whole of the above it appears, that the charge of *ingratitude* towards the mother country, brought with so much confidence against the colonies, is totally without foundation; and that there is much more reason for retorting that charge on Britain, who, not only never contributes any aid, nor affords, by an exclusive commerce, any advantages to Saxony, *her* mother country;

but no longer since than in the last war, without the least provocation, subsidized the King of Prussia while he ravaged that *mother country*, and carried fire and sword into its capital, the fine city of Dresden! An example we hope no provocation will induce us to imitate.*

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* The following preamble to a proposed resolution of Congress (not passed) was drawn up by Dr. Franklin, about the time that the above *Vindication* was written. — EDITOR.

"Whereas the British nation, through great corruption of manners and extreme dissipation and profusion, both private and public, have found all honest resources insufficient to supply their excessive luxury and prodigality, and thereby have been driven to the practice of every injustice, which avarice could dictate or rapacity execute; And whereas, not satisfied with the immense plunder of the East, obtained by sacrificing millions of the human species, they have lately turned their eyes to the West, and, grudging us the peaceable enjoyment of the fruits of our hard labor and virtuous industry, have for years past been endeavouring to extort the same from us, under color of laws regulating trade, and have thereby actually succeeded in draining us of large sums, to our great loss and detriment; And whereas, impatient to seize the whole, they have at length proceeded to open robbery, declaring by a solemn act of Parliament, that all our estates are theirs, and all our property found upon the sea divisible among such of their armed plunderers as shall take the same; and have even dared in the same act to declare, that all the spoilings, thefts, burnings of houses and towns, and murders of innocent people, perpetrated by their wicked and inhuman corsairs on our coasts, previous to any war declared against us, were just actions, and shall be so deemed, contrary to several of the commandments of God (which by this act they presume to repeal), and to all the principles of right, and all the ideas of justice, entertained heretofore by every other nation, savage as well as civilized; thereby manifesting themselves to be *hostes humani generis*; And whereas it is not possible for the people of America to subsist under such continual ravages without making some reprisals; Therefore, Resolved, &c."

ARTICLES

OF

CONFEDERATION AND PERPETUAL UNION.

PROPOSED IN GENERAL CONGRESS.

The following articles exhibit the first sketch of a plan of Confederation, which is known to have been presented to Congress. They seem to have been proposed by Dr. Franklin in his individual capacity, and not as a member of any committee. They were brought forward on the 21st of July, 1775. What proceedings were had in relation to them cannot be ascertained from the Journals; but it is probable, that, after some debate, they were referred to a committee. It is worthy of remark, that, although they are dated nearly a year before the declaration of independence, they could hardly be made practical, without assuming the existence of an independent government. The subject of a confederation was discussed from time to time; but the plan finally acceded to by the States was not adopted by Congress till November 15th, 1777. This ultimate plan differed in many essential points from Dr. Franklin's draft, and was more extensive. It was not ratified by a sufficient number of States to carry it into effect till July 9th, 1778, nor by all the States till March 1st, 1781. — EDITOR.

ARTICLE I.

THE name of this Confederacy shall henceforth be THE UNITED COLONIES OF NORTH AMERICA.

ARTICLE II.

The said United Colonies hereby severally enter into a firm league of friendship with each other, binding on themselves and their posterity, for their common defence against their enemies, for the securities of their liberties and properties, the safety of their persons and families, and their mutual and general welfare.

ARTICLE III.

That each colony shall enjoy and retain as much as it may think fit of its own present laws, customs, rights, privileges, and peculiar jurisdictions within its own limits; and may amend its own constitution, as shall seem best to its own Assembly or Convention.

ARTICLE IV.

That, for the more convenient management of general interests, delegates shall be annually elected in each colony, to meet in general Congress at such time and place as shall be agreed on in the next preceding Congress. Only, where particular circumstances do not make a duration necessary, it is understood to be a rule, that each succeeding Congress be held in a different colony, till the whole number be gone through; and so in perpetual rotation; and that accordingly the next Congress after the present shall be held at Annapolis, in Maryland.

ARTICLE V.

That the power and duty of the Congress shall extend to the determining on war and peace; the sending and receiving ambassadors, and entering into alliances (the reconciliation with Great Britain); the settling all disputes and differences between colony and colony, about limits or any other cause, if such should arise; and the planting of new colonies when proper. The Congress shall also make such general ordinances as, though necessary to the general welfare, particular

Assemblies cannot be competent to, viz. those that may relate to our general commerce, or general currency; the establishment of posts; and the regulation of our common forces. The Congress shall also have the appointment of all general officers, civil and military, appertaining to the general confederacy, such as general treasurer, secretary, &c.

ARTICLE VI.

All charges of wars, and all other general expenses to be incurred for the common welfare, shall be defrayed out of a common treasury, which is to be supplied by each colony in proportion to its number of male polls between sixteen and sixty years of age. The taxes for paying that proportion are to be laid and levied by the laws of each colony.

ARTICLE VII.

The number of delegates to be elected and sent to Congress by each colony shall be regulated, from time to time, by the number of such polls returned; so as that one delegate be allowed for every five thousand polls. And the delegates are to bring with them to every Congress an authenticated return of the number of polls in the respective provinces, which is to be taken triennially, for the purposes above mentioned.

ARTICLE VIII.

At every meeting of the Congress, one half of the members returned, exclusive of proxies, shall be necessary to make a quorum; and each delegate at the Congress shall have a vote in all cases, and, if necessarily absent, shall be allowed to appoint any other delegate from the same colony to be his proxy, who may vote for him.

ARTICLE IX.

An executive Council shall be appointed by the Congress out of their own body, consisting of twelve persons; of whom, in the first appointment, one third, viz. four, shall be for one year, four for two years, and four for three years; and, as the said terms expire, the vacancies shall be filled by appointments for three years; whereby one third of the members will be changed annually. This Council, of whom two thirds shall be a quorum in the recess of Congress, is to execute what shall have been enjoined thereby; to manage the general Continental business and interests; to receive applications from foreign countries; to prepare matters for the consideration of the Congress; to fill up, *pro tempore*, continental offices, that fall vacant; and to draw on the general treasurer for such moneys as may be necessary for general services, and appropriated by the Congress to such services.

ARTICLE X.

No colony shall engage in an offensive war with any nation of Indians without the consent of the Congress, or grand Council above mentioned, who are first to consider the justice and necessity of such war.

ARTICLE XI.

A perpetual alliance, offensive and defensive, is to be entered into as soon as may be with the Six Nations; their limits to be ascertained and secured to them; their land not to be encroached on, nor any private or colony purchases made of them hereafter to be held good; nor any contract for lands to be made, but between the great Council of the Indians at Onondaga and the general Congress. The boundaries and lands of all the other Indians shall also be ascertained and secured to them in the same manner, and persons appointed to reside among them in proper districts; and shall take care to prevent injustice in the trade with them; and be enabled at our general expense, by occasional small supplies, to relieve their personal wants and distresses. And all purchases from them shall be by the Congress, for the general advantage and benefit of the United Colonies.

ARTICLE XII.

As all new institutions may have imperfections, which only time and experience can discover, it is agreed, that the general Congress, from time to time, shall propose such amendments of this constitution as may be found necessary; which, being approved by a majority of the colony Assemblies, shall be equally binding with the rest of the articles of this Confederation.

ARTICLE XIII.

Any and every colony from Great Britain upon the continent of North America, not at present engaged in our association, may, upon application and joining the said association, be received into the Confederation, viz. Ireland, the West India Islands, Quebec, St. John's, Nova Scotia, Bermudas, and the East and West Floridas; and shall thereupon be entitled to all the advantages of our union, mutual assistance, and commerce.

These articles shall be proposed to the several provincial Conventions or Assemblies, to be by them considered; and, if approved, they are advised to empower their delegates to agree to and ratify the same in the ensuing Congress. After which the union thereby established is to continue firm, till the terms of reconciliation proposed in the petition of the last Congress to the King are agreed to; till the acts since made, restraining the American commerce and fisheries, are repealed; till reparation is made for the injury done to Boston, by shutting up its port, for the burning of Charlestown, and for the expense of this unjust war; and till all the British troops are withdrawn from America. On the arrival of these events, the colonies will return to their former connexion and friendship with Britain; but, on failure thereof, this confederation is to be perpetual.

CORRESPONDENCE AND INTERVIEW

WITH LORD HOWE.

Near the beginning of the year 1776, Lord Howe was appointed to command the British fleet in North America, and on the 3d of May was declared joint commissioner with his brother, General William Howe, for the purpose of endeavouring to effect a reconciliation with the colonies, conformable to the terms of an act of Parliament. In the first part of July, Lord Howe arrived at Staten Island, where he found his brother with the British army. He had previously prepared a *Declaration*, announcing the object of his mission, which he designed for distribution in the colonies, accompanied with circular letters to the royal governors. Copies of these papers were forwarded to Congress, by whose order they were immediately published. Lord Howe likewise wrote a private letter to Dr. Franklin, then a member of Congress, which he answered.

Meantime, as Congress took no steps to meet the advances of the British commissioners, in their proposals for a reconciliation, they commenced military operations, and the battle of Long Island was fought. General Sullivan was taken prisoner in this action, and conducted on board Lord Howe's ship. At his request, General Sullivan went to Philadelphia on parole, having in charge certain verbal communications to Congress, tending to open the way to some method of effecting the objects of the commissioners. After maturely considering the subject, Congress resolved to send a committee of their members to hold a conference with Lord Howe. The persons selected for this mission were Franklin, John Adams, and Edward Rutledge.

In regard to the previous correspondence mentioned above, the following memorandum was afterwards written by Dr. Franklin.

"These letters were published in London, to show the insolence of the *insurgents*, in refusing the offer of pardon upon submission, made to them by the British plenipotentiaries. They undoubtedly deserve the attention of the public for another reason, the proof they afford that the commerce of America is deemed by the ministry themselves of such vast importance, as to justify the horrid and expensive war they are now waging to maintain the monopoly of it; that being the principal cause stated by Lord Howe; though their pensioned writers and speakers in Parliament have affected to treat that commerce as a trifle. And they demonstrate further, of how much importance it is to the rest of Europe, that the continuance of that monopoly should be obstructed, and the general freedom of trade, now offered by the Americans, prevented; since by no other means the enormous growing power of Britain both by sea and land, so formidable to their neighbours, and which must follow her success, can possibly be prevented." — EDITOR.

LORD HOWE TO BENJAMIN FRANKLIN.

Eagle, June 20th, 1776.

I cannot, my worthy friend, permit the letters and parcels, which I have sent in the state I received them, to be landed, without adding a word upon the subject of the injurious extremities in which our unhappy differences have engaged us.

You will learn the nature of my mission, from the official despatches, which I have recommended to be forwarded by the same conveyance. Retaining all the earnestness I ever expressed to see our differences accommodated, I shall conceive, if I meet with the disposition in the colonies I was once taught to expect, the most flattering hopes of proving serviceable in the objects of the King's paternal solicitude, by promoting the establishment of lasting peace and union with the colonies. But, if the deep-rooted prejudices of America, and the necessity for preventing her trade from passing into foreign channels, must keep us still a divided people, I shall, from every private as well as public motive, most heartily lament, that this is not the moment wherein those great objects of my ambition are to be attained; and that I am to be longer deprived of an opportunity to assure you personally of the regard with which I am your sincere and faithful humble servant,

HOWE.

P. S. I was disappointed of the opportunity I expected for sending this letter at the time it was dated, and have ever since been prevented by calms and contrary winds from getting here, to inform General Howe of the commission with which I have the satisfaction to be charged, and of his being joined in it.

Off Sandy Hook, 12th of July.

BENJAMIN FRANKLIN TO LORD HOWE.

Philadelphia, July 20th, 1776.

MY LORD,

I received safe the letters your Lordship so kindly forwarded to me, and beg you to accept my thanks.

The official despatches, to which you refer me, contain nothing more than what we had seen in the act of Parliament, viz. offers of pardon upon submission, which I am sorry to find, as it must give your Lordship pain to be sent so far on so hopeless a business.

Directing pardons to be offered the colonies, who are the very parties injured, expresses indeed that opinion of our ignorance, baseness, and insensibility, which your uninformed and proud nation has long been pleased to entertain of us; but it can have no other effect than that of increasing our resentment. It is impossible we should think of submission to a government, that has with the most wanton barbarity and cruelty burnt our defenceless towns in the midst of winter, excited the savages to massacre our farmers, and our slaves to murder their masters, and is even now bringing foreign mercenaries to deluge our settlements with blood. These atrocious injuries have extinguished every remaining spark of affection for that parent country we once held so dear; but, were it possible for *us* to forget and forgive them, it is not possible for *you* (I mean the British nation) to forgive the people you have so heavily injured. You can never confide again in those as fellow subjects, and permit them to enjoy equal freedom, to whom you know you have given such just cause of lasting enmity. And this must impel you, were we again under your government, to endeavour the breaking our spirit by the severest tyranny, and obstructing, by every means in your power, our growing strength and prosperity.

But your Lordship mentions "the King's paternal solicitude for promoting the establishment of lasting *peace* and union with the colonies." If by peace is here meant a peace to be entered into between Britain and America, as distinct states now at war, and his Majesty has given your Lordship powers to treat with us of such a peace, I may venture to say, though without authority, that I think a treaty for that purpose not yet quite impracticable, before we enter into foreign alliances. But I am persuaded you have no such powers. Your nation, though, by punishing those American governors, who have created and fomented the discord, rebuilding our burnt towns, and repairing as far as possible the mischiefs done us, might yet recover a great share of our regard, and the greatest part of our growing commerce, with all the advantage of that additional strength to be derived from a friendship with us; but I know too well her abounding pride and deficient wisdom, to believe she will ever take such salutary measures. Her fondness for conquest, as a warlike nation, her lust of dominion, as an ambitious one, and her thirst for a gainful monopoly, as a commercial one, (none of them legitimate causes of war,) will all join to hide from her eyes every view of her true interests, and continually goad her on in those ruinous distant expeditions, so destructive both of lives and treasure, that must prove as pernicious to her in the end, as the crusades formerly were to most of the nations of Europe.

I have not the vanity, my Lord, to think of intimidating by thus predicting the effects of this war; for I know it will in England have the fate of all my former predictions, not to be believed till the event shall verify it.

Long did I endeavour, with unfeigned and unwearied zeal, to preserve from breaking that fine and noble China vase, the British empire; for I knew, that, being once broken, the separate parts could not retain even their share of the strength or value that existed in the whole, and that a perfect reunion of those parts could scarce ever be hoped for. Your Lordship may possibly remember the tears of joy that wet my cheek, when, at your good sister's in London, you once gave me expectations that a reconciliation might soon take place. I had the misfortune to find those expectations disappointed, and to be treated as the cause of the mischief I was laboring to prevent. My consolation under that groundless and malevolent treatment was, that I retained the friendship of many wise and good men in that country, and, among the rest, some share in the regard of Lord Howe.

The well-founded esteem, and, permit me to say, affection, which I shall always have for your Lordship, makes it painful to me to see you engaged in conducting a war, the great ground of which, as expressed in your letter, is "the necessity of preventing the

American trade from passing into foreign channels." To me it seems, that neither the obtaining or retaining of any trade, how valuable soever, is an object for which men may justly spill each other's blood; that the true and sure means of extending and securing commerce is the goodness and cheapness of commodities; and that the profit of no trade can ever be equal to the expense of compelling it, and of holding it, by fleets and armies.

I consider this war against us, therefore, as both unjust and unwise; and I am persuaded, that cool, dispassionate posterity will condemn to infamy those who advised it; and that even success will not save from some degree of dishonor those, who voluntarily engaged to conduct it. I know your great motive in coming hither was the hope of being instrumental in a reconciliation; and I believe, when you find *that* impossible on any terms given you to propose, you will relinquish so odious a command, and return to a more honorable private station.

With the greatest and most sincere respect, I have the honor to be, my Lord, your Lordship's most obedient humble servant,

B. FRANKLIN.*

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* Colonel William Palfrey, paymaster-general of the American army, went on board Lord Howe's vessel, July 30th, 1776, to make some arrangement for an exchange of prisoners, who had been captured at sea. He was accompanied by Mr. Nathaniel Tracy, who carried with him the above letter from Dr. Franklin to Lord Howe. In a letter to President Hancock, written the next day, Colonel Palfrey says;

"Mr. Tracy delivered the letter from Dr. Franklin, which he (Lord Howe) read. I watched his countenance, and observed him often to exhibit marks of surprise. When he had finished reading it, he said his old friend had expressed himself very warmly; that, when he had the pleasure of seeing him in England, he made him acquainted with his sentiments respecting the dispute between Great Britain and the colonies, and with his earnest desire that a reconciliation might take place, equally honorable and advantageous to both. Possessed of these sentiments,

LORD HOWE TO BENJAMIN FRANKLIN

Eagle, off Staten Island, August 16th, 1776.

I am sorry, my worthy friend, that it is only on the assurances you give me of my having still preserved a place in your esteem, that I can now found a pretension to trouble you with a reply to your favor of the 20th past.

I can have no difficulty to acknowledge, that the powers I am invested with were never calculated to negotiate a reunion with America, under any other description than as subject to the crown of Great Britain. But I do esteem those powers competent, not only to confer and negotiate with any gentlemen of influence in the colonies upon the terms, but also to effect a lasting peace and reunion between the two countries, were the temper of the colonies such as professed in the last petition of the Congress to the King. America would have judged in the discussion how far the means were adequate to the end, both for engaging her confidence and proving our integrity. Nor did I think it necessary to say more in my public declaration; not conceiving it could be understood to refer to peace on any other conditions but those of mutual interest to both countries, which could alone render it permanent.

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and the most ardent desire to be the means of effecting this union, he had accepted the honor the King had done him in appointing him one of the commissioners; and that unfortunately a long passage prevented his arriving here before the declaration of independence. I told him he had now a fair opportunity to mention to his friend, Dr. Franklin, in a private letter, his design in coming out, and what his expectations from America were. This he declined, saying, that the Doctor had grown too warm, and, if he expressed his sentiments fully to him, he should only give him pain, which he would wish to avoid."

The first article in this volume contains Dr. Franklin's narrative of his attempted negotiation, just before he left England, to effect a reconciliation between the two countries, in which Lord Howe took a part.—Editor.

But, as I perceive, from the tenor of your letter, how little I am to reckon upon the advantage of your assistance, for restoring that permanent union which has long been the object of my endeavours, and which, I flattered myself when I left England, would be in the compass of my power; I will only add, that, as the dishonor, to which you deem me exposed by my military situation in this country, has effected no change in your sentiments of personal regard towards me, so shall no difference in political points alter my desire of proving how much I am your sincere and obedient humble servant,

HOWE.

"*In Congress, September 2d,* 1776. Congress being informed that General Sullivan, who was taken prisoner on Long Island, was come to Philadelphia with a message from Lord Howe,

"Ordered, that he be admitted, and heard before Congress.

"General Sullivan being admitted, delivered the verbal message he had in charge from Lord Howe, which he was desired to reduce to writing, and withdrew.

"*September 3d.* General Sullivan having reduced to writing the verbal message from Lord Howe, the same was laid before Congress and read as follows.

"'That, though he could not at present treat with Congress, as such, yet he was very desirous of having a conference with some of the members, whom he would consider for the present only as private gentlemen, and meet them himself as such, at such place as they should appoint.

"'That he, in conjunction with General Howe, had full powers to compromise the disputes between Great Britain and America on terms advantageous to both, the obtaining of which delayed him near two months in England, and prevented his arrival at this place before the declaration of independence took place.

"'That he wished a compact might be settled at this time, when no decisive blow was struck, and neither party could say they were compelled to enter into such agreement.

"'That, in case Congress were disposed to treat, many things, which they had not as yet asked, might and ought to be granted to them; and that, if, upon the conference, they found any probable ground of an accommodation, the authority of Congress must be afterwards acknowledged, otherwise the compact could not be complete.'

" *September 5th.* Resolved, that General Sullivan be requested to inform Lord Howe, that this Congress, being the representatives of the free and independent States of America, cannot, with propriety, send any of its members to confer with his Lordship in their private characters, but that, ever desirous of establishing peace on reasonable terms, they will send a committee of their body to know whether he has any authority to treat with persons authorized by Congress for that purpose on behalf of America, and what that authority is, and to hear such propositions as he shall think fit to make respecting the same.

" Ordered, that a copy of the foregoing resolution be delivered to General Sullivan, and that he be directed immediately to repair to Lord Howe.

" *September 6th.* Resolved, that the committee 'to be sent to know whether Lord Howe has any authority to treat with persons authorized by Congress for that purpose, on behalf of America, and what that authority is, and to hear such propositions as he shall think fit to make respecting the same,' consist of three.

" Congress then proceeded to the election, and, the ballots being taken, Mr. Franklin, Mr. Adams, and Mr. Rutledge were elected."

LORD HOWE TO BENJAMIN FRANKLIN.

Eagle, off Bedlow's Island, September 10th, 1776.

Lord Howe presents his compliments to Dr. Franklin, and according to the tenor of his favor of the 8th, will attend to have the pleasure of meeting him and Messrs. Adams and Rutledge to-morrow morning, at the house on Staten Island opposite to Amboy, as early as the few conveniences for travelling by land on Staten Island will admit. Lord Howe, upon his arrival at the place appointed, will send a boat (if he can procure it in time), with a flag of truce, over to Amboy; and requests the Doctor and the other gentlemen will postpone their intended favor of passing over to meet him, until they are informed as above of his arrival to attend them there.

In case the weather should prove unfavorable foi Lord Howe to pass in his boat to Staten Island to-morrow, as from the present appearance there is some reason to suspect, he will take the next earliest opportunity that offers for that purpose. In this intention he may be further retarded, having been an invalid lately; but will certainly give the most timely notice of that inability. He, however, flatters himself he shall not have occasion to make further excuses on that account.*

"*In Congress, September* 13*th*. The committee appointed to confer with Lord Howe, having returned, made a verbal report.

"Ordered, that they make a report in writing, as soon as conveniently they can.

"*September* 17*th*. The committee appointed to confer with Lord Howe, agreeable to the order of Congress, brought in a report in writing, which was read as follows.

"'In obedience to the orders of Congress, we have had a meeting with Lord Howe. It was on Wednesday last, upon Staten Island, opposite to Amboy, where his Lordship received and entertained us with the utmost politeness.

"'His Lordship opened the conversation by acquainting us, that, though he could not treat with us as a committee of Congress, yet, as his powers enabled him to confer and consult with any private gentlemen of influence in the colonies, on the means of restoring peace between the two countries, he was glad of this opportunity of conferring with us on that subject, if we thought ourselves at liberty to enter into a conference with him in that character.

"'We observed to his Lordship, that, as our business was to hear, he might consider us in what light he pleased, and communicate to us any proposition he might be authorized to make for the purpose mentioned; but that we could consider ourselves in no other character, than that in which we were placed by order of Congress.

* The committee being arrived at Amboy, opposite to the Island, and in possession of the Americans, the admiral sent over his barge to receive and bring them to him, and to leave one of his principal officers as a hostage for their safe return. The committee of Congress had not desired a hostage, and they therefore took the officer back with them. The admiral met them at their landing, and conducted them through his guards to a convenient room for conference. — W. T. F.

" 'His Lordship then entered into a discourse of considerable length, which contained no explicit proposition of peace except one, namely, that the colonies should return to their allegiance and obedience to the government of Great Britain. The rest consisted principally of assurances, that there was an exceeding good disposition in the King and his ministers to make that government easy to us, with intimations, that, in case of our submission, they would cause the offensive acts of Parliament to be revised, and the instructions to governors to be reconsidered; that so, if any just causes of complaint were found in the acts, or any errors in government were perceived to have crept into the instructions, they might be amended or withdrawn.

" 'We gave it as our opinion to his Lordship, that a return to the domination of Great Britain was not now to be expected. We mentioned the repeated humble petitions of the colonies to the King and Parliament, which had been treated with contempt, and answered only by additional injuries; the unexampled patience we had shown under their tyrannical government; and that it was not till the last act of Parliament, which denounced war against us, and put us out of the King's protection, that we declared our independence; that this declaration had been called for by the people of the colonies in general; that every colony had approved of it, when made; and all now considered themselves as independent States, and were settling or had settled their governments accordingly; so that it was not in the power of Congress to agree for them, that they should return to their former dependent state; that there was no doubt of their inclination to peace, and their willingness to enter into a treaty with Britain, that might be advantageous to both countries; that, though his Lordship had at present no power to treat with them as independent States, he might, if there was the same good disposition in Britain, much sooner obtain fresh powers from thence, than powers could be obtained by Congress from the several colonies to consent to a submission.

" 'His Lordship then saying, that he was sorry to find that no accommodation was likely to take place, put an end to the conference.

" 'Upon the whole, it did not appear to your committee, that his Lordship's commission contained any other authority of importance than what is expressed in the act of Parliament, namely, that of granting pardons, with such exceptions as the commissioners shall think proper to make, and of declaring America, or any part of it, to be in the King's peace, upon submission; for, as to the power of inquiring into the state of America, which his Lordship mentioned to us, and of conferring and consulting with any persons the commissioners might think proper, and representing the result of such conversation to the ministry, who, provided the colonies would subject themselves, might, after all, or might not, at their pleasure, make any alterations in the former instructions to governors, or propose in Parliament any amendment of the acts complained of, we apprehended any expectation from the effect of such a power would have been too uncertain and precarious to be relied on by America, had she still continued in her state of dependence.'

"Ordered, that the foregoing report, and also the message from Lord Howe, as delivered by General Sullivan, and the resolution of Congress in consequence thereof, be published by the committee, who brought in the foregoing report."

PROTEST

AGAINST

THE EQUALITY OF VOTING IN CONGRESS.

In the month of July, 1776, a convention of delegates was held in Pennsylvania for the purpose of forming a constitution for that State. Dr. Franklin was president of the convention. Whilst it was in session, a new plan of Confederation was reported to Congress, in which it was provided, that each State should have one vote in determining questions. The following Protest was drawn up by Dr. Franklin, with the view of bringing it before the convention of Pennsylvania; "but he was dissuaded from endeavouring to carry it through, from prudential considerations respecting the necessary union, at that critical period, of all the States in confederation." — EDITOR.

WE, the representatives of the State of Pennsylvania in full convention met, having duly considered the plan of confederation formed in Congress, and submitted to the several States, for their assent or dissent, do hereby declare the dissent of this State to the same, for the following reasons, viz.

1. Because the foundation of every confederation, intended to be lasting, ought to be laid in justice and equity, no unfair advantage being given to, or taken by, any of the contracting parties.

2. Because it is, in the nature of things, just and equal, that the respective States of the confederacy should be represented in Congress, and have votes there in proportion to their importance, arising from

their numbers of people, and the share and degree of strength they afford to the united body. And therefore the seventeenth article,* which gives one vote to the smallest State, and no more to the largest, when the difference between them may be as ten to one, or greater, is unjust, and injurious to the larger States, since all of them are by other articles obliged to contribute in proportion to their respective abilities.

3. Because the practice hitherto in Congress, of allowing only one vote to each colony, was originally taken up under a conviction of its impropriety and injustice, was intended to be in some future time corrected, and was then and since submitted to only as a temporary expedient, to be used in ordinary business, until the means of rectifying the same could be obtained. This clearly appears by the resolve of Congress, dated September 6th, 1774, being the day of its meeting, which resolve is in these words; "That, in determining questions in this Congress, each colony or province shall have one vote, the Congress not being possessed of, or at present able to procure, proper materials for ascertaining the importance of each colony." That importance has since been supposed to be best found in the numbers of the people; for the Congress, not only by their resolution when the issuing of bills was agreed to, but by this present confederation, have judged, that the contribution towards sinking those bills and to the common expense should be in proportion to such numbers, when they could be taken, which has

* This forms part of the *fifth article* of the Confederation, as finally agreed to by all the States. In the eighth article of Dr. Franklin's draft, (see above, p. 93,) he had provided, that "*each delegate* at the Congress should have a vote in all cases." For the author's further views on this subject, see his "Speech in a Committee of the Convention, on the Proportion of Representation and Votes," p. 149. — EDITOR.

not yet been done; and, though the larger colonies submitted to this temporary inequality of representation, expecting it would much sooner have been rectified, it never was understood, that, by the resolution above cited, a power was given to the smaller States to fix that inequality upon them for ever, as those small States have now attempted to do by combining to vote for this seventeenth article, and thereby to deprive the larger States of their just right, acknowledged in the same resolution. Smaller States having given us, in advance, this striking instance of the injustice they are capable of, and of the possible effects of their combination, is of itself a sufficient reason for our determining not to put ourselves in their power by agreeing to this article, as it stands connected with those concerning the quotas of each State; since, being a majority of States in Congress, they may, by the same means, at any time, deprive the larger States of any share in the disposition of our strength and wealth, and the management of our common interests.

But, as the smaller colonies may object, that, if the larger are allowed a number of votes in proportion to their importance, the smaller will then be equally in danger of being overpowered and governed by them, we, not having the least desire of any influence or power that is unjust, or unequal, or disproportioned to the burdens we are to bear, do hereby offer our consent to the said seventeenth article as it now stands, provided the quotas to be contributed by the larger provinces shall be reduced to an equality with the smallest, in which case all, by contributing equally, will have a right to equal votes. Not that we mean thereby to avoid granting additional aids, when the exigence of our common interests shall appear to us to make them proper and necessary; but, leaving to the Congress, with regard to such additional aids, the right of making requisitions as enjoyed by our late kings, we would reserve to ourselves the right of judging of the propriety of these requisitions, or of refusing or complying with them in part, or in the whole, as to us shall seem best, and of modifying our grants with such conditions as we shall judge necessary, in like manner as our Assemblies might formerly do with regard to requisitions from the crown; for it appears to us just and reasonable, that we should retain the disposition of what strength we have, above the equal proportion contributed as aforesaid by our State to the common service, with every power necessary to apply the same, as occasions may arise, for our particular security; this we mean to do from this time forward, unless we are allowed votes in Congress proportioned to the importance of our State, as was originally intended.

SKETCH

OF

PROPOSITIONS FOR A PEACE.

On the 26th of September, 1776, Dr. Franklin was appointed one of the Commissioners from Congress to the Court of France. Before his departure he sketched a brief outline of the terms upon which he supposed a peace might be made with Great Britain, in case an opportunity for a negotiation should offer. His propositions were submitted to the secret committee of Congress, but no occasion presented itself for using them. — EDITOR.

THERE shall be a perpetual peace between Great Britain and the United States of America, on the following conditions.

Great Britain shall renounce and disclaim all pretence of right or authority to govern in any of the United States of America.

To prevent those occasions of misunderstanding, which are apt to arise where the territories of different powers border on each other, through the bad conduct of frontier inhabitants on both sides, Britain shall cede to the United States the provinces or colonies of Quebec, St. John's, Nova Scotia, Bermuda, East and West Florida, and the Bahama Islands, with all their adjoining and intermediate territories now claimed by her.

In return for this cession, the United States shall pay to Great Britain the sum of sterling, in annual payments; that is to say, per annum, for and during the term of years.

And shall, moreover, grant a free trade to all British subjects throughout the United States and the ceded colonies, and shall guaranty to Great Britain the possession of her islands in the West Indies.

MOTIVES FOR PROPOSING A PEACE AT THIS TIME.

1. The having such propositions in charge will, by the law of nations, be some protection to the commissioners or ambassadors, if they should be taken.

2. As the news of our declared independence will tend to unite in Britain all parties against us, so our offering peace, with commerce and payments of money, will tend to divide them again. For peace is as necessary to them as to us; our commerce is wanted by their merchants and manufacturers, who will therefore incline to the accommodation, even though the monopoly is not continued, since it can be easily made to appear their *share* of our growing trade will soon be greater than the *whole* has been heretofore. Then, for the landed interest, who wish an alleviation of taxes, it is demonstrable by figures, that, if we should agree to pay, suppose ten millions in one hundred years, viz. one hundred thousand pounds per annum for that term, it would, being faithfully employed as a sinking fund, more than pay off all their present national debt. It is, besides, a prevailing opinion in England, that they must in the nature of things sooner or later lose the colonies, and many think they had better be without the government of them; so that the proposition will, on that account, have more supporters and fewer opposers.

3. As the having such propositions to make, or any

powers to treat of peace, will furnish a pretence for B. F.'s going to England, where he has many friends and acquaintance, particularly among the best writers and ablest speakers in both Houses of Parliament, he thinks he shall be able when there, if the terms are not accepted, to work up such a division of sentiments in the nation, as greatly to weaken its exertions against the United States, and lessen its credit in foreign countries.

4. The knowledge of there being powers given to the commissioners to treat with England, may have some effect in facilitating and expediting the proposed treaty with France.

5. It is worth our while to offer such a sum for the countries to be ceded, since the vacant lands will in time sell for a great part of what we shall give, if not more; and, if we are to obtain them by conquest, after perhaps a long war, they will probably cost us more than that sum. It is absolutely necessary for us to have them for our own security; and, though the sum may seem large to the present generation, in less than half the term it will be to the whole United States a mere trifle.

A DIALOGUE

BETWEEN

BRITAIN, FRANCE, SPAIN, HOLLAND, SAXONY, AND AMERICA.

A humorous piece, representing the political condition and objects of several countries at the beginning of the American war; written soon after the author's arrival in France, as a Commissioner from the United States. — EDITOR.

Britain. SISTER of Spain, I have a favor to ask of you. My subjects in America are disobedient, and I am about to chastise them; I beg you will not furnish them with any arms or ammunition.

Spain. Have you forgotten, then, that when my subjects in the Low Countries rebelled against me, you not only furnished them with military stores, but joined them with an army and a fleet? I wonder how you can have the impudence to ask such a favor of me, or the folly to expect it!

Britain. You, my dear sister France, will surely not refuse me this favor.

France. Did you not assist my rebel Huguenots with a fleet and an army at Rochelle? And have you not lately aided privately and sneakingly my rebel subjects in Corsica? And do you not at this instant keep their chief, pensioned, and ready to head a fresh revolt there, whenever you can find or make an opportunity? Dear sister, you must be a little silly!

Britain. Honest Holland! You see it is remembered I was once your friend; you will therefore be mine on this occasion. I know, indeed, you are accustomed to smuggle with these rebels of mine. I will wink at that; sell them as much tea as you please, to enervate the rascals, since they will not take it of me; but for God's sake don't supply them with any arms!

Holland. 'T is true you assisted me against Philip, my tyrant of Spain, but have I not assisted you against one of your tyrants;* and enabled you to expel him? Surely that account, as we merchants say, is *balanced*, and I am nothing in your debt. I have indeed some complaints against *you*, for endeavouring to starve me by your *Navigation Acts;* but, being peaceably disposed, I do not quarrel with you for that. I shall only go on quietly with my own business. Trade is my profession; 't is all I have to subsist on. And, let me tell you, I shall make no scruple (on the prospect of a good market for that commodity) even to send my ships to Hell and supply the Devil with brimstone. For you must know, I can insure in London against the burning of my sails.

America to Britain. Why, you old bloodthirsty bully! You, who have been everywhere vaunting your own prowess, and defaming the Americans as poltroons! You, who have boasted of being able to march over all their bellies with a single regiment! You, who by fraud have possessed yourself of their strongest fortress, and all the arms they had stored up in it! You, who have a disciplined army in their country, intrenched to the teeth, and provided with every thing! Do *you* run about begging all Europe not to supply those poor people with a little powder and shot? Do you mean, then, to fall upon them naked and unarmed, and butcher

* James the Second.

them in cold blood? Is this your courage? Is this your magnanimity?

Britain. Oh! you wicked — Whig — Presbyterian — Serpent! Have you the impudence to appear before me after all your disobedience? Surrender immediately all your liberties and properties into my hands, or I will cut you to pieces. Was it for this that I planted your country at so great an expense? That I protected you in your infancy, and defended you against all your enemies?

America. I shall not surrender my liberty and property, but with my life. It is not true, that my country was planted at your expense. Your own records* refute that falsehood to your face. Nor did you ever afford me a man or a shilling to defend me against the Indians, the only enemies I had upon my own account. But, when you have quarrelled with all Europe, and drawn me with you into all your broils, then you value yourself upon protecting me from the enemies you have

* See the Journals of the House of Commons, 1642, viz.

"*Die Veneris, Martii* 10°, 1642.

"Whereas the plantations in New England have, by the blessing of Almighty God, had good and prosperous success, *without any public charge to this State*; and are now likely to prove very happy for the propagation of the Gospel in those parts, and very beneficial and commodious to this kingdom and nation; the Commons now assembled in Parliament do, for the better advancement of those plantations, and the encouragement of the planters to proceed in their undertaking, ordain, that all merchandises and goods, that by any merchant, or other person or persons whatsoever, shall be exported out of this kingdom of England into New England, to be spent, used, or employed there; or, being of the growth of that *kingdom*, shall be from thence imported hither, or shall be laden or put on board in any ship or vessel for necessaries in passing or returning to and fro; and all and every the owner or owners thereof, shall be freed and discharged of and from paying and yielding any custom, subsidy, taxation, imposition, or other duty for the same, either inward or outward, either in this kingdom or New England, or in any port, haven, creek, or other place whatsoever, until the House of Commons shall take further order therein to the contrary. And all and singular customers, &c. are to observe this order."

made for me. I have no natural cause of difference with Spain, France, or Holland, and yet by turns I have joined with you in wars against them all. You would not suffer me to make or keep a separate peace with any of them, though I might easily have done it to great advantage. Does your protecting me in those wars give you a right to fleece me? If so, as I fought for you, as well as you for me, it gives me a proportionable right to fleece you. What think you of an American law to make a monopoly of you and your commerce, as you have done by your laws of me and mine? Content yourself with that monopoly if you are wise, and learn justice if you would be respected!

Britain. You impudent b——h! Am not I your mother country? Is not that a sufficient title to your respect and obedience?

Saxony. *Mother country!* Ha! ha! ha! What respect have *you* the front to claim as a mother country? You know that *I* am *your* mother country, and yet you pay me none. Nay, it is but the other day, that you hired ruffians * to rob me on the highway,† and burn my house! ‡ For shame! Hide your face and hold your tongue. If you continue this conduct, you will make yourself the contempt of Europe!

Britain. O Lord! Where are my friends?

France, Spain, Holland, and Saxony, all together. Friends! Believe us, you have none, nor ever will have any, till you mend your manners. How can we, who are your neighbours, have any regard for you, or expect any equity from you, should your power increase, when we see how basely and unjustly you have used both your *own mother and your own children?*

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* Prussians.

† They entered and raised contributions in Saxony.

‡ And they burnt the fine suburbs of Dresden, the capital of Saxony.

A CATECHISM

RELATIVE TO THE ENGLISH NATIONAL DEBT.

Question 1. Supposing this debt to be only one hundred and ninety-five millions of pounds sterling at present, although it is much more,* and that was all to be counted in shillings, that a man could count at the rate of one hundred shillings per minute, for twelve hours each day, till he has counted the whole, how long would he take in doing it?

Answer. One hundred forty-eight years, one hundred nine days, and twenty-two hours.

Q. 2. The whole of this sum being three thousand nine hundred millions of shillings, and the coinage standard being sixty-two in the Troy pound, what is the whole weight of this sum?

A. Sixty-one millions, seven hundred fifty-two thousand, four hundred and seventy-six Troy pounds.

Q. 3. How many ships would carry this weight, suppose one hundred tons each?

A. Three hundred and fourteen ships.

Q. 4. How many carts would carry this weight, suppose a ton in each?

A. Thirty-one thousand, four hundred and fifty-two carts.

Q. 5. The breadth of a shilling being one inch, if all these shillings were laid in a straight line, close to one another's edges, how long would that line be that would contain them?

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* At present (1777) it is said to be at least two hundred and thirty millions.

A. Sixty-one thousand, five hundred fifty-two miles; which is nine thousand, five hundred seventy-two miles more than twice round the whole circumference of the earth.

Q. 6. Suppose the interest of this debt to be three and a half per cent per annum, what does the whole annual interest amount to?

A. Six millions, seven hundred and seventy thousand pounds.

Q. 7. How doth government raise this interest annually?

A. By taxing those who lent the principal, and others.

Q. 8. When will government be able to pay the principal?

A. When there is more money in England's treasury than there is in all Europe.

Q. 9. And when will that be?

A. Never.

PASSPORTS

FOR MORAVIAN VESSELS, AND FOR CAPTAIN COOK.

In the time of the American war, the Moravian Society in England sent annually a vessel to their missionaries on the coast of Labrador. The Secretary of the Society, Mr. Hutton, applied to Dr. Franklin, then American minister in France, for a passport securing protection to that vessel against American cruisers. It was readily granted, and renewed every year during the war.

When Captain Cook was expected soon to return from his last voyage round the world, Dr. Franklin issued a passport of a similar kind for protecting his vessel, in case it should be met by American cruisers. This act was afterwards properly recognised. "When Cook's *Voyage* was printed," says W. T. Franklin, "the Admiralty Board sent a copy of the work in three volumes quarto to Dr. Franklin, accompanied with the elegant collection of plates, and a very polite letter from Lord Howe, signifying that the present was made with the King's express approbation."

One of the gold medals, struck by the Royal Society in honor of Captain Cook, was likewise sent to Dr. Franklin. In the *Life of Captain Cook*, by Dr. Kippis, the author stated, that Congress disapproved and reversed the orders of Dr. Franklin; but Dr. Kippis became afterwards convinced of the error of this statement, and publicly acknowledged it. — Editor.

I. PASSPORT FOR A MORAVIAN VESSEL.

To all Captains and Commanders of Vessels of War, Privateers, and Letters of Marque, belonging to the United States of America.

Gentlemen,

The religious society commonly called the Moravian Brethren, having established a mission on the coast of Labrador, for the conversion of the savages there to the Christian religion, which has already had very good effects in turning them from their ancient practices of surprising, plundering, and murdering such white people, Americans and Europeans, as, for the purposes of trade or fishery, happened to come on that coast; and persuading them to lead a life of honest industry, and to treat strangers with humanity and kindness; and it being necessary for the support of this useful mission, that a small vessel should go thither every year to furnish supplies and necessaries for the missionaries and their converts; which vessel for the present year is a of about seventy-five tons, called the whereof is master Captain

This is to request you, that, if the said vessel should happen to fall into your hands, you would not suffer her to be plundered, or hindered in her voyage, but on the contrary afford her any assistance she may stand in need of; wherein I am confident your conduct will be approved by the Congress and your owners.

Given at Passy, near Paris, this day of

B. FRANKLIN,

Minister Plenipotentiary from the United States of America at the Court of France.

P. S. The same request is respectfully made to the commanders of armed vessels belonging to France and Spain, friends of the said United States.

B. FRANKLIN.

II. PASSPORT FOR CAPTAIN COOK.

To all Captains and Commanders of armed Ships acting by Commission from the Congress of the United States of America, now in war with Great Britain.

Gentlemen,

A ship having been fitted out from England before the commencement of this war, to make discoveries of new countries in unknown seas, under the conduct of that most celebrated navigator, Captain Cook; an undertaking truly laudable in itself, as the increase of geographical knowledge facilitates the communication between distant nations, in the exchange of useful products and manufactures, and the extension of arts, whereby the common enjoyments of human life are multiplied and augmented, and science of other kinds increased to the benefit of mankind in general; this is, therefore, most earnestly to recommend to every one of you, that, in case the said ship, which is now expected to be soon in the European seas on her return, should happen to fall into your hands, you would not consider her as an enemy, nor suffer any plunder to be made of the effects contained in her, nor obstruct her immediate return to England, by detaining her or sending her into any other part of Europe or to America, but that you would treat the said Captain Cook and his people with all civility and kindness, affording them, as common friends to mankind, all the assistance in your power, which they may happen to stand in need of. In so doing you will not only gratify the generosity of your own dispositions, but there is no doubt of your obtaining the approbation of the Congress, and your other American owners. I have the honor to be, Gentlemen, your most obedient humble servant.

Given at Passy, near Paris, this 10th day of March, 1779.

B. Franklin,

Minister Plenipotentiary from the Congress of the United States to the Court of France.

SUPPLEMENT

TO THE

BOSTON INDEPENDENT CHRONICLE.

Notwithstanding Dr. Franklin's various and important occupations, while minister plenipotentiary in Paris, he occasionally amused himself in composing and printing, by means of a small set of types, and a press he had in his house, several of his light essays, *bagatelles*, or *jeux d'esprit*, written chiefly for the amusement of his intimate friends. Among these were the following, printed on a half-sheet of coarse paper, so as to imitate, as much as possible, a portion of a Boston newspaper. The repeated accounts received from America of the horribly cruel manner in which the Indian allies of Great Britain prosecuted the war against the peaceable inhabitants of the United States, murdering defenceless farmers, with their wives and children, and carrying off their scalps for the reward promised in proportion to the number, (said already to have amounted to *two thousand*,) was the foundation of the first fictitious article in this pretended "*Supplement to the Boston Independent Chronicle.*"

The other article is a *jeu d'esprit* of a gayer turn, originating from a memorial of the British ambassador, Sir Joseph Yorke, reclaiming the King's ships, the *Serapis* and *Countess of Scarborough*, prizes carried into Holland by the American squadron under Commodore Jones; whom Sir Joseph in his memorial designated "the *pirate*, Paul Jones of Scotland, a rebel subject, and a criminal of the state."

The deception intended by this supposed "SUPPLEMENT," (which was very accurately imitated with respect to printing, paper, the insertion of advertisements, &c.,) was, that, by transmitting it to England, it might actually be taken for what it purported to be. — W. T. F.

It is not known, however, that any other use was ever made of the paper, than merely to amuse the author and his private friends

The humor of the piece consists chiefly in its exact imitation of the style of such compositions, and of the typography and other characteristics of a Boston newspaper. — EDITOR.

Boston, March 12th, 1782.

Extract of a Letter from Captain Gerrish, of the New England Militia, dated Albany, March 7th.

THE peltry taken in the expedition [see the account of the expedition to Oswegatchie, on the River St. Lawrence, in our paper of the 1st instant,] will, as you see, amount to a good deal of money. The possession of this booty at first gave us pleasure; but we were struck with horror to find among the packages eight large ones, containing SCALPS of our unhappy country-folks, taken in the three last years by the Seneca Indians from the inhabitants of the frontiers of New York, New Jersey, Pennsylvania, and Virginia, and sent by them as a present to Colonel Haldimand, governor of Canada, in order to be by him transmitted to England. They were accompanied by the following curious letter to that gentleman.

"Teoga, January 3d, 1782.

"May it please your Excellency,

"At the request of the Seneca chiefs, I send herewith to your Excellency, under the care of James Boyd, eight packs of scalps, cured, dried, hooped, and painted, with all the Indian triumphal marks, of which the following is invoice and explanation.

"No. 1. Containing forty-three scalps of Congress soldiers, killed in different skirmishes; these are stretched on black hoops, four inches diameter; the inside of the skin painted red, with a small black spot to note their being killed with bullets. Also sixty-two of farmers killed in their houses; the hoops red; the skin painted brown, and marked with a hoe; a black circle all round, to denote their being surprised in the night; and a black hatchet in the middle, signifying their being killed with that weapon.

"No. 2. Containing ninety-eight of farmers killed in their houses; hoops red; figure of a hoe, to mark their profession; great white circle and sun, to show they were surprised in the daytime; a little red foot, to show they stood upon their defence, and died fighting for their lives and families.

"No. 3. Containing ninety-seven of farmers; hoops green, to show they were killed in their fields; a large white circle with a little round mark on it for the sun, to show that it was in the daytime; black bullet-mark on some, hatchet on others.

"No. 4. Containing one hundred and two of farmers, mixed of the several marks above; only eighteen marked with a little yellow flame, to denote their being of prisoners burnt alive, after being scalped, their nails pulled out by the roots, and other torments; one of these latter supposed to be a rebel clergyman, his band being fixed to the hoop of his scalp. Most of the farmers appear by the hair to have been young or middle-aged men; there being but sixty-seven very gray heads among them all; which makes the service more essential.

"No. 5. Containing eighty-eight scalps of women; hair long, braided in the Indian fashion, to show they were mothers; hoops blue; skin yellow ground, with little red tadpoles, to represent, by way of triumph, the tears of grief occasioned to their relations; a black scalping-knife or hatchet at the bottom, to mark their being killed with those instruments. Seventeen others, hair very gray; black hoops; plain brown color; no mark, but the short club or *casse-tête*, to show they were knocked down dead, or had their brains beat out.

"No. 6. Containing one hundred and ninety-three boys' scalps, of various ages; small green hoops; whitish ground on the skin, with red tears in the middle, and black bullet-marks, knife, hatchet, or club, as their deaths happened.

"No. 7. Two hundred and eleven girls' scalps, big and little; small yellow hoops; white ground; tears; hatchet, club, scalping-knife, &c.

"No. 8. This package is a mixture of all the varieties above mentioned, to the number of one hundred and twelve; with a box of birch bark, containing twenty-nine little infants' scalps of various sizes; small white hoops; white ground; no tears; and only a little black knife in the middle, to show they were ripped out of their mothers' bellies.

"With these packs, the chiefs send to your Excellency the following speech, delivered by Conejogatchie in council, interpreted by the elder Moore, the trader, and taken down by me in writing.

'Father,

'We send you herewith many scalps, that you may see we are not idle friends.

'A blue Belt.'

'Father,

'We wish you to send these scalps over the water to the great King, that he may regard them and be refreshed; and that he may see our faithfulness in destroying his enemies, and be convinced that his presents have not been made to ungrateful people.

'A blue and white Belt with red Tassels.'

'Father,

'Attend to what I am now going to say; it is a matter of much weight. The great King's enemies are many, and they grow fast in number. They were formerly like young panthers; they could neither bite nor scratch; we could play with them safely; we feared nothing they could do to us. But now their bodies are become big as the elk, and strong as the buffalo; they have also got great and sharp claws. They have driven us out of our country for taking part in your quarrel. We expect the great King will give us another country, that our children may live after us, and be his friends and children, as we are. Say this for us to the great King. To enforce it, we give this belt.

'*A great white Belt with blue Tassels.*'

'Father,

'We have only to say farther, that your traders exact more than ever for their goods; and our hunting is lessened by the war, so that we have fewer skins to give for them. This ruins us. Think of some remedy. We are poor; and you have plenty of every thing. We know you will send us powder and guns, and knives and hatchets; but we also want shirts and blankets.

'*A little white Belt.*'

"I do not doubt but that your Excellency will think it proper to give some farther encouragement to those honest people. The high prices they complain of are the necessary effect of the war. Whatever presents may be sent for them, through my hands, shall be distributed with prudence and fidelity. I have the honor of being your Excellency's most obedient

"And most humble servant,

"JAMES CRAUFURD."

It was at first proposed to bury these scalps; but Lieutenant Fitzgerald, who, you know, has got leave of absence to go to Ireland on his private affairs, said he thought it better they should proceed to their destination; and, if they were given to him, he would undertake to carry them to England, and hang them all up in some dark night on the trees in St. James's Park, where they could be seen from the King and Queen's palaces in the morning; for that the sight of them might perhaps strike Muley Ishmael (as he called him) with some compunction of conscience. They were accordingly delivered to Fitz, and he has brought them safe hither. To-morrow they go with his baggage in a wagon for Boston, and will probably be there in a few days after this letter.

I am, &c.

SAMUEL GERRISH.

Boston, March 20th.

Monday last arrived here Lieutenant Fitzgerald above mentioned, and yesterday the wagon with the scalps. Thousands of people are flocking to see them this morning, and all mouths are full of execrations. Fixing them to the trees is not approved. It is now proposed to make them up in decent little packets, seal and direct them; one to the King, containing a sample of every sort for his museum; one to the Queen, with some of women and little children; the rest to be distributed among both Houses of Parliament; a double quantity to the bishops.

Mr. Willis,

Please to insert in your useful paper the following copy of a letter from Commodore Jones, directed

TO SIR J. Y——, &c. &c.

"Ipswich, New England, March 7th, 1781.

"Sir,

"I have lately seen a memorial, said to have been presented by your Excellency to their High Mightinesses the States-General, in which you are pleased to qualify me with the title of '*pirate*.'

"A pirate is defined to be *hostis humani generis* [an enemy to all mankind]. It happens, Sir, that I am an enemy to no part of mankind, except your nation, the English; which nation, at the same time, comes much more within the definition, being actually an enemy to, and at war with, one whole quarter of the world, America, considerable part of Asia and Africa, a great part of Europe, and in a fair way of being at war with the rest.

"A pirate makes war for the sake of *rapine*. This is not the kind of war I am engaged in against England. Ours is a war in defence of *liberty*, the most just of all wars; and of our *properties*, which your nation would have taken from us, without our consent, in violation of our rights, and by an armed force. Yours, therefore is a war of *rapine;* of course, a piratical war; and those who approve of it, and are engaged in it, more justly deserve the name of *pirates*, which you bestow on me. It is indeed a war that coincides with the general spirit of your nation. Your common people in their ale-houses sing the twenty-four songs of Robin Hood, and applaud his deer-stealing and his robberies on the highway; those, who have just learning enough to read, are delighted with your histories of the pirates and of the buccaniers; and even your scholars in the universities study Quintus Curtius, and are taught to admire Alexander for what they call 'his conquests in the Indies.' Severe laws and the hangman keep down the effects of this spirit somewhat among yourselves (though in your little Island you have nevertheless more highway robberies than there are in all the rest of Europe put together); but a foreign war gives it full scope. It is then that, with infinite pleasure, it lets itself loose to strip of their property honest merchants, employed in the innocent and useful occupation of supplying the mutual wants of mankind. Hence, having lately no war with your ancient enemies, rather than be without a war, you chose to make one upon your friends. In this your piratical war with America, the mariners of your fleets and the owners of your privateers were animated against us by the act of your Parliament, which repealed the law of God, 'Thou shalt not steal,' by declaring it lawful for them to rob us of all our property that they could meet with on the ocean. This act, too, had a retrospect, and, going beyond bulls of pardon, declared that all the robberies you *had committed* previous to the act should be *deemed just and lawful.* Your soldiers, too, were promised the plunder of our cities; and your officers were flattered with the division of our lands. You had even the baseness to corrupt our servants, the sailors employed by us, and encourage them to rob their masters, and bring to you the ships and goods they were intrusted with. Is there any society of pirates on the sea or land, who, in declaring wrong to be right, and right wrong, have less authority than your Parliament? Do any of them more justly than your Parliament deserve the *title* you bestow on me?

"You will tell me that we forfeited all our estates by our refusal to pay the taxes your nation would have imposed on us without the consent of our colony Parliaments. Have you then forgotten the incontestable principle, which was the foundation of Hampden's glorious lawsuit with Charles the First, that 'what an English king has no right to demand, an English subject has a right to refuse'? But you cannot so soon have forgotten the instructions of your late honorable father, who, being himself a sound Whig, taught you certainly the principles of the revolution, and that, 'if subjects might in some cases forfeit their property, kings also might forfeit their title, and all claim to the allegiance of their subjects.' I must then suppose you well acquainted with those Whig principles; on which permit me, Sir, to ask a few questions.

"Is not protection as justly due from a king to his people, as obedience from the people to their king?

"If then a king declares his people to be out of his protection;

"If he violates and deprives them of their constitutional rights;

"If he wages war against them;

"If he plunders their merchants, ravages their coasts, burns their towns, and destroys their lives;

"If he hires foreign mercenaries to help him in their destruction;

"If he engages savages to murder their defenceless farmers, women, and children;

"If he cruelly forces such of his subjects as fall into his hands, to bear arms against their country, and become executioners of their friends and brethren;

"If he sells others of them into bondage, in Africa and the East Indies;

"If he excites domestic insurrections among their servants, and encourages servants to murder their masters;

"Does not so atrocious a conduct towards his subjects dissolve their allegiance?

"If not, please to say how or by what means it can possibly be dissolved?

"All this horrible wickedness and barbarity has been and daily is practised by the ——, *your master*, (as you call him in your memorial,) upon the Americans, whom he is still pleased to claim as his subjects.

"During these six years past, he has destroyed not less than forty thousand of those subjects, by battles on land or sea, or by starving them, or poisoning them to death, in the unwholesome air, with the unwholesome food, of his prisons. And he has wasted the lives of at least an equal number of his own soldiers and sailors; many of whom have been *forced* into this odious service, and *dragged* from their families and friends, by the outrageous violence of his illegal press-gangs. You are a gentleman of letters, and have read history; do you recollect any instance of any tyrant, since the beginning of the world, who, in the course of so few years, had done so much mischief, by ————? Let us view one of the worst and blackest of them, Nero. He put to death a few of his courtiers, placemen, and pensioners, and among the rest his *tutor*. Had ———— — ——— done the same, and no more, his crime, though detestable, as an act of lawless power, might have been as useful to his nation, as that of Nero was hurtful to Rome; considering the different characters and merits of the sufferers. Nero indeed wished that the people of Rome had but one neck, that he might behead them all by one stroke; but this was a simple wish. ——— is carrying the wish as fast as he can into execution; and, by continuing in his present course a few years longer, will have destroyed more of the —— people than Nero could have found inhabitants in Rome. Hence the expression of Milton, in speaking of Charles the First, that he was '*Nerone Neronior*,' is still more applicable to ——— — ——. Like Nero, and all other tyrants, while they lived, he indeed has his flatterers, his addressers, his applauders. Pensions, places, and hopes of preferment can bribe even bishops to approve his conduct; but, when those fulsome purchased addresses and panegyrics are sunk and lost in oblivion or contempt, impartial history will step forth, speak honest truth, and rank him among public calamities. The only difference will be, that plagues, pestilences, and famines are of this world, and arise from the nature of things; but voluntary malice, mischief, and murder, are from hell; and this —— will, therefore, stand foremost in the list of diabolical, bloody, and execrable tyrants. His base-bought Parliaments too, who sell him their souls, and extort from the people the money with which they aid his destructive purposes, as they share his guilt, will share his infamy; Parliaments, who, to please him, have repeatedly, by different votes year after year, dipped their hands in human blood, insomuch that methinks I see it dried and caked so thick upon them, that, if they could wash it off in the Thames, which flows under their windows, the whole river would run red to the ocean.

"One is provoked by enormous wickedness; but one is ashamed and humiliated at the view of human baseness. It afflicts me, therefore, to see a gentleman of Sir J Y——'s education and talents, for the sake of a red riband and a paltry stipend, mean enough to style such a ——— *his master*, wear his livery, and hold himself ready at his command even to cut the throats of fellow subjects. This makes it impossible for me to end my letter with the civility of a compliment, and obliges me to subscribe myself simply,

"JOHN PAUL JONES,

"Whom you are pleased to style a '*pirate.*'*

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* *Anecdote of Paul Jones.*—After Jones's crew had landed at Lord Selkirk's, stripped the house of the plate, and taken it on board, the ship lay to, while Jones wrote a letter to his Lordship, which he sent on shore. In this letter he candidly acknowledged, that he meant to have seized him, and to have detained him as a person of much consequence to him in case of a cartel; but disclaimed any concern in taking away his plate; which, he said, was done by the crew in spite of his remonstrances; who said they were determined to be repaid for the hardships and dangers they had encountered in Kirkcudbright Bay, and in attempting to set fire, a few days before, to the shipping in the harbour of Whitehaven. Jones, however, informed his Lordship, that he had secured all the plate, and would certainly return it to him at a convenient opportunity. This he afterwards punctually performed, by sending it to Lord Selkirk's banker, in London. Any person who doubts the fact, may be convinced of its reality, by referring to the *Addenda* to Gilpin's "Tour to the Lakes of Scotland," where they will find it authenticated by Lord Selkirk himself.

PUBLIC ADDRESSES

TO DR. FRANKLIN, AND HIS ANSWERS.

On Dr. Franklin's return to his native country, from his long mission to France, he received congratulatory addresses from various public bodies. Some of these are here inserted, with his answers. — EDITOR.

ADDRESS OF THE ASSEMBLY OF PENNSYLVANIA.

THE representatives of the freemen of the Commonwealth of Pennsylvania, in General Assembly met, in the most affectionate manner congratulate you on your safe arrival in your country after so long an absence on the most important business. We likewise congratulate you on the firm establishment of the independence of America, and the settlement of a general peace, after the interesting struggle in which we were so long engaged.

We are confident, Sir, that we speak the sentiments of this whole country, when we say, that your services, in the public councils and negotiations, have not only merited the thanks of the present generation, but will be recorded in the pages of history, to your immortal honor. And it is particularly pleasing to us, that, while we are sitting as members of the Assembly of Pennsylvania, we have the happiness of welcoming into the state a person, who was so greatly instrumental in forming its free constitution.

May it please God to give you a serene and peaceful enjoyment of the evening of life, and a participation of that happiness you have been so instrumental in securing to others!

Signed by order of the House,

John Bayard, *Speaker.*

Assembly Chambers, September 15th, 1785.

DR. FRANKLIN'S ANSWER.

Mr. Speaker and Gentlemen,

I am extremely happy to find by your friendly and affectionate address, that my endeavours to serve our country in the late important struggle have met with the approbation of so respectable a body as the representatives of the freemen of Pennsylvania. I esteem that approbation as one of the greatest honors of my life. I hope the peace with which God has been graciously pleased to bless us may be lasting, and that the free constitution we now enjoy may long contribute to promote our common felicity. The kind wishes of the General Assembly for my particular happiness affect me very sensibly, and I beg they would accept my thankful acknowledgments.

ADDRESS OF THE AMERICAN PHILOSOPHICAL SOCIETY.

Sir,

It is with peculiar pleasure that the *American Philosophical Society* address you on this occasion.

The high consideration and esteem, in which we hold your character, so intimately combine with our regard for the public welfare, that we participate eminently in the general satisfaction which your return to America produces.

We bid you welcome to your native country, for which you have done the most essential services; and we welcome you to this chair, your occupying of which, as President, adds to our institution much lustre in the eyes of the world.

Sir, it reflects honor on philosophy, when one, distinguished by his deep investigations, and many valuable improvements in it, is known to be equally distinguished for his philanthropy, patriotism, and liberal attachment to the rights of human nature.

We know the favorable influence, that freedom has upon the growth of sciences and arts. We derive encouragement and extraordinary felicity from an assemblage of recent memorable events.

And, while we boast in a most pleasing equality permanently ascertained, and that independence which you had so great a share in establishing, we have reason to expect, that this Society will proceed, with an increasing success, to conduct the important business for which they originally associated.

DR. FRANKLIN'S ANSWER.

Gentlemen,

The great honor done me by this Society, in choosing me so many years successively their President, notwithstanding my absence in Europe, and the very kind welcome they are pleased to give me on my return, demand my most grateful acknowledgments; which I beg they would be pleased to accept, with my warmest wishes of success to their laudable endeavours for the promoting of useful knowledge among us, to which I shall be happy if I can in any degree contribute.

ADDRESS OF THE PROVOST, VICE-PROVOST, AND PROFESSORS OF THE UNIVERSITY OF PENNSYLVANIA.

HONORED SIR,

The Provost, Vice-Provost, and Professors of the University of Pennsylvania beg leave to congratulate you on your safe arrival in your native country, after having accomplished the duties of your exalted character with dignity and success.

While we participate in the general happiness of America, to the establishment of which your political abilities and patriotic exertions have so signally contributed, we feel a particular pleasure in paying our acknowledgments to the gentleman, who first projected the liberal plan of the institution over which we have the honor to preside.

Not contented with enriching the world with the most important discoveries in natural philosophy, your benevolence and liberality of sentiment early engaged you to make provision for exciting a spirit of inquiry into the secret operations of nature; for exalting and refining the genius of America, by the propagation of useful learning; and for qualifying many of her sons to make that illustrious figure, which has commanded the esteem and admiration of the most polished nations of Europe.

Among the many benevolent projections, which have laid so ample a foundation for the esteem and gratitude of your native country, permit this seminary to reckon her first establishment, upon the solid principles of equal liberty, as one of the most considerable and important. And now, when restored, through the influence of our happy constitution, to her original broad and catholic bottom; when enriched by the protection and generous donations of a public-spirited and patriotic Assembly;

and when flourishing under the countenance of the best friends of religion, learning, and liberty in the state; she cannot but promise herself the continued patronage of the evening of that life, which divine Providence has so eminently distinguished.

May the same indulgent Providence yet continue your protracted life, enriched and crowned with the best of blessings, to nurse and cherish this favorite child of your youth; that the future sons of science in this western world may have additional reason to remember the name of FRANKLIN with gratitude and pleasure.

Signed, in the name and by order of the Faculty, by

JOHN EWING, *Provost.*

Philadelphia, September 16*th*, 1785.

DR. FRANKLIN'S ANSWER.

I am greatly obliged, Gentlemen, by your kind congratulations on my safe arrival.

It gives me extreme pleasure to find, that seminaries of learning are increasing in America, and particularly that the University over which you preside, continues to flourish. My best wishes will always attend it.

The instruction of youth is one of those employments, which to the public are most useful; it ought, therefore, to be esteemed among the most honorable. Its successful exercise does not, however, always meet with the reward it merits, except in the satisfaction of having contributed to the forming of virtuous and able men for the service of their country.

PROPOSALS FOR CONSIDERATION

IN THE CONVENTION FOR FORMING THE CONSTITUTION OF THE UNITED STATES.

June 26th, 1787.

THAT the legislatures of the several States shall choose and send an equal number of delegates, namely, , who are to compose the second branch of the general legislature.

That, in all cases or questions wherein the sovereignties of the individual States may be affected, or whereby their authority over their own citizens may be diminished, or the authority of the general government within the several States augmented, each State shall have *equal* suffrage.

That, in the appointment of all civil officers of the *general government*, in the election of whom the second branch may, by the Constitution, have part, each State shall have *equal* suffrage.

That, in fixing the salaries of such officers, in all allowances for public services, and generally in all appropriations and dispositions of money, to be drawn out of the general treasury, and in all laws for supplying the treasury, the delegates of the several States shall have suffrage *in proportion to the sums their respective States had actually contributed to that treasury from their taxes or internal excises.*

That, in case general duties should be laid by impost on goods imported, a liberal estimation shall be made of the amount of such impost paid in the price of the commodities by those States that import but little, and a proportionate addition shall be allowed of suffrage to such States, and an equal diminution of the suffrage of the States importing.

REMARKS.

The steady course of public measures is most probably to be expected from a number.

A single person's measures may be good. The successor often differs in opinion of those measures, and adopts others; often is ambitious of distinguishing himself by opposing them, and offering new projects. One is peaceably disposed; another may be fond of war, &c. Hence foreign States can never have that confidence in the treaties or friendship of such a government, as in that which is conducted by a number.

The single head may be sick; who is to conduct the public affairs in that case? When he dies, who are to conduct till a new election? If a council, why not continue them? Shall we not be harassed with factions for the election of successors; and become, like Poland, weak from our dissensions?

Consider the present distracted condition of Holland. They had at first a Stadtholder, the Prince of Orange, a man of undoubted and great merit. They found some inconveniences, however, in the extent of powers annexed to that office, and exercised by a single person. On his death, they resumed and divided those powers among the states and cities; but there has been a constant struggle since between that family and the nation. In the last century, the then Prince of Orange found means to inflame the populace against their magistrates, excite a general insurrection, in which an excellent minister, Dewitt, was murdered, all the old magistrates displaced, and the Stadtholder re-invested with all the former powers. In this century, the father of the present Stadtholder, having married a British princess, did, by exciting another insurrection, force from the nation a decree, that the stadtholdership should be thenceforth hereditary in his family. And now his son, being suspected of having favored England in the late war, and thereby lost the confidence of the nation, is forming an internal faction to support his power, and reinstate his favorite, the Duke of Brunswick; and he holds up his family alliances with England and Prussia to terrify opposition. It was this conduct of the Stadtholder, which induced the states to recur to the protection of France, and put their troops under a French, rather than the Stadtholder's German general, the Duke of Brunswick. And this is the source of all the present disorders in Holland, which, if the Stadtholder has abilities equal to his inclinations, will probably, after a ruinous and bloody civil war, end in establishing an hereditary monarchy in his family.

SPEECH IN THE CONVENTION;

ON THE SUBJECT OF SALARIES.

Sir,

It is with reluctance that I rise to express a disapprobation of any one article of the plan, for which we are so much obliged to the honorable gentleman who laid it before us. From its first reading, I have borne a good will to it, and, in general, wished it success. In this particular of salaries to the executive branch, I happen to differ; and, as my opinion may appear new and chimerical, it is only from a persuasion that it is right, and from a sense of duty, that I hazard it. The committee will judge of my reasons when they have heard them, and their judgment may possibly change mine. I think I see inconveniences in the appointment of salaries; I see none in refusing them, but, on the contrary, great advantages.

Sir, there are two passions which have a powerful influence in the affairs of men. These are *ambition* and *avarice;* the love of power and the love of money. Separately, each of these has great force in prompting men to action; but, when united in view of the same object, they have in many minds the most violent effects. Place before the eyes of such men a post of *honor*, that shall at the same time be a place of *profit*, and they will move heaven and earth to obtain it. The vast number of such places it is, that renders the British government so tempestuous. The struggles for them are the true source of all those factions which are perpetually dividing the nation, distracting its councils, hurrying it sometimes into fruitless and mischievous wars, and often compelling a submission to dishonorable terms of peace.

And of what kind are the men that will strive for this profitable preëminence, through all the bustle of cabal, the heat of contention, the infinite mutual abuse of parties, tearing to pieces the best of characters? It will not be the wise and moderate, the lovers of peace and good order, the men fittest for the trust. It will be the bold and the violent, the men of strong passions and indefatigable activity in their selfish pursuits. These will thrust themselves into your government, and be your rulers. And these, too, will be mistaken in the expected happiness of their situation; for their vanquished competitors, of the same spirit, and from the same motives, will perpetually be endeavouring to distress their administration, thwart their measures, and render them odious to the people.

Besides these evils, Sir, though we may set out in the beginning with moderate salaries, we shall find, that such will not be of long continuance. Reasons will never be wanting for proposed augmentations; and there will always be a party for giving more to the rulers, that the rulers may be able in return to give more to them. Hence, as all history informs us, there has been in every state and kingdom a constant kind of warfare between the governing and the governed; the one striving to obtain more for its support, and the other to pay less. And this has alone occasioned great convulsions, actual civil wars, ending either in dethroning of the princes or enslaving of the people. Generally, indeed, the ruling power carries its point, and we see the revenues of princes constantly increasing, and we see that they are never satisfied, but always in want of more. The more the people are discontented with the oppression of taxes, the greater need the prince has of money to distribute among his partisans, and pay the troops that are to suppress all resistance, and enable him to plunder at pleasure. There is scarce a king in a hundred, who would not, if he could, follow the example of Pharaoh,—get first all the people's money, then all their lands, and then make them and their children servants for ever. It will be said, that we do not propose to establish kings. I know it. But there is a natural inclination in mankind to kingly government. It sometimes relieves them from aristocratic domination. They had rather have one tyrant than five hundred. It gives more of the appearance of equality among citizens; and that they like. I am apprehensive, therefore,—perhaps too apprehensive,—that the government of these States may in future times end in a monarchy. But this catastrophe, I think, may be long delayed, if in our proposed system we do not sow the seeds of contention, faction, and tumult, by making our posts of honor places of profit. If we do, I fear, that, though we employ at first a number and not a single person, the number will in time be set aside; it will only nourish the fœtus of a king (as the honorable gentleman from Virginia very aptly expressed it), and a king will the sooner be set over us.

It may be imagined by some, that this is an Utopian idea, and that we can never find men to serve us in the executive department, without paying them well for their services. I conceive this to be a mistake. Some existing facts present themselves to me, which incline me to a contrary opinion. The high sheriff of a county in England is an honorable office, but it is not a profitable one. It is rather expensive, and therefore not sought for. But yet it is executed, and well executed, and usually by some of the principal gentlemen of the county. In France, the office of counsellor, or member of their judiciary parliaments, is more honorable. It is therefore purchased at a high price; there are indeed fees on the law proceedings, which are divided among them, but these fees do not amount to more than three per cent on the sum paid for the place. Therefore, as legal interest is there at five per cent, they in fact pay two per cent for being allowed to do the judiciary business of the nation, which is at the same time entirely exempt from the burthen of paying them any salaries for their services. I do not, however, mean to recommend this as an eligible mode for our judiciary department. I only bring the instance to show, that the pleasure of doing good and serving their country, and the respect such conduct entitles them to, are sufficient motives with some minds, to give up a great portion of their time to the public, without the mean inducement of pecuniary satisfaction.

Another instance is that of a respectable society, who have made the experiment, and practised it with success, now more than a hundred years. I mean the Quakers. It is an established rule with them that they are not to go to law, but in their controversies they must apply to their monthly, quarterly, and yearly meetings. Committees of these sit with patience to hear the parties, and spend much time in composing their differences. In doing this, they are supported by a sense of duty, and the respect paid to usefulness. It is honorable to be so employed, but it was never made profitable by salaries, fees, or perquisites. And indeed, in all cases of public service, the less the profit the greater the honor.

To bring the matter nearer home, have we not seen the greatest and most important of our offices, that of general of our armies, executed for eight years together, without the smallest salary, by a patriot whom I will not now offend by any other praise; and this, through fatigues and distresses, in common with the other brave men, his military friends and companions, and the constant anxieties peculiar to his station? And shall we doubt finding three or four men in all the United States, with public spirit enough to bear sitting in peaceful council, for perhaps an equal term, merely to preside over our civil concerns, and see that our laws are duly executed? Sir, I have a better opinion of our country. I think we shall never be without a sufficient number of wise and good men to undertake, and execute well and faithfully, the office in question.

Sir, the saving of the salaries, that may at first be proposed, is not an object with me. The subsequent mischiefs of proposing them are what I apprehend.

And therefore it is that I move the amendment. If it is not seconded or accepted, I must be contented with the satisfaction of having delivered my opinion frankly, and done my duty.

SPEECH IN A COMMITTEE OF THE CONVENTION;

ON THE PROPORTION OF REPRESENTATION AND VOTES.

Mr. Chairman,

It has given me great pleasure to observe, that, till this point, *the Proportion of Representation*, came before us, our debates were carried on with great coolness and temper. If any thing of a contrary kind has, on this occasion, appeared, I hope it will not be repeated; for we are sent hither to *consult*, not to *contend*, with each other; and declarations of a fixed opinion, and of determined resolutions never to change it, neither enlighten nor convince us. Positiveness and warmth on one side naturally beget their like on the other; and tend to create and augment discord and division in a great concern, wherein harmony and union are extremely necessary, to give weight to our counsels, and render them effectual in promoting and securing the common good.

I must own, that I was originally of opinion, it would be better if every member of Congress, or our national council, were to consider himself rather as a representative of the whole, than as an agent for the interests of a particular State; in which case the proportion of members for each State would be of less consequence, and it would not be very material whether they voted by States or individually. But as I find this is not to be expected, I now think the number of representatives should bear some proportion to the number of the represented, and that the decisions should be by the majority of members, not by the majority of States. This is objected to, from an apprehension that the greater States would then swallow up the smaller. I do not at present clearly see what advantage the greater States could propose to themselves by swallowing the smaller, and therefore do not apprehend they would attempt it. I recollect, that in the beginning of this century, when the union was proposed of the two kingdoms, England and Scotland, the Scotch patriots were full of fears, that, unless they had an equal number of representatives in Parliament, they should be ruined by the superiority of the English. They finally agreed, however, that the different proportions of importance in the union of the two nations should be attended to; whereby they were to have only forty members in the House of Commons, and only sixteen of their peers were to sit in the House of Lords; a very great inferiority of numbers. And yet, to this day, I do not recollect that any thing has been done in the Parliament of Great Britain to the prejudice of Scotland; and whoever looks over the lists of public officers, civil and military, of that nation, will find, I believe, that the North Britons enjoy at least their full proportion of emolument.

But, Sir, in the present mode of voting by States, it is equally in the power of the lesser States to swallow up the greater; and this is mathematically demonstrable. Suppose, for example, that seven smaller States had each three members in the House, and the six larger to have, one with another, six members; and that, upon a question, two members of each smaller State should be in the affirmative, and one in the negative; they will make

Affirmatives,	14	Negatives	7
And that all the large States should be unanimously in the negative; they would make		Negatives	36
		In all	43

It is then apparent, that the 14 carry the question against the 43, and the minority overpowers the majority, contrary to the common practice of assemblies in all countries and ages.

The greater States, Sir, are naturally as unwilling to have their property left in the disposition of the smaller, as the smaller are to leave theirs in the disposition of the greater. An honorable gentleman has, to avoid this difficulty, hinted a proposition of equalizing the States. It appears to me an equitable one; and I should, for my own part, not be against such a measure, if it might be found practicable. Formerly, indeed, when almost every province had a different constitution, some with greater, others with fewer privileges, it was of importance to the borderers, when their boundaries were contested, whether, by running the division lines, they were placed on one side or the other. At present, when such differences are done away, it is less material. The interest of a State is made up of the interests of its individual members. If they are not injured, the State is not injured. Small States are more easily, well, and happily governed, than large ones. If, therefore, in such an equal division, it should be found necessary to diminish Pennsylvania, I should not be averse to the giving a part of it to New Jersey, and another to Delaware; but, as there would probably be considerable difficulties in adjusting such a division; and, however equally made at first, it would be continually varying by the augmentation of inhabitants in some States, and their more fixed proportion in others, and thence frequent occasion for new divisions; I beg leave to propose for the consideration of the committee another mode, which appears to me to be as equitable, more easily carried into practice, and more permanent in its nature.

Let the weakest State say what proportion of money or force it is able and willing to furnish for the general purposes of the Union.

Let all the others oblige themselves to furnish each an equal proportion.

The whole of these joint supplies to be absolutely in the disposition of Congress.

The Congress in this case to be composed of an equal number of delegates from each State;

And their decisions to be by the majority of individual members voting.

If these joint and equal supplies should, on particular occasions, not be sufficient, let Congress make requisitions on the richer and more powerful States for further aids, to be voluntarily afforded; so leaving each State the right of considering the necessity and utility of the aid desired, and of giving more or less, as it should be found proper.

This mode is not new; it was formerly practised with success by the British government, with respect to Ireland and the Colonies. We sometimes gave even more than they expected, or thought just to accept; and in the last war, carried on while we were united, they gave us back in five years a million sterling. We should probably have continued such voluntary contributions, whenever the occasions appeared to require them for the common good of the empire. It was not till they chose to force us, and to deprive us of the merit and pleasure of voluntary contributions, that we refused and resisted. Those contributions, however, were to be disposed of at the pleasure of a government in which we had no representative. I am therefore persuaded, that they will not be refused to one in which the representation shall be equal.

My learned colleague has already mentioned that the present mode of voting by States, was submitted to originally by Congress, under a conviction of its impropriety, inequality, and injustice. This appears in the words of their resolution. It is of September 6th, 1774. The words are,

"Resolved, That, in determining questions in this Congress, each colony or province shall have one vote; the Congress not being possessed of, or at present able to procure, materials for ascertaining the importance of each colony."

MOTION

FOR PRAYERS IN THE CONVENTION.

Mr. President,

The small progress we have made, after four or five weeks' close attendance and continual reasonings with each other, our different sentiments on almost every question, several of the last producing as many *Noes* as *Ayes*, is, methinks, a melancholy proof of the imperfection of the human understanding We indeed seem to *feel* our own want of political wisdom, since we have been running all about in search of it. We have gone back to ancient history for models of government, and examined the different forms of those republics, which, having been originally formed with the seeds of their own dissolution, now no longer exist; and we have viewed modern states all round Europe, but find none of their constitutions suitable to our circumstances.

In this situation of this assembly, groping, as it were, in the dark to find political truth, and scarce able to distinguish it when presented to us, how has it happened, Sir, that we have not hitherto once thought of humbly applying to the Father of Lights to illuminate our understandings? In the beginning of the contest with Britain, when we were sensible of danger, we had daily prayers in this room for the divine protection. Our prayers, Sir, were heard;—and they were graciously answered. All of us, who were engaged in the struggle, must have observed frequent instances of a superintending Providence in our favor. To that kind Providence we owe this happy opportunity of consulting in peace on the means of establishing our future national felicity. And have we now forgotten that powerful Friend? or do we imagine we no longer need its assistance? I have lived, Sir, a long time; and the longer I live, the more convincing proofs I see of this truth, *that* God *governs in the affairs of men.* And, if a sparrow cannot fall to the ground without his notice, is it probable that an empire can rise without his aid? We have been assured, Sir, in the Sacred Writings, that "except the Lord build the house, they labor in vain that build it." I firmly believe this; and I also believe, that, without his concurring aid, we shall succeed in this political building no better than the builders of Babel;

we shall be divided by our little, partial, local interests, our projects will be confounded, and we ourselves shall become a reproach and a by-word down to future ages. And, what is worse, mankind may hereafter, from this unfortunate instance, despair of establishing government by human wisdom, and leave it to chance, war, and conquest.

I therefore beg leave to move,

That henceforth prayers, imploring the assistance of Heaven and its blessing on our deliberations, be held in this assembly every morning before we proceed to business; and that one or more of the clergy of this city be requested to officiate in that service.*

SPEECH IN THE CONVENTION,

AT THE CONCLUSION OF ITS DELIBERATIONS.

Mr. President,

I confess, that I do not entirely approve of this Constitution at present; but, Sir, I am not sure I shall never approve it; for, having lived long, I have experienced many instances of being obliged, by better information or fuller consideration, to change opinions even on important subjects, which I once thought right, but found to be otherwise. It is therefore that, the older I grow, the more apt I am to doubt my own judgment of others. Most men, indeed, as well as most sects in religion, think themselves in possession of all truth, and that wherever others differ from them, it is so far error. Steele, a Protestant, in a ded-

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* *Note by Dr. Franklin.* — "The convention, except three or four persons, thought prayers unnecessary!"

ication, tells the Pope, that the only difference between our two churches in their opinions of the certainty of their doctrine, is, the Romish Church is *infallible*, and the Church of England is *never in the wrong*. But, though many private persons think almost as highly of their own infallibility as of that of their sect, few express it so naturally as a certain French lady, who, in a little dispute with her sister, said, "But I meet with nobody but myself that is *always* in the right." "*Je ne trouve que moi qui aie toujours raison.*"

In these sentiments, Sir, I agree to this Constitution, with all its faults, — if they are such; because I think a general government necessary for us, and there is no *form* of government but what may be a blessing to the people, if well administered; and I believe, further, that this is likely to be well administered for a course of years, and can only end in despotism, as other forms have done before it, when the people shall become so corrupted as to need despotic government, being incapable of any other. I doubt, too, whether any other convention we can obtain, may be able to make a better constitution; for, when you assemble a number of men, to have the advantage of their joint wisdom, you inevitably assemble with those men all their prejudices, their passions, their errors of opinion, their local interests, and their selfish views. From such an assembly can a *perfect* production be expected? It therefore astonishes me, Sir, to find this system approaching so near to perfection as it does; and I think it will astonish our enemies, who are waiting with confidence to hear, that our counsels are confounded like those of the builders of Babel, and that our States are on the point of separation, only to meet hereafter for the purpose of cutting one-another's throats. Thus I consent, Sir, to this Constitution, because I expect no better, and because I am not sure that it is not the best. The opinions I have had of its *errors* I sacrifice to the public good. I have never whispered a syllable of them abroad. Within these walls they were born, and here they shall die. If every one of us, in returning to our constituents, were to report the objections he has had to it, and endeavour to gain partisans in support of them, we might prevent its being generally received, and thereby lose all the salutary effects and great advantages resulting naturally in our favor among foreign nations, as well as among ourselves, from our real or apparent unanimity. Much of the strength and efficiency of any government, in procuring and securing happiness to the people, depends on *opinion*, on the general opinion of the goodness of that government, as well as of the wisdom and integrity of its governors. I hope, therefore, for our own sakes, as a part of the people, and for the sake of our posterity, that we shall act heartily and unanimously in recommending this Constitution, wherever our influence may extend, and turn our future thoughts and endeavours to the means of having it *well administered.*

On the whole, Sir, I cannot help expressing a wish, that every member of the convention who may still have objections to it, would with me on this occasion doubt a little of his own infallibility, and, to make *manifest* our *unanimity*, put his name to this instrument.

[Then the motion was made for adding the last formula, viz. "Done in convention by the unanimous consent," &c.; which was agreed to and added accordingly.]

A COMPARISON

OF THE

CONDUCT OF THE ANCIENT JEWS AND OF THE ANTI-FEDERALISTS IN THE UNITED STATES OF AMERICA.

A ZEALOUS advocate for the proposed Federal Constitution, in a certain public assembly, said, that "the repugnance of a great part of mankind to good government was such, that he believed, that, if an angel from Heaven was to bring down a constitution formed there for our use, it would nevertheless meet with violent opposition." He was reproved for the supposed extravagance of the sentiment; and he did not justify it. Probably it might not have immediately occurred to him, that the experiment had been tried, and that the event was recorded in the most faithful of all histories, the Holy Bible; otherwise he might, as it seems to me, have supported his opinion by that unexceptionable authority.

The Supreme Being had been pleased to nourish up a single family, by continued acts of his attentive providence, till it became a great people; and, having rescued them from bondage by many miracles, performed by his servant Moses, he personally delivered to that chosen servant, in presence of the whole nation, a constitution and code of laws for their observance; accompanied and sanctioned with promises of great rewards, and threats of severe punishments, as the consequence of their obedience or disobedience.

This constitution, though the Deity himself was to be at its head (and it is therefore called by political writers a *Theocracy*), could not be carried into execution but by the means of his ministers; Aaron and his sons were therefore commissioned to be, with Moses, the first established ministry of the new government.

One would have thought, that the appointment of men, who had distinguished themselves in procuring the liberty of their nation, and had hazarded their lives in openly opposing the will of a powerful monarch, who would have retained that nation in slavery, might have been an appointment acceptable to a grateful people; and that a constitution framed for them by the Deity himself might, on that account, have been secure of a universal welcome reception. Yet there were in every one of the thirteen tribes some discontented, restless spirits, who were continually exciting them to reject the proposed new government, and this from various motives.

Many still retained an affection for Egypt, the land of their nativity; and these, whenever they felt any inconvenience or hardship, though the natural and unavoidable effect of their change of their situation, exclaimed against their leaders as the authors of their trouble; and were not only for returning into Egypt, but for stoning their deliverers.* Those inclined to idolatry were displeased that their golden calf was destroyed. Many of the chiefs thought the new constitution might be injurious to their particular interests. that the profitable places would be *engrossed by the families and friends of Moses and Aaron*, and others equally well-born excluded.† In Josephus and the Talmud, we learn some particulars, not so fully narrated

* Numbers, ch. xiv.

† Numbers, ch. xvi. verse 3. "And they gathered themselves together against Moses and Aaron, and said unto them, 'Ye take too much upon you, seeing all the congregation are holy, every one of them; whereforo then, lift ye up yourselves above the congregation?'"

in the Scripture. We are there told, "That Corah was ambitious of the priesthood, and offended that it was conferred on Aaron; and this, as he said, by the authority of Moses only, *without the consent of the people.* He accused Moses of having, by various artifices, fraudulently obtained the government, and deprived the people of their liberties; and of conspiring with Aaron to perpetuate the tyranny in their family. Thus, though Corah's real motive was the supplanting of Aaron, he persuaded the people that he meant only the public good; and they, moved by his insinuations, began to cry out, 'Let us maintain the common liberty of our *respective tribes*; we have freed ourselves from the slavery imposed upon us by the Egyptians, and shall we suffer ourselves to be made slaves by Moses? If we must have a master, it were better to return to Pharaoh, who at least fed us with bread and onions, than to serve this new tyrant, who by his operations has brought us into danger of famine.' Then they called in question the *reality of his conference* with God; and objected to the privacy of their meetings, and the preventing any of the people from being present at the colloquies, or even approaching the place, as grounds of great suspicion. They accused Moses also of *peculation;* as embezzling part of the golden spoons and the silver chargers, that the princes had offered at the dedication of the altar,* and the offerings of gold by the common people,† as well as most of the poll-tax;‡ and Aaron they accused of pocketing much of the gold of which he pretended to have made a molten calf. Besides peculation, they charged Moses with *ambition;* to gratify which passion he had, they said,

* Numbers, ch. vii.

† Exodus, ch. xxxv. verse 22.

‡ Numbers, ch. iii., and Exodus, ch. xxx.

deceived the people, by promising to bring them to a land flowing with milk and honey; instead of doing which, he had brought them *from* such a land; and that he thought light of all this mischief, provided he could make himself an *absolute prince.** That, to support the new dignity with splendor in his family, the partial poll-tax already levied and given to Aaron † was to be followed by a general one,‡ which would probably be augmented from time to time, if he were suffered to go on promulgating new laws, on pretence of new occasional revelations of the divine will, till their whole fortunes were devoured by that aristocracy."

Moses denied the charge of peculation; and his accusers were destitute of proofs to support it; though *facts*, if real, are in their nature capable of proof. "I have not," said he (with holy confidence in the presence of God), "I have not taken from this people the value of an ass, nor done them any other injury." But his enemies had made the charge, and with some success among the populace; for no kind of accusation is so readily made, or easily believed, by knaves, as the accusation of knavery.

In fine, no less than two hundred and fifty of the principal men, "famous in the congregation, men of renown," § heading and exciting the mob, worked them up to such a pitch of phrensy, that they called out, "Stone them, stone them, and thereby secure our liberties; and let us choose other captains, that may lead us back into Egypt, in case we do not succeed in reducing the Canaanites!"

* Numbers, ch. xvi. verse 13. "Is it a small thing that thou hast brought us up out of a land that floweth with milk and honey, to kill us in the wilderness, except thou make thyself altogether a prince over us?"

† Numbers, ch. iii. ‡ Exodus, ch. xxx § Numbers, ch. xvi.

On the whole, it appears, that the Israelites were a people jealous of their newly-acquired liberty, which jealousy was in itself no fault; but, when they suffered it to be worked upon by artful men, pretending public good, with nothing really in view but private interest, they were led to oppose the establishment of the new constitution, whereby they brought upon themselves much inconvenience and misfortune. It further appears, from the same inestimable history, that, when after many ages that constitution was become old and much abused, and an amendment of it was proposed, the populace, as they had accused Moses of the ambition of making himself a prince, and cried out, "Stone him, stone him;" so, excited by their high priests and scribes, they exclaimed against the Messiah, that he aimed at becoming the King of the Jews, and cried, "Crucify him, crucify him." From all which we may gather, that popular opposition to a public measure is no proof of its impropriety, even though the opposition be excited and headed by men of distinction.

To conclude, I beg I may not be understood to infer, that our General Convention was divinely inspired, when it formed the new federal constitution, merely because that constitution has been unreasonably and vehemently opposed; yet I must own I have so much faith in the general government of the world by Providence, that I can hardly conceive a transaction of such momentous importance to the welfare of millions now existing, and to exist in the posterity of a great nation, should be suffered to pass without being in some degree influenced, guided, and governed by that omnipotent, omnipresent, and beneficent Ruler, in whom all inferior spirits live, and move, and have their being.

B. F

QUERIES AND REMARKS

RESPECTING ALTERATIONS IN THE CONSTITUTION OF PENNSYLVANIA.

The first Constitution of Pennsylvania was adopted in 1776. Dr. Franklin was a principal agent in forming it. The following QUERIES AND REMARKS were written in reply to a paper, entitled "*Hints for the Members of Convention*," which was published in the *Federal Gazette*, November 3d, 1789. — EDITOR.

I. OF THE EXECUTIVE BRANCH.

"*Your executive should consist of a single person.*"

On this I would ask, Is he to have no council? How is he to be informed of the state and circumstances of the different counties, their wants, their abilities, their dispositions, and the characters of the principal people, respecting their integrity, capacities, and qualifications for offices? Does not the present construction of our executive provide well for these particulars? And, during the number of years it has existed, have its errors or failures in answering the end of its appointment been more or greater than might have been expected from a single person?

"*But an individual is more easily watched and controlled than any greater number.*"

On this I would ask, Who is to watch and control him? and by what means is he to be controlled? Will not those means, whatever they are, and in whatever body vested, be subject to the same inconveniences of expense, delay, obstruction of good intentions, &c., which are objected to the present executive?

II. THE DURATION OF THE APPOINTMENT

"*This should be governed by the following principles, the independence of the magistrate, and the stability of his administration; neither of which can be secured but by putting both beyond the reach of every annual gust of folly and of faction.*"

On this it may be asked, ought it not also to be put beyond the reach of every triennial, quinquennial, or septennial gust of folly and faction, and, in short, beyond the reach of folly and of faction at any period whatever? Does not this reasoning aim at establishing a monarchy at least for life, like that of Poland? or to prevent the inconveniences such as that kingdom is subject to in a new election on every decease? Are the freemen of Pennsylvania convinced, from a view of the history of such governments, that it will be for their advantage to submit themselves to a government of such construction?

III. ON THE LEGISLATIVE BRANCH.

"*A plural legislature is as necessary to good government as a single executive. It is not enough that your legislature should be numerous; it should also be divided. Numbers alone are not a sufficient barrier against the impulses of passion, the combination of interest, the intrigues of faction, the haste of folly, or the spirit of encroachment. One division should watch over and control the other, supply its wants, correct its blunders, and cross its designs, should they be criminal* *or erroneous. Wisdom is the specific quality of the legislature, grows out of the number of the body, and is made up of the portions of sense and knowledge which each member brings to it.*"

On this it may be asked, May not the wisdom brought to the legislature by each member be as effectual a barrier against the impulses of passion, &c., when the members are united in one body, as when they are divided? If one part of the legislature may control the operations of the other, may not the impulses of passion, the combinations of interest, the intrigues of faction, the haste of folly, or the spirit of encroachment in one of those bodies obstruct the good proposed by the other, and frustrate its advantages to the public? Have we not experienced in this State, when a province under the government of the proprietors, the mischiefs of a second branch existing in the proprietary family, countenanced and aided by an aristocratic council? How many delays and what great expenses were occasioned in carrying on the public business; and what a train of mischiefs, even to the preventing of the defence of the province during several years, when distressed by an Indian war, by the iniquitous demand that the proprietary property should be exempt from taxation! The wisdom of a few members in one single legislative body, may it not frequently stifle bad motions in their infancy, and so prevent their being adopted? whereas, if those wise men, in case of a double legislature, should happen to be in that branch wherein the motion did not arise, may it not, after being adopted by the other, occasion long disputes and contentions between the two bodies, expensive to the public, obstructing the public business, and promoting factions among the people, many tempers naturally adhering obstinately to measures they have once publicly adopted? Have we not seen, in one of our neighbouring States, a bad measure, adopted by one branch of the legislature, for want of the assistance of some more intelligent members who had been packed into the other, occasion many debates, conducted with much asperity, which could not be settled but by an expensive general appeal to the public? And have we not seen, in another neighbouring State, a similar difference between the two branches, occasioning long debates and contentions, whereby the State was prevented for many months enjoying the advantage of having Senators in the Congress of the United States? And has our present legislative in one Assembly committed any errors of importance, which they have not remedied, or may not easily remedy; more easily, probably, than if divided into branches? And if the wisdom brought by the members to the Assembly is divided into two branches, may it not be too weak in each to support a good measure, or obstruct a bad one? The division of the legislature into two or three branches in England, was it the product of wisdom, or the effect of necessity, arising from the preëxisting prevalence of an odious feudal system? which government, notwithstanding this division, is now become, in fact, an absolute monarchy; since the * * * *, by bribing the representatives with the people's money, carries, by his ministers, all the measures that please him; which is equivalent to governing without a Parliament, and renders the machine of government much more complex and expensive, and, from its being more complex, more easily put out of order. Has not the famous political fable of the snake, with two heads and one body, some useful instruction contained in it? She was going to a brook to drink, and in her way was to pass through a hedge, a twig of which opposed her direct course; one head chose to go on the right side of the twig, the other on the left; so that time was spent in the contest, and, before the decision was completed, the poor snake died with thirst.

"*Hence it is that the two branches should be elected by persons differently qualified; and in short, that, as far as possible, they should be made to represent different interests. Under this reason I would establish a legislature of two Houses. The upper should represent the property; the lower, the population of the State. The upper should be chosen by freemen possessing in land and houses one thousand pounds; the lower, by all such as had resided four years in the country, and paid taxes. The first should be chosen for four, the last for two years. They should be in authority coëqual.*"

Several questions may arise upon this proposition. 1st. What is the proportion of freemen possessing lands and houses of one thousand pounds' value, compared to that of freemen whose possessions are inferior? Are they as one to ten? Are they even as one to twenty? I should doubt whether they are as one to fifty. If this minority is to choose a body expressly to control that which is to be chosen by the great majority of the freemen, what have this great majority done to forfeit so great a portion of their right in elections? Why is this power of control, contrary to the spirit of all democracies, to be vested in a minority, instead of a majority? Then, is it intended, or is it not, that the rich should have a vote in the choice of members for the lower House, while those of inferior property are deprived of the right of voting for members of the upper House? And why should the upper House, chosen by a minority, have equal power with the lower chosen by a majority? Is it supposed that wisdom is the necessary concomitant of riches, and that one man worth a thousand pounds must have as much wisdom as twenty who have each only nine hundred and ninety-nine; and why is property to be represented at all? Suppose one of our Indian nations should now agree to form a civil society; each individual would bring into the stock of the society little more property than his gun and his blanket, for at present he has no other. We know, that, when one of them has attempted to keep a few swine, he has not been able to maintain a property in them, his neighbours thinking they have a right to kill and eat them whenever they want provision, it being one of their maxims that hunting is free for all; the accumulation therefore of property in such a society, and its security to individuals in every society, must be an effect of the protection afforded to it by the joint strength of the society, in the execution of its laws. Private property therefore is a creature of society, and is subject to the calls of that society, whenever its necessities shall require it, even to its last farthing; its contributions to the public exigences are not to be considered as conferring a benefit on the public, entitling the contributors to the distinctions of honor and power, but as the return of an obligation previously received, or the payment of a just debt. The combinations of civil society are not like those of a set of merchants, who club their property in different proportions for building and freighting a ship, and may therefore have some right to vote in the disposition of the voyage in a greater or less degree according to their respective contributions; but the important ends of civil society, and the personal securities of life and liberty there, remain the same in every member of the society; and the poorest continues to have an equal claim to them with the most opulent, whatever difference time, chance, or industry may occasion in their circumstances. On these considerations, I am sorry to see the signs this paper I have been considering affords, of a disposition among some of our people to commence an aristocracy, by giving the rich a predominancy in government, a choice peculiar to themselves in one half the legislature to be proudly called the UPPER House, and the other branch, chosen by the majority of the people, degraded by the denomination of the LOWER; and giving to this upper House a permanency of four years, and but two to the lower. I hope, therefore, that our Representatives in the convention will not hastily go into these innovations, but take the advice of the Prophet, "*Stand in the old ways, view the ancient paths, consider them well, and be not among those that are given to change.*"

LETTERS AND PAPERS

ON

ELECTRICITY.

ELECTRICITY.

By the brilliant discoveries of Dr. Franklin in electricity he was first known as a philosopher; and his fame was widely extended in Europe, on account of these discoveries, before he had risen to eminence in his own country. His attention was drawn to this subject rather by accident, than by any previous study or knowledge of facts. Being at Boston in the year 1746, he met there a Dr. Spence, who had lately arrived from Scotland, and whom he saw perform some electrical experiments. As the subject was quite new to him, these experiments excited his curiosity. Soon after he returned to Philadelphia, the Library Company in that city received from Mr. Peter Collinson, of London, a glass tube, with instructions how to use it in making experiments. Mr. Collinson was a member of the Royal Society, devoted to the promotion of science and useful improvements. With this tube, and such additional apparatus as he invented or constructed, Franklin began a course of experiments, assisted by two or three of his friends. A history of the results was drawn up by Dr. Stuber, who resided in Philadelphia, and who seems to have written from minute and accurate information.

"His observations," says Dr. Stuber, "he communicated, in a series of letters, to his friend Collinson, the first of which is dated March 28th, 1747. In these he shows the power of points in drawing and throwing off the electrical matter, which had hitherto escaped the notice of electricians. He also made the grand discovery of a *plus* and *minus*, or of a *positive* and *negative* state of electricity. We give him the honor of this, without hesitation; although the English have claimed it for their countryman, Dr. Watson. Watson's paper is dated January 21st, 1748; Franklin's July 11th, 1747, several months prior. Shortly after, Franklin, from his principles of the *plus* and *minus* state, explained, in a satisfactory manner, the phenomena of the Leyden phial, first observed by Mr. Cuneus, or by Professor Muschenbroeck, of Leyden, which had much perplexed philosophers. He showed clearly, that, when charged, the bottle contained no more electricity than before, but that as much was taken from one side as was thrown on the other; and that, to discharge it, nothing was necessary but to produce a communication between the two sides, by which the equilibrium might be restored, and that then no signs of electricity would remain. He afterwards demonstrated, by experiments, that the electricity did not reside in the coating, as had been supposed, but in the pores of the glass itself. After a phial was charged, he removed the coating, and found that upon applying a new coating the shock might still be received. In the year 1749, he first suggested his idea of explaining the phenomena of thunder-gusts, and of the *aurora borealis*, upon electrical principles. He points out many particulars in which lightning and electricity agree; and he adduces many facts, and reasonings from facts, in support of his positions.

"In the same year, he conceived the astonishingly bold and grand idea of ascertaining the truth of his doctrine, by actually drawing down the lightning, by means of sharp-pointed iron rods, raised into the region of the clouds. Even in this uncertain state, his passion to be useful to mankind displayed itself in a powerful manner. Admitting the identity of electricity and lightning, and knowing the power of points in repelling bodies charged with electricity, and in conducting their fire silently and imperceptibly, he suggested the idea of securing houses, ships, &c., from being damaged by lightning, by erecting pointed rods, that should rise some feet above the most elevated part, and descend some feet into the ground or the water. The effect of these, he concluded, would be either to prevent a stroke by repelling the cloud beyond the striking distance, or by drawing off the electrical fire which it contained; or, if they could not effect this, they would at least conduct the electric matter to the earth, without any injury to the building.

"It was not until the summer of 1752, that he was enabled to complete his grand and unparalleled discovery by experiment. The plan which he had originally proposed was, to erect, on some high tower or other elevated place, a sentry-box, from which should rise a pointed iron rod, insulated by being fixed in a cake of resin. Electrified clouds passing over this would, he conceived, impart to it a portion of their electricity, which would be rendered evident to the senses by sparks being emitted, when a key, the knuckle, or other conductor was presented to it. Philadelphia at this time afforded no opportunity of trying an experiment of this kind. While Franklin was waiting for the erection of a spire, it occurred to him that he might have more ready access to the region of clouds by means of a common kite. He prepared one by fastening two cross sticks to a silk handkerchief, which would not suffer so much from the rain as paper. To the upright stick was affixed an iron point. The string was, as usual, of hemp, except the lower end, which was silk. Where the hempen string terminated, a key was fastened. With this apparatus, on the appearance of a thunder-gust approaching, he went out into the commons, accompanied by his son, to whom alone he communicated his intentions, well knowing the ridicule, which, too generally for the interest of science, awaits unsuccessful experiments in philosophy. He placed himself under a shed, to avoid the rain; his kite was raised, a thunder-cloud passed over it, no sign of electricity appeared. He almost despaired of success, when suddenly he observed the loose fibres of his string to move towards an erect position. He now presented his knuckle to the key, and received a strong spark. How exquisite must his sensations have been at this moment! On this experiment depended the fate of his theory. If he succeeded, his name would rank high among those who had improved science; if he failed, he must inevitably be subjected to the derision of mankind, or, what is worse, their pity, as a well-meaning man, but a weak, silly projector. The anxiety, with which he looked for the result of his experiment, may be easily conceived. Doubts and despair had begun to prevail, when the fact was ascertained, in so clear a manner, that even the most incredulous could no longer withhold their assent. Repeated sparks were drawn from the key, a phial was charged, a shock given, and all the experiments made which are usually performed with electricity.

"About a month before this period, some ingenious Frenchman had completed the discovery in the manner originally proposed by Dr. Franklin. The letters which he sent to Mr. Collinson, it is said, were refused a place in the Transactions of the Royal Society of London. However this may be, Collinson published them in a separate volume, under the title of 'New Experiments and Observations on Electricity, made at Philadelphia, in America.' They were read with avidity, and soon translated into different languages. A very incorrect French translation fell into the hands of the celebrated Buffon, who, notwithstanding the disadvantages under which the work labored, was much pleased with it, and repeated the experiments with success. He prevailed on his friend, M. Dalibard, to give his countrymen a more correct translation of the works of the American electrician. This contributed much towards spreading a knowledge of Franklin's principles in France. The King, Louis the Fifteenth, hearing of these experiments, expressed a wish to be a spectator of them. A course of experiments was given at the seat of the Duc D'Ayen, at St. Germain, by M. de Lor. The applauses, which the King bestowed upon Franklin, excited in Buffon, Dalibard, and De Lor, an earnest desire of ascertaining the truth of his theory of thunder-gusts. Buffon erected his apparatus on the tower of Montbar, M. Dalibard at Marly-la-ville, and De Lor at his house in the *Estrapade* at Paris, some of the highest ground in that capital. Dalibard's machine first showed signs of electricity. On the 10th of May, 1752, a thunder-cloud passed over it in the absence of M. Dalibard, and a number of sparks were drawn from it by Coiffier, joiner, with whom Dalibard had left directions how to proceed, and by M. Raulet, the prior of Marly-la-ville.

"An account of this experiment was given to the Royal Academy of Sciences, by M. Dalibard, in a Memoir dated May 13th, 1752. On the 18th of May, M. de Lor proved equally successful with the apparatus erected at his own house. These philosophers soon excited those of other parts of Europe to repeat the experiment; amongst whom, none signalized themselves more than Father Beccaria, of Turin, to whose observations science is much indebted. Even the cold regions of Russia were penetrated by the ardor for discovery. Professor Richmann bade fair to add much to the stock of knowledge on this subject, when an unfortunate flash from his conductor put a period to his existence. The friends of science will long remember, with regret, the amiable martyr to electricity.

"By these experiments Franklin's theory was established in the most convincing manner. When the truth of it could no longer be doubted, envy and vanity endeavoured to detract from its merit. That an American, an inhabitant of the obscure city of Philadelphia, the name of which was hardly known, should be able to make discoveries and to frame theories, which had escaped the notice of the enlightened philosophers of Europe, was too mortifying to be admitted. He must certainly have taken the idea from some one else. An American, a being of an inferior order, make discoveries! Impossible. It was said, that the Abbé Nollet, 1748, had suggested the idea of the similarity of lightning and electricity in his *Leçons de Physique.* It is true, that the Abbé mentions the idea; but he throws it out as a bare conjecture, and proposes no mode of ascertaining the truth of it. He himself acknowledges, that Franklin first entertained the bold thought of bringing lightning from the heavens, by means of pointed rods fixed in the air. The similarity of lightning and electricity is so strong, that we need not be surprised at notice being taken of it, as soon as electrical phenomena became familiar. We find it mentioned by Dr. Wall and Mr. Grey, while the science was in its infancy. But the honor of forming a regular theory of thunder-gusts, of suggesting a mode of determining the truth of it by experiments, and of putting these experiments in practice, and thus establishing the theory upon a firm and solid basis, is incontestably due to Franklin. Dalibard, who made the first experiments in France, says, that he only followed the track which Franklin had pointed out.

"It has been of late asserted, that the honor of completing the experiment with the electrical kite does not belong to Franklin. Some late English paragraphs have attributed it to some Frenchman, whose name they do not mention; and the Abbé Bertholon gives it to M. de Romas, assessor to the *Presidéal* of Nérac; the English paragraphs probably refer to the same person. But a very slight attention will convince us of the injustice of this procedure. Dr. Franklin's experiment was made in June, 1752; and his letter, giving an account of it, is dated October 19th, 1752. M. de Romas made his first attempt on the 14th of May, 1753, but was not successful until the 7th of June; a year after Franklin had completed the discovery, and when it was known to all the philosophers in Europe.

"Besides these great principles, Franklin's letters on electricity contain a number of facts and hints, which have contributed greatly towards reducing this branch of knowledge to a science. His friend, Mr. Kinnersley, communicated to him a discovery of the different kinds of electricity, excited by rubbing glass and sulphur. This, we have said, was first observed by M. Du Faye; but it was for many years neglected. The philosophers were disposed to account for the phenomena, rather from a difference in the quantity of electricity collected; and even Du Faye himself seems at last to have adopted this doctrine. Franklin at first entertained the same idea; but, upon repeating the experiments, he perceived that Mr. Kinnersley was right; and that the *vitreous* and *resinous* electricity of Du Faye were nothing more than the *positive* and *negative* states, which he had before observed; and that the glass globe charged *positively*, or increased the quantity of electricity on the prime conductor, while the globe of sulphur diminished its natural quantity, or charged *negatively*. These experiments and observations opened a new field for investigation, upon which electricians entered with avidity; and their labors have added much to the stock of our knowledge.

"In September, 1752, Franklin entered upon a course of experiments, to determine the state of electricity in the clouds. From a number of experiments he formed this conclusion; 'That the clouds of a thunder-gust are most commonly in a negative state of electricity, but sometimes in a positive state;' and from this it follows, as a necessary consequence, 'that, for the most part, in thunder-strokes, it is the earth that strikes into the clouds, and not the clouds that strike into the earth.' The letter containing these observations is dated in September, 1753; and yet the discovery of ascending thunder has been said to be of a modern date, and has been attributed to the Abbé Bertholon, who published his memoir on the subject in 1776.

"Franklin's letters have been translated into most of the European languages, and into Latin. In proportion as they have become known, his principles have been adopted. Some opposition was made to his theories, particularly by the Abbé Nollet, who was, however, but feebly supported, while the first philosophers in Europe stepped forth in defence of Franklin's principles, amongst whom Dalibard and Beccaria were the most distinguished. The opposition has gradually ceased, and the Franklinian system is now universally adopted, where science flourishes."

In speaking of the first publication of his papers on electricity, Franklin himself says; "Obliged as we were to Mr. Collinson for the present of the tube, &c., I thought it right he should be informed of our success in using it, and wrote him several letters containing accounts of our experiments. He got them read in the Royal Society, where they were not at first thought worth so much notice as to be printed in their Transactions. One paper, which I wrote for Mr. Kinnersley, on the sameness of lightning with electricity, I sent to Mr. Mitchel, an acquaintance of mine, and one of the members also of that Society; who wrote me word, that it had been read, but was laughed at by the connoisseurs. The papers, however, being shown to Dr. Fothergill, he thought them of too much value to be stifled, and advised the printing of them. Mr. Collinson then gave them to Cave for publication, in his *Gentleman's Magazine;* but he chose to print them separately in a pamphlet, and Dr. Fothergill wrote the preface. Cave, it seems, judged rightly for his profession; for, by the additions that arrived afterwards, they swelled to a quarto volume, which has had five editions, and cost him nothing for copy-money."

The following is an extract from the Preface to the first edition of the pamphlet published by Cave, as above mentioned.

"It may be necessary to acquaint the reader, that the following observations and experiments were not drawn up with a view to their being made public, but were communicated at different times, and most of them in letters, written on various topics, as matters only of private amusement.

"But some persons, to whom they were read, and who had themselves been conversant in electrical disquisitions, were of opinion, they contained so many curious and interesting particulars relative to this affair, that it would be doing a kind of injustice to the public, to confine them solely to the limits of a private acquaintance.

"The editor was therefore prevailed upon to commit such extracts of letters and other detached pieces as were in his hands to the press, without waiting for the ingenious author's permission so to do; and this was done with the less hesitation, as it was apprehended the author's engagements in other affairs would scarce afford him leisure to give the public his reflections and experiments on the subject, finished with that care and precision, of which the treatise before us shows he is alike studious and capable."

Dr. Priestley, in his *History of Electricity*, published in the year 1767, gives a full account of Franklin's experiments and discoveries. "Nothing was ever written upon the subject of electricity," he says, "which was more generally read and admired in all parts of Europe, than these letters. There is hardly any European language into which they have not been translated; and, as if this were not sufficient to make them properly known, a translation of them has lately been made into Latin. It is not easy to say, whether we are most pleased with the simplicity and perspicuity with which these letters are written, the modesty with which the author proposes every hypothesis of his own, or the noble frankness with which he relates his mistakes, when they were corrected by subsequent experiments.

"Though the English have not been backward in acknowledging the great merit of this philosopher, he has had the singular good fortune to be, perhaps, even more celebrated abroad than at home; so that, to form a just idea of the great and deserved reputation of Dr. Franklin, we must read the foreign publications on the subject of electricity; in many of which the terms *Franklinism*, *Franklinist*, and the *Franklinian system*, occur in almost every page. In consequence of this, Dr. Franklin's principles bid fair to be handed down to posterity as equally expressive of the true principles of electricity, as the *Newtonian philosophy* is of the true system of nature in general."

The observations and theories of Franklin met with high favor in France, where his experiments were repeated, and the results verified to the admiration of the scientific world. In the year 1753, his friend, Peter Collinson, wrote to him from London; "The King of France strictly commands the Abbé Mazéas to write a letter in the politest terms to the Royal Society, to return the King's thanks and compliments, in an express manner, to Mr. Franklin of Pennsylvania, for his useful discoveries in electricity, and the application of pointed rods to prevent the terrible effects of thunder-storms." And the same Mr. Collinson wrote as follows to the Reverend Jared Eliot, of Connecticut, in a letter dated, London, November 22d, 1753. "Our friend Franklin will be honored on St. Andrew's day, the 30th instant, the anniversary of the Royal Society, when the Right Honorable the Earl of Macclesfield will make an oration on Mr. Franklin's new discoveries in electricity, and, as a reward and encouragement, will bestow on him a gold medal." This ceremony accordingly took place, and the medal was conferred.

The best translation of Franklin's papers on electricity is that in French by M. Dubourg, published at Paris in two elegant quarto volumes, in the year 1773. Several of his other philosophical writings, and some of his political pieces, are also included in these volumes, with valuable additions and remarks by the learned translator. Letters and other original papers were transmitted by Dr. Franklin to M. Dubourg, and appeared for the first time in his translation. — Editor.

TO PETER COLLINSON.

Introductory Letter.

Philadelphia, 28 March, 1747.

Sir,

Your kind present of an electric tube, with directions for using it, has put several of us on making electrical experiments, in which we have observed some particular phenomena, that we look upon to be new. I shall therefore communicate them to you in my next, though possibly they may not be new to you; as, among the numbers daily employed in those experiments on your side the water, it is probable some one or other has hit on the same observations. For my own part, I never was before engaged in any study that so totally engrossed my attention and my time, as this has lately done; for what with making experiments when I can be alone, and repeating them to my friends and acquaintance, who, from the novelty of the thing, come continually in crowds to see them, I have, during some months past, had little leisure for any thing else.

I am, &c.

B. FRANKLIN.

TO PETER COLLINSON.

Wonderful Effect of Points.—Positive and Negative Electricity.—Electrical Kiss.—Counterfeit Spider.—Simple and commodious Electrical Machine.

Philadelphia, 11 July, 1747.

SIR,

In my last I informed you that, in pursuing our electrical inquiries, we had observed some particular phenomena, which we looked upon to be new, and of which I promised to give you some account, though I apprehended they might not possibly be new to you, as so many hands are daily employed in electrical experiments on your side the water, some or other of which would probably hit on the same observations.

The first is the wonderful effect of pointed bodies, both in *drawing off* and *throwing off* the electrical fire. For example,

Place an iron shot, of three or four inches diameter, on the mouth of a clean, dry glass bottle. By a fine silken thread from the ceiling, right over the mouth of the bottle, suspend a small cork ball, about the bigness of a marble; the thread of such a length, as that the cork ball may rest against the side of the shot. Electrify the shot, and the ball will be repelled to the distance of four or five inches, more or less, according to the quantity of electricity. When in this state, if you present to the shot, the point of a long, slender, sharp bodkin, at six or eight inches distance, the repellency is instantly destroyed, and the cork flies to the shot. A blunt body must be brought within an inch, and draw a spark, to produce the same effect. To prove that the electrical fire is *drawn off* by the point, if you take the blade of the bodkin out of the wooden handle, and fix it in a stick of sealing-wax, and then present it at the distance aforesaid, or if you bring it very near, no such effect follows; but sliding one finger along the wax till you touch the blade, and the ball flies to the shot immediately. If you present the point in the dark, you will see, sometimes at a foot distance and more, a light gather upon it, like that of a fire-fly, or glow-worm; the less sharp the point, the nearer you must bring it to observe the light; and, at whatever distance you see the light, you may draw off the electrical fire, and destroy the repellency. If a cork ball so suspended be repelled by the tube, and a point be presented quick to it, though at a considerable distance, it is surprising to see how suddenly it flies back to the tube. Points of wood will do near as well as those of iron, provided the wood is not dry; for perfectly dry wood will no more conduct electricity than sealing-wax.

To show that points will *throw off** as well as *draw*

* This power of points to *throw off* the electrical fire, was first communicated to me by my ingenious friend, Mr. Thomas Hopkinson, since

off the electrical fire; lay a long sharp needle upon the shot, and you cannot electrize the shot so as to make it repel the cork ball. Or fix a needle to the end of a suspended gun-barrel, or iron rod, so as to point beyond it like a little bayonet;* and, while it remains there, the gun-barrel, or rod, cannot by applying the tube to the other end be electrized so as to give a spark, the fire continually running out silently at the point. In the dark you may see it make the same appearance as it does in the case before mentioned.

The repellency between the cork ball and the shot is likewise destroyed; 1st, by sifting fine sand on it; this does it gradually; 2dly, by breathing on it; 3dly, by making a smoke about it from burning wood; † 4thly, by candle-light, even though the candle is at a foot distance; these do it suddenly. The light of a bright coal from a wood fire, and the light of a red-hot iron do it likewise; but not at so great a distance. Smoke, from dry rosin dropped on hot iron, does not destroy the repellency; but is attracted by both shot and cork ball, forming proportionable atmospheres round them, making them look beautifully, somewhat like some of the figures in Burnet's or Whiston's *Theory of the Earth.*

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deceased, whose virtue and integrity, in every station of life, public and private, will ever make his memory dear to those who knew him, and knew how to value him.

* This was Mr. Hopkinson's experiment, made with an expectation of drawing a more sharp and powerful spark from the point, as from a kind of focus, and he was surprised to find little or none.

† We suppose every particle of sand, moisture, or smoke, being first attracted and then repelled, carries off with it a portion of the electrical fire; but that the same still subsists in those particles, till they communicate it to something else, and that it is never really destroyed. So, when water is thrown on common fire, we do not imagine the element is thereby destroyed or annihilated, but only dispersed, each particle of water carrying off in vapor its portion of the fire, which it had attracted and attached to itself.

N. B. This experiment should be made in a closet, where the air is very still, or it will be apt to fail.

The light of the sun thrown strongly on both cork and shot by a looking-glass, for a long time together, does not impair the repellency in the least. This difference between fire-light and sun-light is another thing that seems new and extraordinary to us.*

We had for some time been of opinion, that the electrical fire was not created by friction, but collected, being really an element diffused among, and attracted by, other matter, particularly by water and metals. We had even discovered and demonstrated its afflux to the electrical sphere, as well as its efflux, by means of little, light windmill-wheels made of stiff paper vanes, fixed obliquely, and turning freely on fine wire axes; also by little wheels, of the same matter, but formed like water-wheels. Of the disposition and application of which wheels, and the various phenomena resulting, I could, if I had time, fill you a sheet.† The impossibility of electrizing one's self (though standing on wax) by rubbing the tube, and drawing the fire from it; and the manner of doing it, by passing the tube near a person or thing standing on the floor, &c., had also occurred to us some months before Mr. Watson's ingenious *Sequel* came to hand; and these were some of the

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* This different effect probably did not arise from any difference in the light, but rather from the particles separated from the candle, being first attracted and then repelled, carrying off the electric matter with them; and from the rarefying the air, between the glowing coal or red-hot iron and the electrized shot, through which rarefied air the electric fluid could more readily pass.

† These experiments with the wheels were made and communicated to me by my worthy and ingenious friend, Mr. Philip Syng; but we afterwards discovered, that the motion of those wheels was not owing to any afflux or efflux of the electric fluid, but to various circumstances of attraction and repulsion. 1750.

new things I intended to have communicated to you. But now I need only mention some particulars not hinted in that piece, with our reasonings thereupon; though perhaps the latter might well enough be spared.

1. A person standing on wax, and rubbing the tube, and another person on wax drawing the fire, they will both of them (provided they do not stand so as to touch one another) appear to be electrized, to a person standing on the floor; that is, he will perceive a spark on approaching each of them with his knuckle.

2. But, if the persons on wax touch one another during the exciting of the tube, neither of them will appeared to be electrized.

3. If they touch one another after exciting the tube, and drawing the fire as aforesaid, there will be a stronger spark between them, than was between either of them and the person on the floor.

4. After such strong spark, neither of them discover any electricity.

These appearances we attempt to account for thus. We suppose, as aforesaid, that electrical fire is a common element, of which every one of the three persons above mentioned has his equal share, before any operation is begun with the tube. *A*, who stands on wax and rubs the tube, collects the electrical fire from himself into the glass; and, his communication with the common stock being cut off by the wax, his body is not again immediately supplied. *B*, (who stands on wax likewise) passing his knuckle along near the tube, receives the fire which was collected by the glass from *A*; and his communication with the common stock being likewise cut off, he retains the additional quantity received. To *C*, standing on the floor, both appear to be electrized; for he, having only the middle quantity of electrical fire, receives a spark upon approaching *B*, who has an over quantity; but gives one to *A*, who has an under quantity. If *A* and *B* approach to touch each other, the spark is stronger, because the difference between them is greater. After such touch there is no spark between either of them and *C*, because the electrical fire in all is reduced to the original equality. If they touch while electrizing, the equality is never destroyed, the fire only circulating. Hence have arisen some new terms among us; we say *B* (and bodies like circumstanced) is electrized *positively; A, negatively.* Or rather, *B* is electrized *plus; A, minus.* And we daily in our experiments electrize bodies *plus* or *minus*, as we think proper. To electrize *plus* or *minus*, no more needs to be known than this, that the parts of the tube or sphere that are rubbed, do, in the instant of the friction, attract the electrical fire, and therefore take it from the thing rubbing; the same parts immediately, as the friction upon them ceases, are disposed to give the fire they have received to any body that has less. Thus you may circulate it, as Mr. Watson has shown; you may also accumulate or subtract it, upon or from any body, as you connect that body with the rubber, or with the receiver, the communication with the common stock being cut off. We think that ingenious gentleman was deceived, when he imagined (in his *Sequel*), that the electrical fire came down the wire from the ceiling to the gun-barrel, thence to the sphere, and so electrized the machine and the man turning the wheel, &c. We suppose it was *driven off*, and not brought on through that wire; and that the machine and man, &c., were electrized *minus*, that is, had less electrical fire in them than things in common.

As the vessel is just upon sailing, I cannot give you so large an account of American electricity as I intended; I shall only mention a few particulars more. We find granulated lead better to fill the phial with, than water, being easily warmed, and keeping warm and dry in damp air. We fire spirits with the wire of the phial. We light candles, just blown out, by drawing a spark among the smoke, between the wire and snuffers. We represent lightning, by passing the wire in the dark, over a China plate, that has gilt flowers, or applying it to gilt frames of looking-glasses, &c. We electrize a person twenty or more times running, with a touch of the finger on the wire, thus; He stands on wax. Give him the electrized bottle in his hand. Touch the wire with your finger, and then touch his hand or face; there are sparks every time.* We increase the force of the electrical kiss vastly, thus; Let *A* and *B* stand on wax; or *A* on wax, and *B* on the floor; give one of them the electrized phial in hand; let the other take hold of the wire; there will be a small spark; but when their lips approach, they will be struck and shocked. The same, if another gentleman and lady, *C* and *D*, standing also on wax, and joining hands with *A* and *B*, salute or shake hands. We suspend by fine silk thread a counterfeit spider, made of a small piece of burnt cork, with legs of linen thread, and a grain or two of lead stuck in him, to give him more weight. Upon the table, over which he hangs, we stick a wire upright, as high as the phial and wire, four or five inches from the spider; then we animate him, by setting the electrified phial at the same distance on the other side of him; he will immediately fly to the wire of the phial, bend his legs in touching it, then spring off, and fly to the wire in the table, thence again to the wire of the

* By taking a spark from the wire, the electricity within the bottle is diminished; the outside of the bottle then draws some from the person holding it, and leaves him in the negative state. Then when his hand or face is touched, an equal quantity is restored to him from the person touching.

phial, playing with his legs against both, in a very entertaining manner, appearing perfectly alive to persons unacquainted. He will continue this motion an hour or more in dry weather. We electrify, upon wax in the dark, a book that has a double line of gold round upon the covers, and then apply a knuckle to the gilding; the fire appears everywhere upon the gold like a flash of lightning; not upon the leather, nor if you touch the leather instead of the gold. We rub our tubes with buckskin, and observe always to keep the same side to the tube, and never to sully the tube by handling; thus they work readily and easily, without the least fatigue, especially if kept in tight pasteboard cases, lined with flannel, and sitting close to the tube.* This I mention, because the European papers on electricity frequently speak of rubbing the tube as a fatiguing exercise. Our spheres are fixed on iron axes, which pass through them. At one end of the axis there is a small handle, with which you turn the sphere like a common grindstone. This we find very commodious, as the machine takes up but little room, is portable, and may be enclosed in a tight box, when not in use. It is true, the sphere does not turn so swift as when the great wheel is used; but swiftness we think of little importance, since a few turns will charge the phial, &c., sufficiently.†

I am, &c.

B. FRANKLIN.

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* Our tubes are made here of green glass, twenty-seven or thirty inches long, as big as can be grasped.

† This simple, easily-made machine was a contrivance of Mr. Syng.

TO PETER COLLINSON.

Observations on the Leyden Bottle, with Experiments proving the different Electrical State of its different Surfaces.

Philadelphia, 1 September, 1747.

Sir,

The necessary trouble of copying long letters, which perhaps, when they come to your hands, may contain nothing new, or worth your reading, (so quick is the progress made with you in electricity,) half discourages me from writing any more on that subject. Yet I cannot forbear adding a few observations on M. Muschenbroek's wonderful bottle.

1. The non-electric contained in the bottle differs, when electrized, from a non-electric electrized out of the bottle, in this; that the electrical fire of the latter is accumulated *on its surface*, and forms an electrical atmosphere round it of considerable extent; but the electrical fire is crowded *into the substance* of the former, the glass confining it.*

2. At the same time that the wire and the top of the bottle, &c. is electrized *positively* or *plus*, the bottom of the bottle is electrized *negatively* or *minus*, in exact proportion; that is, whatever quantity of electrical fire is thrown in at the top, an equal quantity goes out of the bottom.† To understand this, suppose the common quantity of electricity in each part of the bottle, before

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* See this opinion rectified in § 16 and 17 of the next letter. The fire in the bottle was found by subsequent experiments not to be contained in the non-electric, but *in the glass*. 1748.

† What is said here, and after, of the *top* and *bottom* of the bottle, is true of the *inside* and *outside* surfaces, and should have been so expressed.

the operation begins, is equal to twenty; and at every stroke of the tube, suppose a quantity equal to one is thrown in; then, after the first stroke, the quantity contained in the wire and upper part of the bottle will be twenty-one, in the bottom nineteen; after the second, the upper part will have twenty-two, the lower eighteen, and so on, till, after twenty strokes, the upper part will have a quantity of electrical fire equal to forty, the lower part none; and then the operation ends; for no more can be thrown into the upper part, when no more can be driven out of the lower part. If you attempt to throw more in, it is spewed back through the wire, or flies out in loud cracks through the sides of the bottle.

3. The equilibrium cannot be restored in the bottle by *inward* communication or contact of the parts; but it must be done by a communication formed *without* the bottle, between the top and bottom, by some non-electric, touching or approaching both at the same time; in which case it is restored with a violence and quickness inexpressible; or touching each alternately, in which case the equilibrium is restored by degrees.

4. As no more electrical fire can be thrown into the top of the bottle, when all is driven out of the bottom, so, in a bottle not yet electrized, none can be thrown into the top, when none *can* get out at the bottom; which happens either when the bottom is too thick, or when the bottle is placed on an electric *per se*. Again, when the bottle is electrized, but little of the electrical fire can be *drawn out* from the top, by touching the wire, unless an equal quantity can at the same time *get in* at the bottom.* Thus, place an electrized bottle on clean glass or dry wax, and you will not, by touching the wire, get out the fire from the top.

* See the preceding note, relating to *top* and *bottom*.

Place it on a non-electric, and touch the wire, you will get it out in a short time; but soonest when you form a direct communication as above.

So wonderfully are these two states of electricity, the *plus* and *minus*, combined and balanced in this miraculous bottle! situated and related to each other in a manner that I can by no means comprehend! If it were possible that a bottle should in one part contain a quantity of air strongly compressed, and in another part a perfect vacuum, we know the equilibrium would be instantly restored *within*. But here we have a bottle containing at the same time a *plenum* of electrical fire, and a *vacuum* of the same fire; and yet the equilibrium cannot be restored between them but by a communication *without!* though the *plenum* presses violently to expand, and the hungry vacuum seems to attract as violently in order to be filled.

5. The shock to the nerves (or convulsion rather) is occasioned by the sudden passing of the fire through the body in its way from the top to the bottom of the bottle. The fire takes the shortest * course, as Mr. Watson justly observes. But it does not appear from experiment, that, in order for a person to be shocked, a communication with the floor is necessary; for he that holds the bottle with one hand, and touches the wire with the other, will be shocked as much, though his shoes be dry, or even standing on wax, as otherwise. And, on the touch of the wire (or of the gun-barrel, which is the same thing), the fire does not proceed from the touching finger to the wire, as is supposed, but from the wire to the finger, and passes through the body to the other hand, and so into the bottom of the bottle.

* Other circumstances being equal.

Experiments confirming the above.

EXPERIMENT I.

Place an electrized phial on wax; a small cork ball, suspended by a dry silk thread, held in your hand, and brought near to the wire, will first be attracted, and then repelled; when in this state of repellency, sink your hand, that the ball may be brought towards the bottom of the bottle; it will be there instantly and strongly attracted, till it has parted with its fire.

If the bottle had a *positive* electrical atmosphere, as well as the wire, an electrified cork would be repelled from one as well as from the other.

EXPERIMENT II.

Pl. I. Fig. 1. From a bent wire (*a*) sticking in the table, let a small linen thread (*b*) hang down within half an inch of the electrized phial (*c*). Touch the wire or the phial repeatedly with your finger, and at every touch you will see the thread instantly attracted by the bottle. (This is best done by a vinegar-cruet, or some such bellied bottle.) As soon as you draw any fire out from the upper part by touching the wire, the lower part of the bottle draws an equal quantity in by the thread.

EXPERIMENT III.

Fig. 2. Fix a wire in the lead, with which the bottom of the bottle is armed (*d*), so as that, bending upwards, its ring-end may be level with the top or ring-end of the wire in the cork (*e*), and at three or four inches distance. Then electrize the bottle, and place it on wax. If a cork, suspended by a silk thread (*f*), hang between these two wires, it will play incessantly

from one to the other, till the bottle is no longer electrized; that is, it fetches and carries fire from the top to the bottom * of the bottle, till the equilibrium is restored.

EXPERIMENT IV.

FIG. 3. Place an electrized phial on wax; take a wire (*g*) in form of a *C*, the ends at such a distance when bent, as that the upper may touch the wire of the bottle, when the lower touches the bottom; stick the outer part on a stick of sealing-wax (*h*), which will serve as a handle; then apply the lower end to the bottom of the bottle, and gradually bring the upper end near the wire in the cork. The consequence is, spark follows spark till the equilibrium is restored. Touch the top first, and, on approaching the bottom with the other end, you have a constant stream of fire from the wire entering the bottle. Touch the top and bottom together, and the equilibrium will instantly be restored, the crooked wire forming the communication.

EXPERIMENT V.

FIG. 4. Let a ring of thin lead, or paper, surround a bottle (*i*), even at some distance from or above the bottom. From that ring let a wire proceed up, till it touch the wire of the cork (*k*). A bottle so fixed cannot by any means be electrized; the equilibrium is never destroyed; for while the communication between the upper and lower parts of the bottle is continued by the outside wire, the fire only circulates; what is driven out at bottom, is constantly supplied from the top.* Hence a bottle cannot be electrized, that is foul or

* See the preceding note, relating to *top* and *bottom*.

moist on the outside, if such moisture continue up to the cork or wire.

EXPERIMENT VI.

Place a man on a cake of wax, and present him the wire of the electrified phial to touch, you standing on the floor, and holding it in your hand. As often as he touches it, he will be electrified *plus;* and any one standing on the floor may draw a spark from him. The fire in this experiment passes out of the wire into him; and at the same time out of your hand into the bottom of the bottle.

EXPERIMENT VII.

Give him the electrical phial to hold; and do you touch the wire; as often as you touch it, he will be electrified *minus*, and may draw a spark from any one standing on the floor. The fire now passes from the wire to you, and from him into the bottom of the bottle.

EXPERIMENT VIII.

Lay two books on two glasses, back towards back, two or three inches distant. Set the electrified phial on one, and then touch the wire; that book will be electrified *minus;* the electrical fire being drawn out of it by the bottom of the bottle. Take off the bottle, and, holding it in your hand, touch the other with the wire; that book will be electrified *plus;* the fire passing into it from the wire, and the bottle at the same time supplied from your hand. A suspended small cork ball will play between these books till the equilibrium is restored.

EXPERIMENT IX.

When a body is electrized *plus*, it will repel a positively electrified feather or small cork ball. When *minus* (or when in the common state), it will attract them, but stronger when *minus* than when in the common state, the difference being greater.

EXPERIMENT X.

Though, as in *Experiment* VI, a man standing on wax may be electrized a number of times by repeatedly touching the wire of an electrized bottle (held in the hand of one standing on the floor), he receiving the fire from the wire each time; yet holding it in his own hand, and touching the wire, though he draws a strong spark, and is violently shocked, no electricity remains in him; the fire only passing through him, from the upper to the lower part of the bottle. Observe, before the shock, to let some one on the floor touch him to restore the equilibrium in his body; for, in taking hold of the bottom of the bottle, he sometimes becomes a little electrized *minus*, which will continue after the shock, as would also any *plus* electricity, which he might have given him before the shock. For restoring the equilibrium in the bottle does not at all affect the electricity in the man through whom the fire passes; that electricity is neither increased nor diminished

EXPERIMENT XI.

The passing of the electrical fire from the upper to the lower part* of the bottle, to restore the equilibrium, is rendered strongly visible by the following pretty experiment. Take a book whose covering is filleted with gold; bend a wire of eight or ten inches long, in the form of (*m*), Fig. 5; slip it on the end of the cover of the book, over the gold line, so as that the shoulder of it may press upon one end of the gold line, the ring

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* That is, from the *inside* to the *outside*.

up, but leaning towards the other end of the book. Lay the book on a glass or wax,* and on the other end of the gold lines set the bottle electrized; then bend the springing wire, by pressing it with a stick of wax, till its ring approaches the ring of the bottle wire; instantly there is a strong spark and stroke, and the whole line of gold, which completes the communication between the top and bottom of the bottle, will appear a vivid flame, like the sharpest lightning. The closer the contact between the shoulder of the wire and the gold at one end of the line, and between the bottom of the bottle and the gold at the other end, the better the experiment succeeds. The room should be darkened. If you would have the whole filleting round the cover appear in fire at once, let the bottle and wire touch the gold in the diagonally opposite corners.

I am, &c.

B. FRANKLIN.

TO PETER COLLINSON.

Farther Experiments confirming the preceding Observations. — Leyden Bottle analyzed. — Electrical Battery. — Magical Picture. — Electrical Wheel or Jack. — Electrical Feast.

Philadelphia, 1748.

SIR,

§ 1. There will be the same explosion and shock if the electrified phial is held in one hand by the hook, and the coating touched with the other, as when held by the coating, and touched at the hook.

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* Placing the book on glass or wax is not necessary to produce the appearance; it is only to show that the visible electricity is not brought up from the common stock in the earth.

Plate 1

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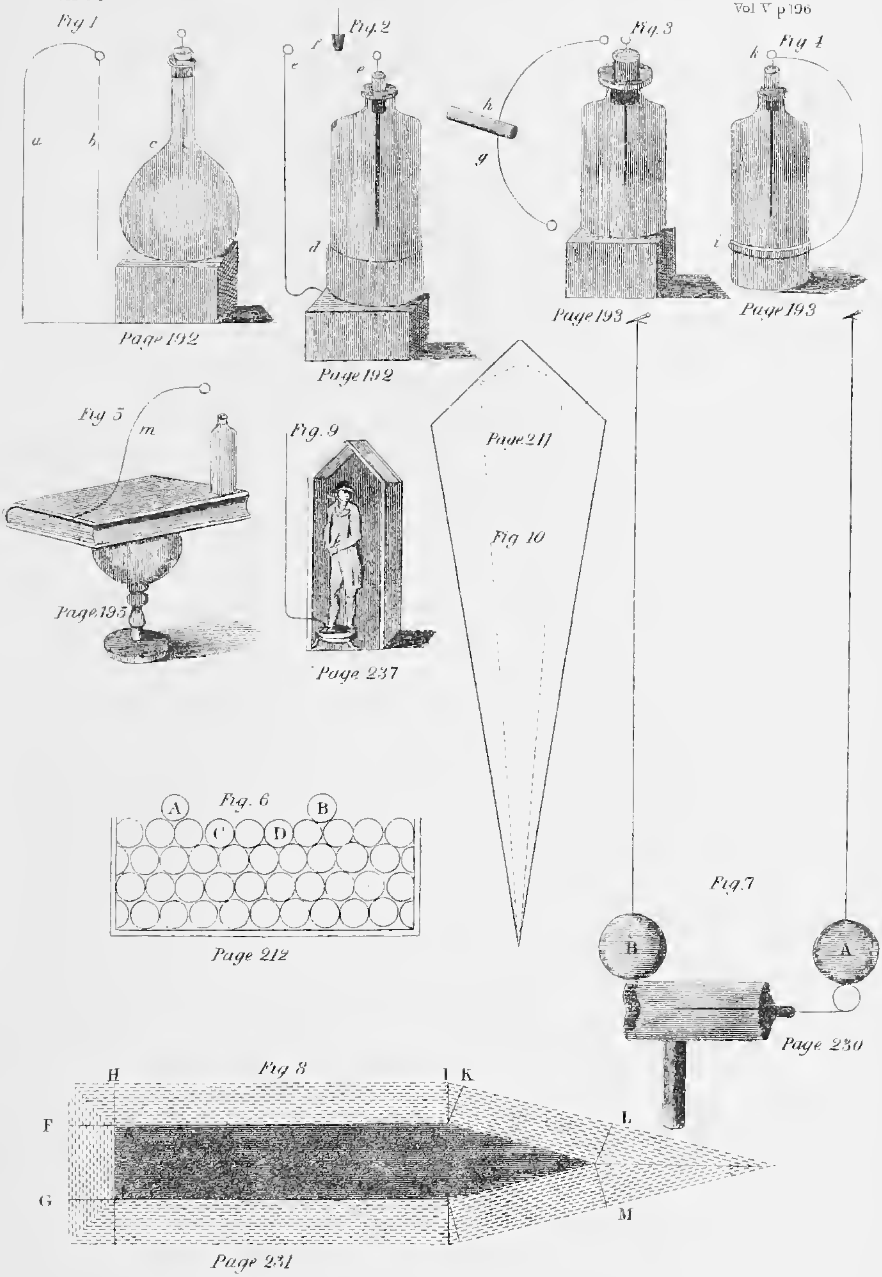

In this experiment the bottles are totally discharged, or the equilibrium within them restored. The *abounding* of fire in one of the hooks (or rather in the internal surface of one bottle) being exactly equal to the *wanting* of the other; and therefore, as each bottle has in itself the *abounding* as well as the *wanting*, the wanting and abounding must be equal in each bottle. See § 8, 9, 10, 11. But if a man holds in his hands two bottles, one fully electrified, the other not at all, and brings their hooks together, he has but half a shock, and the bottles will both remain half electrified, the one being half discharged, and the other half charged.

7. Place two phials equally charged on a table, at five or six inches distance. Let a cork ball, suspended by a silk thread, hang between them. If the phials were both charged through their hooks, the cork, when it has been attracted and repelled by the one, will not be attracted, but equally repelled by the other. But, if the phials were charged, the one through the hook, and the other through the coating,* the ball, when it is repelled from one hook, will be as strongly attracted by the other, and play vigorously between them, fetching the electric fluid from the one, and delivering it to the other, till both phials are nearly discharged.

8. When we use the terms of *charging* and *discharging* the phial, it is in compliance with custom, and for want of others more suitable. Since we are of opinion, that there is really no more electrical fire in the phial after what is called its *charging*, than before, nor less after its *discharging;* excepting only the small spark

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* To charge a bottle commodiously through the coating, place it on a glass stand; form a communication from the prime conductor to the coating, and another from the hook to the wall or floor. When it is charged, remove the latter communication before you take hold of the bottle otherwise great part of the fire will escape by it.

that might be given to, and taken from, the non-electric matter, if separated from the bottle, which spark may not be equal to a five-hundredth part of what is called the explosion.

For if, on the explosion, the electrical fire came out of the bottle by one part, and did not enter in again by another, then, if a man, standing on wax, and holding the bottle in one hand, takes the spark by touching the wire hook with the other, the bottle being thereby *discharged*, the man would be *charged;* or whatever fire was lost by one, would be found in the other, since there was no way for its escape; but the contrary is true.

9. Besides, the phial will not suffer what is called a *charging*, unless as much fire can go out of it one way, as is thrown in by another. A phial cannot be charged standing on wax or glass, or hanging on the prime conductor, unless a communication be formed between its coating and the floor.

10. But suspend two or more phials on the prime conductor, one hanging on the tail of the other; and a wire from the last to the floor, an equal number of turns of the wheel shall charge them all equally, and every one as much as one alone would have been; what is driven out at the tail of the first, serving to charge the second; what is driven out of the second charging the third; and so on. By this means a great number of bottles might be charged with the same labor, and equally high, with one alone; were it not that every bottle receives new fire, and loses its old with some reluctance, or rather gives some small resistance to the charging, which in a number of bottles becomes more equal to the charging power, and so repels the fire back again on the globe, sooner in proportion than a single bottle would do.

11. When a bottle is charged in the common way, its *inside* and *outside surfaces* stand ready, the one to give fire by the hook, the other to receive it by the coating; the one is full and ready to throw out, the other empty and extremely hungry; yet, as the first will not *give out*, unless the other can at the same instant *receive in*, so neither will the latter receive in, unless the first can at the same instant give out. When both can be done at once, it is done with inconceivable quickness and violence.

12. So a straight spring (though the comparison does not agree in every particular), when forcibly bent, must, to restore itself, contract that side which in the bending was extended, and extend that which was contracted; if either of these two operations be hindered, the other cannot be done. But the spring is not said to be *charged* with elasticity when bent, and *discharged* when unbent; its quantity of elasticity is always the same.

13. Glass, in like manner, has within its substance always the same quantity of electrical fire, and that a very great quantity in proportion to the mass of glass, as shall be shown hereafter.

14. This quantity, proportioned to the glass, it strongly and obstinately retains, and will have neither more nor less, though it will suffer a change to be made in its parts and situation; that is, we may take away part of it from one of the sides, provided we throw an equal quantity into the other.

15. Yet, when the situation of the electrical fire is thus altered in the glass; when some has been taken from one side, and some added to the other, it will not be at rest, or in its natural state, till it is restored to its original equality. And this restitution cannot be made through the substance of the glass, but must be done by a non-electric communication formed without, from surface to surface.

16. Thus, the whole force of the bottle, and power of giving a shock, is in the *glass itself;* the non-electrics in contact with the two surfaces, serving only to *give* and *receive* to and from the several parts of the glass; that is, to give on one side, and take away from the other.

17. This was discovered here in the following manner; purposing to analyze the electrified bottle, in order to find wherein its strength lay, we placed it on glass, and drew out the cork and wire, which for that purpose had been loosely put in. Then taking the bottle in one hand, and bringing a finger of the other near its mouth, a strong spark came from the water, and the shock was as violent as if the wire had remained in it, which showed that the force did not lie in the wire. Then, to find if it resided in the water, being crowded into and condensed in it, as confined by the glass, which had been our former opinion, we electrified the bottle again, and, placing it on glass, drew out the wire and cork as before; then, taking up the bottle, we decanted all its water into an empty bottle, which likewise stood on glass; and taking up that other bottle, we expected, if the force resided in the water, to find a shock from it; but there was none. We judged then, that it must either be lost in decanting, or remain in the first bottle. The latter we found to be true; for that bottle on trial gave the shock, though filled up as it stood with fresh unelectrified water from a tea-pot. To find, then, whether glass had this property merely as glass, or whether the form contributed any thing to it, we took a pane of sash-glass, and, laying it on the hand, placed a plate of lead on its upper surface; then electrified that plate, and bringing a finger to it, there was a spark and shock. We then took two plates of lead of equal dimensions, but less

than the glass by two inches every way, and electrified the glass between them, by electrifying the uppermost lead; then separated the glass from the lead, in doing which, what little fire might be in the lead was taken out, and the glass being touched in the electrified parts with a finger, afforded only very small pricking sparks, but a great number of them might be taken from different places. Then dexterously placing it again between the leaden plates, and completing a circle between the two surfaces, a violent shock ensued. Which demonstrated the power to reside in glass as glass, and that the non-electrics in contact served only, like the armature of a loadstone, to unite the force of the several parts, and bring them at once to any point desired; it being the property of a non-electric, that the whole body instantly receives or gives what electrical fire is given to, or taken from, any one of its parts.

18. Upon this we made what we called an *electrical battery*, consisting of eleven panes of large sash-glass, armed with thin leaden plates, pasted on each side, placed vertically, and supported at two inches distance on silk cords, with thick hooks of leaden wire, one from each side, standing upright, distant from each other, and convenient communications of wire and chain, from the giving side of one pane, to the receiving side of the other; that so the whole might be charged together, and with the same labor as one single pane; and another contrivance to bring the giving sides, after charging, in contact with one long wire, and the receivers with another, which two long wires would give the force of all the plates of glass at once through the body of any animal forming the circle with them. The plates may also be discharged separately, or any number together that is required. But this

machine is not much used, as not perfectly answering our intention with regard to the ease of charging, for the reason given, § 10. We made also, of large glass panes, magical pictures, and self-moving animated wheels, presently to be described.

19. I perceive by the ingenious Mr. Watson's last book, lately received, that Dr. Bevis had used, before we had, panes of glass to give a shock;* though, till that book came to hand, I thought to have communicated it to you as a novelty. The excuse for mentioning it here is, that we tried the experiment differently, drew different consequences from it (for Mr. Watson still seems to think the fire *accumulated on the non-electric* that is in contact with the glass, p. 72) and, as far as we hitherto know, have carried it farther.

20. The magical picture † is made thus. Having a large mezzotinto with a frame and glass, suppose of the KING (God preserve him), take out the print, and cut a pannel out of it near two inches distant from the frame all round. If the cut is through the picture, it is not the worse. With thin paste, or gum-water, fix the border that is cut off on the inside the glass, pressing it smooth and close; then fill up the vacancy by gilding the glass well with leaf-gold or brass. Gild likewise the inner edge of the back of the frame all round, except the top part, and form a communication between that gilding and the gilding behind the glass; then put in the board, and that side is finished. Turn up the glass, and gild the fore side exactly over the back gilding, and when it is dry, cover it by pasting on the pannel of the picture that hath been cut out, observing to bring the correspondent parts of the border

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* I have since heard, that Mr. Smeaton was the first who made use of panes of glass for that purpose.

† Contrived by Mr. Kinnersley.

and picture together, by which the picture will appear of a piece, as at first, only part is behind the glass, and part before. Hold the picture horizontally by the top, and place a little movable gilt crown on the King's head. If now the picture be moderately electrified, and another person take hold of the frame with one hand, so that his fingers touch its inside gilding, and with the other hand endeavour to take off the crown, he will receive a terrible blow, and fail in the attempt. If the picture were highly charged, the consequence might perhaps be as fatal* as that of high treason; for, when the spark is taken through a quire of paper laid on the picture by means of a wire communication, it makes a fair hole through every sheet, that is, through forty-eight leaves, though a quire of paper is thought good armour against the push of a sword, or even against a pistol bullet, and the crack is exceeding loud. The operator, who holds the picture by the upper end, where the inside of the frame is not gilt, to prevent its falling, feels nothing of the shock, and may touch the face of the picture without danger, which he pretends is a test of his loyalty. If a ring of persons take the shock among them, the experiment is called *The Conspirators*.

21. On the principle, in § 7, that hooks of bottles, differently charged, will attract and repel differently, is made an electrical wheel, that turns with considerable strength. A small upright shaft of wood passes at right angles through a thin round board, of about twelve inches diameter, and turns on a sharp point of iron, fixed in the lower end, while a strong wire in the upper end, passing through a small hole in a thin brass plate, keeps the shaft truly vertical. About thirty *radii*

* We have since found it fatal to small animals, though not to large ones. The biggest we have yet killed is a hen. 1750.

of equal length, made of sash-glass, cut in narrow strips, issue horizontally from the circumference of the board, the ends most distant from the centre being about four inches apart. On the end of every one, a brass thimble is fixed. If now the wire of a bottle, electrified in the common way, be brought near the circumference of this wheel, it will attract the nearest thimble, and so put the wheel in motion; that thimble, in passing by, receives a spark, and thereby being electrified is repelled, and so driven forwards; while a second, being attracted, approaches the wire, receives a spark, and is driven after the first, and so on till the wheel has gone once round, when the thimbles before electrified approaching the wire, instead of being attracted as they were at first, are repelled, and the motion presently ceases. But if another bottle, which had been charged through the coating, be placed near the same wheel, its wire will attract the thimble repelled by the first, and thereby double the force that carries the wheel round; and, not only taking out the fire that had been communicated to the thimbles by the first bottle, but even robbing them of their natural quantity, instead of being repelled when they come again towards the first bottle, they are more strongly attracted, so that the wheel mends its pace, till it goes with great rapidity, twelve or fifteen rounds in a minute, and with such strength, as that the weight of one hundred Spanish dollars, with which we once loaded it, did not seem in the least to retard its motion. This is called an electrical jack; and, if a large fowl were spitted on the upright shaft, it would be carried round before a fire with a motion fit for roasting.

22. But this wheel, like those driven by wind, water, or weights, moves by a foreign force, to wit, that of the bottles. The self-moving wheel, though constructed

on the same principles, appears more surprising. It is made of a thin, round plate of window-glass, seventeen inches diameter, well gilt on both sides, all but two inches next the edge. Two small hemispheres of wood are then fixed with cement to the middle of the upper and under sides, centrally opposite, and in each of them a thick strong wire eight or ten inches long, which together make the axis of the wheel. It turns horizontally on a point at the lower end of its axis, which rests on a bit of brass cemented within a glass salt-cellar. The upper end of its axis passes through a hole in a thin brass plate cemented to a long strong piece of glass, which keeps it six or eight inches distant from any non-electric, and has a small ball of wax or metal on its top, to keep in the fire. In a circle on the table which supports the wheel, are fixed twelve small pillars of glass, at about four inches distance, with a thimble on the top of each. On the edge of the wheel is a small leaden bullet, communicating by a wire with the gilding of the *upper* surface of the wheel; and about six inches from it is another bullet, communicating in like manner with the *under* surface. When the wheel is to be charged by the upper surface, a communication must be made from the under surface to the table. When it is well charged, it begins to move; the bullet nearest to a pillar moves towards the thimble on that pillar, and passing by electrifies it, and then pushes itself from it; the succeeding bullet, which communicates with the other surface of the glass, more strongly attracts that thimble, on account of its being before electrified by the other bullet; and thus the wheel increases its motion till it comes to such a height that the resistance of the air regulates it. It will go half an hour, and make, one minute with another, twenty turns in a minute, which is six hundred turns in the whole; the bullet of the upper surface giving in each turn twelve sparks to the thimbles, which makes seven thousand two hundred sparks; and the bullet of the under surface receiving as many from the thimbles; those bullets moving in the time near two thousand five hundred feet. The thimbles are well fixed, and in so exact a circle, that the bullets may pass within a very small distance of each of them. If, instead of two bullets, you put eight, four communicating with the upper surface and four with the under surface, placed alternately, which eight at about six inches distance completes the circumference, the force and swiftness will be greatly increased, the wheel making fifty turns in a minute; but then it will not continue moving so long. These wheels may be applied, perhaps, to the ringing of chimes,* and moving of light-made orreries.

23. A small wire bent circularly, with a loop at each end; let one end rest against the under surface of the wheel, and bring the other end near the upper surface, it will give a terrible crack, and the force will be discharged.

24. Every spark in that manner drawn from the surface of the wheel, makes a round hole in the gilding, tearing off a part of it in coming out; which shows that the fire is not accumulated on the gilding, but is in the glass itself.

25. The gilding being varnished over with turpentine varnish, the varnish, though dry and hard, is burnt by the spark drawn through it, and gives a strong smell and visible smoke. And, when the spark is drawn through paper, all round the hole made by it, the paper will be blacked by the smoke, which sometimes penetrates several of the leaves. Part of the

* This was afterwards done with success by Mr. Kinnersley.

gilding torn off is also found forcibly driven into the hole made in the paper by the stroke.

26. It is amazing to observe in how small a portion of glass a great electrical force may lie. A thin glass bubble, about an inch diameter, weighing only six grains, being half filled with water, partly gilt on the outside, and furnished with a wire hook, gives, when electrified, as great a shock as a man can well bear. As the glass is thickest near the orifice, I suppose the lower half, which, being gilt, was electrified and gave the shock, did not exceed two grains; for it appeared, when broken, much thinner than the upper half. If one of these thin bottles be electrified by the coating, and the spark taken out through the gilding, it will break the glass inwards, at the same time that it breaks the gilding outwards.

27. And allowing (for the reasons before given, § 8, 9, 10,) that there is no more electrical fire in a bottle after charging than before, how great must be the quantity in this small portion of glass! It seems as if it were of its very substance and essence. Perhaps if that due quantity of electrical fire so obstinately retained by glass, could be separated from it, it would no longer be glass; it might lose its transparency, or its brittleness, or its elasticity. Experiments may possibly be invented hereafter to discover this.

28. We were surprised at the account, given in Mr. Watson's book, of a shock communicated through a great space of dry ground, and suspect there must be some metalline quality in the gravel of that ground; having found that simply dry earth, rammed in a glass tube, open at both ends, and a wire hook inserted in the earth at each end, the earth and wires making part of a circuit, would not conduct the least perceptible shock; and, indeed, when one wire was electrified, the

other hardly showed any signs of its being in connexion with it.* Even a thoroughly wet packthread sometimes fails of conducting a shock, though it otherwise conducts electricity very well. A dry cake of ice, or an icicle held between two in a circle, likewise prevents the shock, which one would not expect, as water conducts it so perfectly well. Gilding on a new book, though at first it conducts the shock extremely well, yet fails after ten or a dozen experiments, though it appears otherwise in all respects the same, which we cannot account for.†

29. There is one experiment more which surprises us, and is not hitherto satisfactorily accounted for; it is this. Place an iron shot on a glass stand, and let a ball of damp cork, suspended by a silk thread, hang in contact with the shot. Take a bottle in each hand, one that is electrified through the hook, the other through the coating; apply the giving wire to the shot, which will electrify it *positively*, and the cork shall be repelled; then apply the requiring wire, which will take out the spark given by the other; when the cork will return to the shot; apply the same again, and take out another spark, so will the shot be electrified *negatively*, and the cork in that case shall be repelled equally as before. Then apply the giving wire to the shot, and give the spark it wanted, so will the cork return; give it another, which will be an addition to its natural

* Probably the ground is never so dry.

† We afterwards found, that it failed after one stroke with a large bottle; and the continuity of the gold appearing broken, and many of its parts dissipated, the electricity could not pass the remaining parts without leaping from part to part through the air, which always resists the motion of this fluid, and was probably the cause of the gold's not conducting so well as before; the number of interruptions in the line of gold, making, when added together, a space larger, perhaps, than the striking distance.

quantity, so will the cork be repelled again; and so may the experiment be repeated as long as there is any charge in the bottles. Which shows, that bodies having less than the common quantity of electricity repel each other, as well as those that have more.

Chagrined a little that we have been hitherto able to produce nothing in this way of use to mankind; and the hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them for this season, somewhat humorously, in a party of pleasure on the banks of the *Skuylkill.** Spirits, at the same time, are to be fired by a spark sent from side to side through the river, without any other conductor than the water; an experiment which we some time since performed, to the amazement of many.† A turkey is to be killed for our dinner by the *electrical shock*,

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* The river that washes one side of Philadelphia, as the Delaware does the other; both are ornamented with the summer habitations of the citizens, and the agreeable mansions of the principal people of this colony.

† As the possibility of this experiment has not been easily conceived, I shall here describe it. Two iron rods, about three feet long, were planted just within the margin of the river, on the opposite sides. A thick piece of wire, with a small round knob at its end, was fixed on the top of one of the rods, bending downwards, so as to deliver commodiously the spark upon the surface of the spirit. A small wire fastened by one end to the handle of the spoon, containing the spirit, was carried across the river, and supported in the air by the rope commonly used to hold by, in drawing the ferry-boats over. The other end of this wire was tied round the coating of the bottle; which being charged, the spark was delivered from the hook to the top of the rod standing in the water on that side. At the same instant the rod on the other side delivered a spark into the spoon, and fired the spirit; the electric fire returning to the coating of the bottle, through the handle of the spoon and the supported wire connected with them.

That the electric fire thus actually passes through the water, has since been satisfactorily demonstrated to many, by an experiment of Mr. Kinnersley's, performed in a trough of water about ten feet long. The hand, being placed under water in the direction of the spark (which always takes the straight or shortest course, if sufficient, and other circumstances are equal), is struck and penetrated by it as it passes.

and roasted by the *electrical jack*, before a fire kindled by the *electrified bottle;* when the healths of all the famous electricians in England, Holland, France, and Germany are to be drank in *electrified bumpers*,* under the discharge of guns from the *electrical battery.*

TO PETER COLLINSON.

Observations and Suppositions towards forming a new Hypothesis for explaining the several Phenomena of Thunder-gusts.†

SIR,

Non-electric bodies, that have electric fire thrown into them, will retain it till other electrics, that have less, approach; and then it is communicated by a snap, and becomes equally divided.

2. Electrical fire loves water, is strongly attracted by it, and they can subsist together.

3. Air is an electric *per se*, and, when dry, will not conduct the electrical fire; it will neither receive it, nor give it to other bodies; otherwise no body surrounded by air could be electrified positively and negatively; for, should it be attempted positively, the air would immediately take away the overplus; or negatively, the air would supply what was wanting.

4. Water being electrified, the vapors arising from it will be equally electrified; and floating in the air, in

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* An *electrified bumper* is a small, thin, glass tumbler, nearly filled with wine, and electrified as the bottle. This when brought to the lips gives a shock, if the party be close shaved, and does not breathe on the liquor. — April 29th, 1749.

† Thunder-gusts are sudden storms of thunder and lightning, which are frequently of short duration, but sometimes produce mischievous effects.

the form of clouds, or otherwise, will retain that quantity of electrical fire, till they meet with other clouds or bodies not so much electrified, and then will communicate as before mentioned.

5. Every particle of matter electrified is repelled by every other particle equally electrified. Thus the stream of a fountain, naturally dense and continual, when electrified, will separate and spread in the form of a brush, every drop endeavouring to recede from every other drop. But, on taking out the electrical fire, they close again.

6. Water being strongly electrified (as well as when heated by common fire) rises in vapors more copiously; the attraction of cohesion among its particles being greatly weakened, by the opposite power of repulsion introduced with the electrical fire; and, when any particle is by any means disengaged, it is immediately repelled, and so flies into the air.

7. Particles happening to be situated as *A* and *B* (Fig. 6, *representing the profile of a vessel of water*) are more easily disengaged than *C* and *D*, as each is held by contact with three only, whereas *C* and *D* are each in contact with nine. When the surface of the water has the least motion, particles are continually pushed into the situation represented by *A* and *B*.

8. Friction between a non-electric and an electric *per se* will produce electrical fire; not by *creating*, but *collecting* it; for it is equally diffused in our walls, floors, earth, and the whole mass of common matter. Thus the whirling glass globe, during its friction against the cushion, draws fire from the cushion, the cushion is supplied from the frame of the machine, that from the floor on which it stands. Cut off the communication by thick glass or wax, placed under the cushion, and no fire can be *produced*, because it cannot be *collected*.

9. The ocean is a compound of water, a non-electric, and salt, an electric *per se.*

10. When there is a friction among the parts near its surface, the electrical fire is collected from the parts below. It is then plainly visible in the night; it appears in the stern and in the wake of every sailing vessel; every dash of an oar shows it, and every surf and spray; in storms the whole sea seems on fire. The detached particles of water, then repelled from the electrified surface, continually carry off the fire as it is collected; they rise and form clouds, and those clouds are highly electrified, and retain the fire till they have an opportunity of communicating it.

11. The particles of water, rising in vapors, attach themselves to particles of air.

12. The particles of air are said to be hard, round, separate, and distant from each other; every particle strongly repelling every other particle, whereby they recede from each other, as far as common gravity will permit.

13. The space between any three particles, equally repelling each other, will be an equilateral triangle.

14. In air compressed, these triangles are smaller; in rarefied air they are larger.

15. Common fire, joined with air, increases the repulsion, enlarges the triangles, and thereby makes the air specifically lighter. Such air, among denser air, will rise.

16. Common fire, as well as electrical fire, gives repulsion to the particles of water, and destroys their attraction of cohesion; hence common fire, as well as electrical fire, assists in raising vapors.

17. Particles of water, having no fire in them, mutually attract each other. Three particles of water then, being attached to the three particles of a triangle of

air, would, by their mutual attraction operating against the air's repulsion, shorten the sides and lessen the triangle, whereby that portion of air made denser would sink to the earth with its water, and not rise to the formation of a cloud.

18. But, if every particle of water attaching itself to air brings with it a particle of common fire, the repulsion of the air being assisted and strengthened by the fire, more than obstructed by the mutual attraction of the particles of water, the triangle dilates, and that portion of air, becoming rarer and specifically lighter, rises.

19. If the particles of water bring electrical fire when they attach themselves to air, the repulsion between the particles of water electrified, joins with the natural repulsion of the air, to force its particles to a greater distance, whereby the triangles are dilated, and the air rises, carrying up with it the water.

20. If the particles of water bring with them portions of *both sorts* of fire, the repulsion of the particles of air is still more strengthened and increased, and the triangles farther enlarged.

21. One particle of air may be surrounded by twelve particles of water of equal size with itself, all in contact with it, and by more added to those.

22. Particles of air, thus loaded, would be drawn nearer together by the mutual attraction of the particles of water, did not the fire, common or electrical, assist their repulsion.

23. If air, thus loaded, be compressed by adverse winds, or by being driven against mountains, &c., or condensed by taking away the fire that assisted it in expanding, the triangles contract, the air with its water will descend as a dew; or, if the water surrounding one particle of air comes in contact with the water

surrounding another, they coalesce and form a drop, and we have rain.

24. The sun supplies (or seems to supply) common fire to vapors, whether raised from earth or sea.

25. Those vapors, which have both common and electrical fire in them, are better supported than those which have only common fire in them; for when vapors rise into the coldest region above the earth, the cold will not diminish the electrical fire, if it doth the common.

26. Hence clouds, formed by vapors raised from fresh waters within land, from growing vegetables, moist earth, &c., more speedily and easily deposite their water, having but little electrical fire to repel and keep the particles separate. So that the greatest part of the water raised from the land, is let fall on the land again; and winds blowing from the land to the sea are dry, there being little use for rain on the sea, and to rob the land of its moisture, in order to rain on the sea, would not appear reasonable.

27. But clouds, formed by vapors raised from the sea, having both fires, and particularly a great quantity of the electrical, support their water strongly, raise it high, and being moved by winds, may bring it over the middle of the broadest continent from the middle of the widest ocean.

28. How these ocean clouds, so strongly supporting their water, are made to deposite it on the land where it is wanted, is next to be considered.

29. If they are driven by winds against mountains, those mountains, being less electrified, attract them, and on contact take away their electrical fire, (and, being cold, the common fire also); hence the particles close towards the mountains and towards each other. If the air was not much loaded, it only falls in dews on the

mountain tops and sides, forms springs, and descends to the vales in rivulets, which, united, make larger streams and rivers. If much loaded, the electrical fire is at once taken from the whole cloud; and, in leaving it, flashes brightly and cracks loudly; the particles instantly coalescing for want of that fire, and falling in a heavy shower.

30. When a ridge of mountains thus dams the clouds, and draws the electrical fire from the cloud first approaching it; that which next follows, when it comes near the first cloud, now deprived of its fire, flashes into it, and begins to deposite its own water; the first cloud again flashing into the mountains; the third approaching cloud, and all succeeding ones, acting in the same manner as far back as they extend, which may be over many hundred miles of country.

31. Hence the continual storms of rain, thunder, and lightning on the east side of the Andes, which, running north and south, and being vastly high, intercept all the clouds brought against them from the Atlantic ocean by the trade winds, and oblige them to deposite their waters, by which the vast rivers Amazons, La Plata, and Oroonoko are formed, which return the water into the same sea, after having fertilized a country of very great extent.

32. If a country be plain, having no mountains to intercept the electrified clouds, yet it is not without means to make them deposite their water. For, if an electrified cloud, coming from the sea, meets in the air a cloud raised from the land, and therefore not electrified, the first will flash its fire into the latter, and thereby both clouds shall be made suddenly to deposite water.

33. The electrified particles of the first cloud close when they lose their fire; the particles of the other

clouds close in receiving it; in both, they have thereby an opportunity of coalescing into drops. The concussion or jerk given to the air, contributes also to shake down the water, not only from those two clouds, but from others near them. Hence the sudden fall of rain immediately after flashes of lightning.

34. To show this by an easy experiment; take two round pieces of pasteboard, two inches diameter; from the centre and circumference of each of them suspend, by fine silk threads eighteen inches long, seven small balls of wood, or seven peas equal in goodness; so will the balls, appending to each pasteboard, form equal equilateral triangles, one ball being in the centre, and six at equal distances from that and from each other; and thus they represent particles of air. Dip both sets in water, and some adhering to each ball, they will represent air loaded. Dexterously electrify one set, and its balls will repel each other to a greater distance, enlarging the triangles. Could the water supported by seven balls come into contact, it would form a drop or drops so heavy as to break the cohesion it had with the balls, and so fall. Let the two sets then represent two clouds, the one a sea cloud electrified, the other a land cloud. Bring them within the sphere of attraction, and they will draw towards each other, and you will see the separated balls close thus; the first electrified ball that comes near an unelectrified ball by attraction joins it, and gives it fire; instantly they separate, and each flies to another ball of its own party, one to give, the other to receive fire; and so it proceeds through both sets, but so quick as to be in a manner instantaneous. In the cohesion they shake off and drop their water, which represents rain.

35. Thus, when sea and land clouds would pass at too great a distance for the flash, they are attracted

towards each other till within that distance; for the sphere of electrical attraction is far beyond the distance of flashing.

36. When a great number of clouds from the sea meet a number of clouds raised from the land, the electrical flashes appear to strike in different parts; and, as the clouds are jostled and mixed by the winds, or brought near by the electrical attraction, they continue to give and receive flash after flash, till the electrical fire is equally diffused.

37. When the gun-barrel (in electrical experiments) has but little electrical fire in it, you must approach it very near with your knuckle before you can draw a spark. Give it more fire, and it will give a spark at a greater distance. Two gun-barrels united, and as highly electrified, will give a spark at a still greater distance. But, if two gun-barrels electrified will strike at two inches distance, and make a loud snap, to what a great distance may ten thousand acres of electrified cloud strike and give its fire, and how loud must be that crack?

38. It is a common thing to see clouds at different heights passing different ways, which shows different currents of air, one under the other. As the air between the tropics is rarefied by the sun, it rises, the denser northern and southern air pressing into its place. The air, so rarefied and forced up, passes northward and southward, and must descend into the polar regions, if it has no opportunity before, that the circulation may be carried on.

39. As currents of air, with the clouds therein, pass different ways, it is easy to conceive how the clouds, passing over each other, may attract each other, and so come near enough for the electrical stroke. And also how electrical clouds may be carried within land very far from the sea, before they have an opportunity to strike

40. When the air, with its vapors raised from the ocean between the tropics, comes to descend in the polar regions, and to be in contact with the vapors arising there, the electrical fire they brought begins to be communicated, and is seen in clear nights, being first visible where it is first in motion, that is, where the contact begins, or in the most northern part; from thence the streams of light seem to shoot southerly, even up to the zenith of northern countries. But, though the light seems to shoot from the north southerly, the progress of the fire is really from the south northerly, its motion beginning in the north being the reason that it is there seen first.

For the electrical fire is never visible but when in motion, and leaping from body to body, or from particle to particle, through the air. When it passes through dense bodies, it is unseen. When a wire makes part of the circle, in the explosion of the electrical phial, the fire, though in great quantity, passes in the wire invisibly; but, in passing along a chain, it becomes visible as it leaps from link to link. In passing along leaf gilding it is visible; for the leaf gold is full of pores; hold a leaf to the light and it appears like a net, and the fire is seen in its leaping over the vacancies. And, as when a long canal filled with still water is opened at one end, in order to be discharged, the motion of the water begins first near the opened end, and proceeds towards the close end, though the water itself moves from the close towards the opened end; so the electrical fire discharged into the polar regions, perhaps from a thousand leagues length of vaporized air, appears first where it is first in motion, that is, in the most northern part, and the appearance proceeds southward, though the fire really moves northward. This is supposed to account for the *aurora borealis*.

41. When there is great heat on the land, in a particular region (the sun having shone on it perhaps several days, while the surrounding countries have been screened by clouds), the lower air is rarefied and rises, the cooler, denser air above descends; the clouds in that air meet from all sides, and join over the heated place; and, if some are electrified, others not, lightning and thunder succeed, and showers fall. Hence thunder-gusts after heats, and cool air after gusts; the water, and the clouds that bring it, coming from a higher and therefore a cooler region.

42. An electrical spark, drawn from an irregular body at some distance, is scarcely ever straight, but shows crooked and waving in the air. So do the flashes of lightning, the clouds being very irregular bodies.

43. As electrified clouds pass over a country, high hills and high trees, lofty towers, spires, masts of ships, chimneys, &c., as so many prominences and points, draw the electrical fire, and the whole cloud discharges there.

44. Dangerous, therefore, is it to take shelter under a tree, during a thunder-gust. It has been fatal to many, both men and beasts.

45. It is safer to be in the open field for another reason. When the clothes are wet, if a flash in its way to the ground should strike your head, it may run in the water over the surface of your body; whereas, if your clothes were dry, it would go through the body, because the blood and other humors, containing so much water, are more ready conductors.

Hence a wet rat cannot be killed by the exploding electrical bottle, when a dry rat may.*

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* This was tried with a bottle, containing about a quart It is since thought, that one of the large glass jars, mentioned in these papers, might have killed him, though wet.

46. Common fire is in all bodies, more or less, as well as electrical fire. Perhaps they may be different modifications of the same element; or they may be different elements. The latter is by some suspected.

47. If they are different things, yet they may and do subsist together in the same body.

48. When electrical fire strikes through a body, it acts upon the common fire contained in it, and puts that fire in motion; and, if there be a sufficient quantity of each kind of fire, the body will be inflamed.

49. When the quantity of common fire in the body is small, the quantity of the electrical fire (or the electrical stroke) should be greater; if the quantity of common fire be great, less electrical fire suffices to produce the effect.

50. Thus spirits must be heated before we can fire them by the electrical spark.* If they are much heated, a small spark will do; if not, the spark must be greater.

51. Till lately, we could only fire warm vapors; but now we can burn hard, dry rosin. And, when we can procure greater electrical sparks, we may be able to fire, not only unwarmed spirits, as lightning does, but even wood, by giving sufficient agitation to the common fire contained in it, as friction we know will do.

52. Sulphureous and inflammable vapors, arising from the earth, are easily kindled by lightning. Besides what arise from the earth, such vapors are sent out by stacks of moist hay, corn, or other vegetables, which heat and reek. Wood, rotting in old trees or buildings, does the same. Such are therefore easily and often fired.

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* We have since fired spirits without heating them, when the weather is warm. A little, poured into the palm of the hand, will be warmed sufficiently by the hand, if the spirit be well rectified. Ether takes fire most readily.

53. Metals are often melted by lightning, though perhaps not from heat in the lightning, nor altogether from agitated fire in the metals. For, as whatever body can insinuate itself between the particles of metal, and overcome the attraction by which they cohere (as sundry *menstrua* can), will make the solid become a fluid, as well as fire, yet without heating it; so, the electrical fire, or lightning, creating a violent repulsion between the particles of the metal it passes through, the metal is fused.

54. If you would, by a violent fire, melt off the end of a nail, which is half driven into a door, the heat given the whole nail, before a part would melt, must burn the board it sticks in; and the melted part would burn the floor it dropped on. But, if a sword can be melted in the scabbard, and money in a man's pocket by lightning, without burning either, it must be a cold fusion.*

55. Lightning rends some bodies. The electrical spark will strike a hole through a quire of strong paper.

56. If the source of lightning, assigned in this paper, be the true one, there should be little thunder heard at sea far from land. And accordingly some old sea-captains, of whom inquiry has been made, do affirm, that the fact agrees perfectly with the hypothesis; for that, in crossing the great ocean, they seldom meet with thunder till they come into soundings; and that the islands far from the continent have very little of it. And a curious observer, who lived thirteen years at

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* These facts, though related in several accounts, are now doubted; since it has been observed, that the parts of a bell-wire which fell on the floor, being broken and partly melted by lightning, did actually burn into the boards (See "Philosophical Transactions," Vol. LI. Part I.) And Mr. Kinnersley has found, that a fine iron wire, melted by electricity, has had the same effect.

Bermudas, says, there was less thunder there in that whole time, than he has sometimes heard in a month at Carolina.

TO PETER COLLINSON.

Accumulation of the Electrical Fire proved to be in the electrified Glass.—Effect of Lightning on the Needle of Compasses explained.—Gunpowder fired by the Electric Flame.

Philadelphia, 27 July, 1750.

Sir,

Mr. Watson, I believe, wrote his Observations on my last paper in haste, without having first well considered the experiments, related § 17,* which still appear to me decisive in the question, *Whether the accumulation of the electrical fire be in the electrified glass, or in the non-electric matter connected with the glass?* and to demonstrate that it is really in the glass.

As to the experiment that ingenious gentleman mentions, and which he thinks conclusive on the other side, I persuade myself he will change his opinion of it, when he considers, that, as one person applying the wire of the charged bottle to warm spirits, in a spoon held by another person, both standing on the floor, will fire the spirits, and yet such firing will not determine whether the accumulation was in the glass or the non-electric; so the placing another person between them, standing on wax, with a basin in his hand, into which the water from the phial is poured, *while he at the instant of pouring* presents a finger of his other hand to the spirits, does not at all alter the case; the stream from the phial,

* See the paper entitled, *Farther Experiments*, &c.

the side of the basin, with the arms and body of the person on the wax, being altogether but as one long wire, reaching from the internal surface of the phial to the spirits.

June 29th, 1751. In Captain Waddell's account of the effects of lightning on his ship, I could not but take notice of the large *comazants* (as he calls them), that settled on the spintles at the top-mast heads, and burned like very large torches (before the stroke). According to my opinion, the electrical fire was then drawing off, as by points, from the cloud; the largeness of the flame betokening the great quantity of electricity in the cloud; and, had there been a good wire communication from the spintle heads to the sea, that could have conducted more freely than tarred ropes, or masts of turpentine wood, I imagine there would either have been no stroke, or, if a stroke, the wire would have conducted it all into the sea without damage to the ship.

His compasses lost the virtue of the loadstone, or the poles were reversed, the north point turning to the south. By electricity we have (*here* at Philadelphia) frequently given polarity to needles, and reversed it at pleasure. Mr. Wilson, at London, tried it on too large masses, and with too small force.

A shock from four large glass jars, sent through a fine sewing-needle, gives it polarity, and it will traverse when laid on water. If the needle, when struck, lies east and west, the end entered by the electric blast points north. If it lies north and south, the end that lay towards the north will continue to point north when placed on water, whether the fire entered at that end, or at the contrary end.

The polarity given is strongest when the needle is struck lying north and south; weakest, when lying east and west. Perhaps if the force was still greater, the south end, entered by the fire (when the needle lies north and south) might become the north, otherwise it puzzles us to account for the inverting of compasses by lightning; since their needles must always be found in that situation, and by our little experiments, whether the blast entered the north and went out at the south end of the needle, or the contrary, still the end that lay to the north should continue to point north.

In these experiments the ends of the needle are sometimes finely blued, like a watch-spring, by the electric flame. This color, given by the flash from two jars only, will wipe off; but four jars fix it, and frequently melt the needles. I send you some, that have had their heads and points melted off by our mimic lightning; and a pin, that had its point melted off, and some part of its head and neck run. Sometimes the surface on the body of the needle is also run, and appears blistered when examined by a magnifying-glass. The jars I make use of hold seven or eight gallons, and are coated and lined with tin-foil; each of them takes a thousand turns * of a globe nine inches diameter to charge it.

I send you two specimens of tin-foil melted between glass, by the force of two jars only.

I have not heard that any of your European electricians have ever been able to fire gunpowder by the electric flame. We do it here in this manner; a small cartridge is filled with dry powder, hard rammed, so as to bruise some of the grains; two pointed wires are then thrust in, one at each end, the points approaching

* The cushion being afterwards covered with a long flap of buckskin, which might cling to the globe, and care being taken to keep that flap of a due temperature, between too dry and too moist, we found so much more of the electric fluid was obtained, as that one hundred and fifty turns were sufficient. 1753.

each other in the middle of the cartridge till within the distance of half an inch; then, the cartridge being placed in the circuit, when the four jars are discharged, the electric flame leaping from the point of one wire to the point of the other, within the cartridge amongst the powder, *fires it*, and the explosion of the powder is at the same instant with the crack of the discharge. Yours, &c.

B. FRANKLIN.

TO PETER COLLINSON.

Introductory Letter to some additional Papers.

Philadelphia, 29 July, 1750.

SIR,

As you first put us on electrical experiments, by sending to our Library Company a tube, with directions how to use it; and as our honorable Proprietary enabled us to carry those experiments to a greater height, by his generous present of a complete electrical apparatus; it is fit that both should know, from time to time, what progress we make. It was in this view I wrote and sent you my former papers on this subject, desiring, that, as I had not the honor of a direct correspondence with that bountiful benefactor to our library, they might be communicated to him through your hands. In the same view I write and send you this additional paper. If it happens to bring you nothing new, (which may well be, considering the number of ingenious men in Europe, continually engaged in the same researches,) at least it will show, that the instruments put into our hands are not neglected; and that, if no valuable discoveries are made by us, whatever the cause may be, it is not want of industry and application.

I am, Sir, your much obliged humble servant,

B. FRANKLIN.

Opinions and Conjectures concerning the Properties and Effects of the Electrical Matter, and the Means of preserving Buildings, Ships, &c. from Lightning, arising from Experiments and Observations made at Philadelphia, 1749. — *Golden Fish.* — *Extraction of Effluvial Virtues by Electricity impracticable.*

§ 1. THE electrical matter consists of particles extremely subtile, since it can permeate common matter, even the densest metals, with such ease and freedom as not to receive any perceptible resistance.

2. If any one should doubt whether the electrical matter passes through the substance of bodies, or only over and along their surfaces, a shock from an electrified large glass jar, taken through his own body, will probably convince him.

3. Electrical matter differs from common matter in this, that the parts of the latter mutually attract, those of the former mutually repel each other. Hence the appearing divergency in a stream of electrified effluvia.

4. But, though the particles of electrical matter dc repel each other, they are strongly attracted by all other matter.*

5. From these three things, the extreme subtilty of the electrical matter, the mutual repulsion of its parts, and the strong attraction between them and other matter, arises this effect, that, when a quantity of electrical matter is applied to a mass of common matter, of any bigness or length, within our observation, (which hath not already got its quantity,) it is immediately and equally diffused through the whole.

6. Thus, common matter is a kind of sponge to the

* See the ingenious Essays on Electricity, in the Transactions, by Mr. Ellicot.

electrical fluid. And as a sponge would receive no water, if the parts of water were not smaller than the pores of the sponge; and even then but slowly, if there were not a mutual attraction between those parts and the parts of the sponge; and would still imbibe it faster, if the mutual attraction among the parts of the water did not impede, some force being required to separate them; and fastest, if, instead of attraction, there were a mutual repulsion among those parts, which would act in conjunction with the attraction of the sponge; so is the case between the electrical and common matter.

7. But in common matter there is (generally) as much of the electrical, as it will contain within its substance. If more is added, it lies without upon the surface, and forms what we call an electrical atmosphere; and then the body is said to be electrified.

8. It is supposed, that all kinds of common matter do not attract and retain the electrical, with equal strength and force, for reasons to be given hereafter. And that those called electrics *per se*, as glass, &c., attract and retain it strongest, and contain the greatest quantity.

9. We know, that the electrical fluid is *in* common matter, because we can pump it *out* by the globe or tube. We know that common matter has near as much as it can contain, because, when we add a little more to any portion of it, the additional quantity does not enter, but forms an electrical atmosphere. And we know, that common matter has not (generally) more than it can contain, otherwise all loose portions of it would repel each other, as they constantly do when they have electric atmospheres.

10. The beneficial uses of this electric fluid in the creation we are not yet well acquainted with, though doubtless such there are, and those very considerable; but we may see some pernicious consequences that

would attend a much greater proportion of it. For, had this globe we live on, as much of it in proportion as we can give to a globe of iron, wood, or the like, the particles of dust and other light matters that get loose from it, would, by virtue of their separate electrical atmospheres, not only repel each other, but be repelled from the earth, and not easily be brought to unite with it again; whence our air would continually be more and more clogged with foreign matter, and grow unfit for respiration. This affords another occasion of adoring that wisdom which has made all things by weight and measure!

11. If a piece of common matter be supposed entirely free from electrical matter, and a single particle of the latter be brought nigh, it will be attracted, and enter the body, and take place in the centre, or where the attraction is every way equal. If more particles enter, they take their places where the balance is equal between the attraction of the common matter, and their own mutual repulsion. It is supposed they form triangles, whose sides shorten as their number increases, till the common matter has drawn in so many, that its whole power of compressing those triangles by attraction is equal to their whole power of expanding themselves by repulsion; and then will such a piece of matter receive no more.

12. When part of this natural proportion of electrical fluid is taken out of a piece of common matter, the triangles formed by the remainder are supposed to widen by the mutual repulsion of the parts, until they occupy the whole piece.

13. When the quantity of electrical fluid, taken from a piece of common matter, is restored again, it enters the expanded triangles, being again compressed till there is room for the whole.

14. To explain this; take two apples, or two balls of wood or other matter, each having its own natural quantity of the electrical fluid. Suspend them by silk lines from the ceiling. Apply the wire of a well-charged phial, held in your hand, to one of them (*A*) Fig. 7, and it will receive from the wire a quantity of the electrical fluid, but will not imbibe it, being already full. The fluid, therefore, will flow round its surface, and form an electrical atmosphere. Bring *A* into contact with *B*, and half the electrical fluid is communicated, so that each has now an electrical atmosphere, and therefore they repel each other. Take away these atmospheres, by touching the balls, and leave them in their natural state; then, having fixed a stick of sealing-wax to the middle of the phial to hold it by, apply the wire to *A*, at the same time the coating touches *B*. Thus will a quantity of the electrical fluid be drawn out of *B*, and thrown on *A*. So that *A* will have a redundance of this fluid, which forms an atmosphere round, and *B* an exactly equal deficiency. Now, bring these balls again into contact, and the electrical atmosphere will not be divided between *A* and *B*, into two smaller atmospheres as before; for *B* will drink up the whole atmosphere of *A*, and both will be found again in their natural state.

15. The form of the electrical atmosphere is that of the body it surrounds. This shape may be rendered visible in a still air, by raising a smoke from dry rosin dropt into a hot tea-spoon under the electrified body, which will be attracted, and spread itself equally on all sides, covering and concealing the body.* And this form it takes, because it is attracted by all parts of the surface of the body, though it cannot enter the

* See p. 183.

substance already replete. Without this attraction, it would not remain round the body, but dissipate in the air.

16. The atmosphere of electrical particles surrounding an electrified sphere, is not more disposed to leave it, or more easily drawn off from any one part of the sphere than another, because it is equally attracted by every part. But that is not the case with bodies of any other figure. From a cube it is more easily drawn at the corners than at the plane sides, and so from the angles of a body of any other form, and still most easily from the angle that is most acute. Thus, if a body shaped as *A*, *B*, *C*, *D*, *E*, in Fig. 8, be electrified, or have an electrical atmosphere communicated to it, and we consider every side as a base on which the particles rest, and by which they are attracted, one may see, by imagining a line from *A* to *F*, and another from *E* to *G*, that the portion of the atmosphere included in *F*, *A*, *E*, *G*, has the line *A*, *E*, for its basis. So the portion of atmosphere, included in *H*, *A*, *B*, *I*, has the line *A*, *B* for its basis. And likewise the portion included in *K*, *B*, *C*, *L*, has *B*, *C* to rest on; and so on the other side of the figure. Now, if you would draw off this atmosphere with any blunt, smooth body, and approach the middle of the side *A*, *B*, you must come very near, before the force of your attractor exceeds the force or power with which that side holds its atmosphere. But there is a small portion between *I*, *B*, *K*, that has less of the surface to rest on, and to be attracted by, than the neighbouring portions, while at the same time there is a mutual repulsion between its particles, and the particles of those portions; therefore here you can get it with more ease, or at a greater distance. Between *F*, *A*, *H*, there is a larger portion that has yet a less surface to rest on, and to attract it; here, therefore, you

can get it away still more easily. But easiest of all, between *L, C, M*, where the quantity is largest, and the surface to attract and keep it back the least. When you have drawn away one of these angular portions of the fluid, another succeeds in its place from the nature of fluidity, and the mutual repulsion before mentioned; and so the atmosphere continues flowing off at such angle, like a stream, till no more is remaining. The extremities of the portions of atmosphere over these angular parts, are likewise at a greater distance from the electrified body, as may be seen by the inspection of the above figure; the point of the atmosphere of the angle *C* being much farther from *C*, than any other part of the atmosphere over the lines *C, B*, or *B, A*; and, besides the distance arising from the nature of the figure, where the attraction is less, the particles will naturally expand to a greater distance by their mutual repulsion. On these accounts we suppose electrified bodies discharge their atmospheres upon unelectrified bodies more easily, and at a greater distance from their angles and points, than from their smooth sides. Those points will also discharge into the air, when the body has too great an electrical atmosphere, without bringing any non-electric near to receive what is thrown off. For the air, though an electric *per se*, yet has always more or less water and other non-electric matters mixed with it; and these attract and receive what is so discharged.

17. But points have a property, by which they *draw on* as well as *throw off* the electrical fluid, at greater distances than blunt bodies can. That is, as the pointed part of an electrified body will discharge the atmosphere of that body, or communicate it farthest to another body, so the point of an unelectrified body will draw off the electrical atmosphere from an electrified body,

farther than a blunter part of the same unelectrified body will do. Thus, a pin held by the head, and the point presented to an electrified body, will draw off its atmosphere at a foot distance; where, if the head were presented instead of the point, no such effect would follow. To understand this, we may consider, that, if a person standing on the floor would draw off the electrical atmosphere from an electrified body, an iron crow and a blunt knitting-needle held alternately in his hand, and presented for that purpose, do not draw with different forces in proportion to their different masses. For the man, and what he holds in his hand, be it large or small, are connected with the common mass of unelectrified matter; and the force with which he draws is the same in both cases, it consisting in the different proportion of electricity in the electrified body, and that common mass. But the force, with which the electrified body retains its atmosphere by attracting it, is proportioned to the surface over which the particles are placed; that is, four square inches of that surface retain their atmosphere with four times the force that one square inch retains its atmosphere. And, as, in plucking the hairs from the horse's tail, a degree of strength not sufficient to pull away a handful at once, could yet easily strip it hair by hair, so a blunt body presented cannot draw off a number of particles at once, but a pointed one, with no greater force, takes them away easily, particle by particle.

18. These explanations of the power and operation of points, when they first occurred to me, and while they first floated in my mind, appeared perfectly satisfactory; but now I have written them, and considered them more closely, I must own I have some doubts about them; yet, as I have at present nothing better to offer in their stead, I do not cross them out; for, even

a bad solution read, and its faults discovered, has often given rise to a good one, in the mind of an ingenious reader.

19. Nor is it of much importance to us to know the manner in which nature executes her laws; it is enough if we know the laws themselves. It is of real use to know that China left in the air unsupported will fall and break; but *how* it comes to fall, and *why* it breaks, are matters of speculation. It is a pleasure indeed to know them, but we can preserve our China without it.

20. Thus, in the present case, to know this power of points may possibly be of some use to mankind, though we should never be able to explain it. The following experiments, as well as those in my first paper show this power. I have a large prime conductor, made of several thin sheets of clothier's pasteboard, formed into a tube, near ten feet long and a foot diameter It is covered with Dutch embossed paper, almost totally gilt. This large metallic surface supports a much greater electrical atmosphere than a rod of iron of fifty times the weight would do. It is suspended by silk lines, and when charged will strike, at near two inches distance, a pretty hard stroke, so as to make one's knuckle ache. Let a person standing on the floor present the point of a needle, at twelve or more inches distance from it, and while the needle is so presented, the conductor cannot be charged, the point drawing off the fire as fast as it is thrown on by the electrical globe. Let it be charged, and then present the point at the same distance, and it will suddenly be discharged. In the dark you may see the light on the point, when the experiment is made. And, if the person holding the point stands upon wax, he will be electrified by receiving the fire at that distance. Attempt to draw off the electricity with a blunt body, as a bolt of iron round

at the end, and smooth, (a silversmith's iron punch, inch thick, is what I use,) and you must bring it within the distance of three inches before you can do it, and then it is done with a stroke and crack. As the pasteboard tube hangs loose on silk lines, when you approach it with the punch-iron, it likewise will move towards the punch, being attracted while it is charged; but if, at the same instant, a point be presented as before, it retires again, for the point discharges it. Take a pair of large brass scales, of two or more feet beam, the cords of the scales being silk. Suspend the beam by a packthread from the ceiling, so that the bottom of the scales may be about a foot from the floor; the scales will move round in a circle by the untwisting of the packthread. Set the iron punch on the end upon the floor, in such a place as that the scales may pass over it in making their circle; then electrify one scale by applying the wire of a charged phial to it. As they move round, you see that scale draw nigher to the floor, and dip more when it comes over the punch; and, if that be placed at a proper distance, the scale will snap and discharge its fire into it. But, if a needle be stuck on the end of the punch, its point upward, the scale, instead of drawing nigh to the punch, and snapping, discharges its fire silently through the point, and rises higher from the punch. Nay, even if the needle be placed upon the floor near the punch, its point upwards, the end of the punch, though so much higher than the needle, will not attract the scale and receive its fire, for the needle will get it and convey it away, before it comes nigh enough for the punch to act. And this is constantly observable in these experiments, that the greater quantity of electricity on the pasteboard tube, the farther it strikes or discharges its fire, and the point likewise will draw it off at a still greater distance.

Now if the fire of electricity and that of lightning be the same, as I have endeavoured to show at large in a former paper, this pasteboard tube and these scales may represent electrified clouds. If a tube of only ten feet long will strike and discharge its fire on the punch at two or three inches distance, an electrified cloud of perhaps ten thousand acres may strike and discharge on the earth at a proportionably greater distance. The horizontal motion of the scales over the floor, may represent the motion of the clouds over the earth; and the erect iron punch, a hill or high building; and then we see how electrified clouds passing over hills or high buildings at too great a height to strike, may be attracted lower till within their striking distance. And, lastly, if a needle fixed on the punch with its point upright, or even on the floor below the punch, will draw the fire from the scale silently at a much greater than the striking distance, and so prevent its descending towards the punch; or if in its course it would have come nigh enough to strike, yet being first deprived of its fire it cannot, and the punch is thereby secured from the stroke; I say, if these things are so, may not the knowledge of this power of points be of use to mankind, in preserving houses, churches, ships, &c. from the stroke of lightning, by directing us to fix, on the highest parts of those edifices, upright rods of iron made sharp as a needle, and gilt to prevent rusting, and from the foot of those rods a wire down the outside of the building into the ground, or down round one of the shrouds of a ship, and down her side till it reaches the water? Would not these pointed rods probably draw the electrical fire silently out of a cloud before it came nigh enough to strike, and thereby secure us from that most sudden and terrible mischief?

21. To determine the question, whether the clouds

that contain lightning are electrified or not, I would propose an experiment to be tried where it may be done conveniently. On the top of some high tower or steeple, place a kind of sentry-box, (as in Fig. 9,) big enough to contain a man and an electrical stand. From the middle of the stand let an iron rod rise and pass bending out of the door, and then upright twenty or thirty feet, pointed very sharp at the end. If the electrical stand be kept clean and dry, a man standing on it, when such clouds are passing low, might be electrified and afford sparks, the rod drawing fire to him from a cloud. If any danger to the man should be apprehended (though I think there would be none), let him stand on the floor of his box, and now and then bring near to the rod the loop of a wire that has one end fastened to the leads, he holding it by a wax handle; so the sparks, if the rod is electrified, will strike from the rod to the wire, and not affect him.

22. Before I leave this subject of lightning, I may mention some other similarities between the effects of that and those of electricity. Lightning has often been known to strike people blind. A pigeon that we struck dead to appearance by the electrical shock, recovering life, drooped about the yard several days, eat nothing, though crumbs were thrown to it, but declined and died. We did not think of its being deprived of sight; but afterward a pullet, struck dead in like manner, being recovered by repeatedly blowing into its lungs, when set down on the floor, ran headlong against the wall, and on examination appeared perfectly blind. Hence we concluded, that the pigeon also had been absolutely blinded by the shock. The biggest animal we have yet killed, or tried to kill, with the electrical stroke, was a well-grown pullet.

23. Reading in the ingenious Dr. Miles's account of

the thunder-storm at Stretham, the effect of the lightning in stripping off all the paint that had covered a gilt moulding of a pannel of wainscot, without hurting the rest of the paint, I had a mind to lay a coat of paint over the filleting of gold on the cover of a book, and try the effect of a strong electrical flash sent through that gold from a charged sheet of glass. But, having no paint at hand, I pasted a narrow strip of paper over it; and when dry, sent the flash through the gilding, by which the paper was torn off from end to end, with such force that it was broke in several places, and in others brought away part of the grain of the Turkey-leather in which it was bound; and convinced me, that, had it been painted, the paint would have been stripped off in the same manner with that on the wainscot at Stretham.

24. Lightning melts metals, and I hinted in my paper on that subject, that I suspected it to be a cold fusion; I do not mean a fusion by force of cold, but a fusion without heat.* We have also melted gold, silver, and copper, in small quantities, by the electrical flash. The manner is this; take leaf-gold, leaf-silver, or leaf-gilt copper, commonly called leaf-brass, or Dutch gold; cut off from the leaf long narrow strips, the breadth of a straw. Place one of these strips between two strips of smooth glass that are about the width of your finger. If one strip of gold, the length of the leaf, be not long enough for the glass, add another to the end of it, so that you may have a little part hanging out loose at each end of the glass. Bind the pieces of glass together from end to end with strong silk thread; then place it so as to be part of an electrical circuit, (the ends of gold hanging out being of use to join with the

* See note in page 222.

other parts of the circuit,) and send the flash through it, from a large electrified jar or sheet of glass. Then, if your strips of glass remain whole, you will see that the gold is missing in several places, and instead of it a metallic stain on both the glasses; the stains on the upper and under glass exactly similar in the minutest stroke, as may be seen by holding them to the light; the metal appeared to have been not only melted, but even vitrified, or otherwise so driven into the pores of the glass, as to be protected by it from the action of the strongest *aqua fortis* or *aqua regia*. I send you enclosed two little pieces of glass with these metallic stains upon them, which cannot be removed without taking part of the glass with them. Sometimes the stain spreads a little wider than the breadth of the leaf, and looks brighter at the edge, as by inspecting closely you may observe in these. Sometimes the glass breaks to pieces; once the upper glass broke into a thousand pieces, looking like coarse salt. The pieces I send you were stained with Dutch gold. True gold makes a darker stain, somewhat reddish; silver, a greenish stain. We once took two pieces of thick looking-glass, as broad as a gunter's scale, and six inches long; and, placing leaf-gold between them, put them between two smoothly-plained pieces of wood, and fixed them tight in a book-binder's small press; yet, though they were so closely confined, the force of the electrical shock shivered the glass into many pieces. The gold was melted, and stained into the glass, as usual. The circumstances of the breaking of the glass differ much in making the experiment, and sometimes it does not break at all; but this is constant, that the stains in the upper and under pieces are exact counterparts of each other. And, though I have taken up the pieces of glass between my fingers immediately after this melting, I never could perceive the least warmth in them.

25. In one of my former papers, I mentioned, that gilding on a book, though at first it communicated the shock perfectly well, yet failed after a few experiments, which we could not account for. We have since found, that one strong shock breaks the continuity of the gold in the filleting, and makes it look rather like dust of gold, abundance of its parts being broken and driven off; and it will seldom conduct above one strong shock. Perhaps this may be the reason; when there is not a perfect continuity in the circuit, the fire must leap over the vacancies; there is a certain distance, which it is able to leap over according to its strength; if a number of small vacancies, though each be very minute, taken together exceed that distance, it cannot leap over them, and so the shock is prevented.

26. From the before-mentioned law of electricity, that points, as they are more or less acute, draw on and throw off the electrical fluid with more or less power, and at greater or less distances, and in larger or smaller quantities in the same time, we may see how to account for the situation of the leaf of gold suspended between two plates, the upper one continually electrified, the under one in a person's hand standing on the floor. When the upper plate is electrified, the leaf is attracted, and raised towards it, and would fly to that plate, were it not for its own points. The corner that happens to be uppermost when the leaf is rising, being a sharp point, from the extreme thinness of the gold, draws and receives at a distance a sufficient quantity of the electric fluid to give itself an electric atmosphere, by which its progress to the upper plate is stopped, and it begins to be repelled from that plate, and would be driven back to the under plate, but that its lowest corner is likewise a point, and throws off or discharges the overplus of the leaf's atmosphere, as fast

as the upper corner draws it on. Were these two points perfectly equal in acuteness, the leaf would take place exactly in the middle space, for its weight is a trifle compared to the power acting on it; but it is generally nearest the unelectrified plate, because, when the leaf is offered to the electrified plate, at a distance, the sharpest point is commonly first affected and raised towards it; so *that* point, from its greater acuteness, receiving the fluid faster than its opposite can discharge it at equal distances, it retires from the electrified plate, and draws nearer to the unelectrified plate, till it comes to a distance where the discharge can be exactly equal to the receipt, the latter being lessened, and the former increased; and there it remains as long as the globe continues to supply fresh electrical matter. This will appear plain, when the difference of acuteness in the corners is made very great. Cut a piece of Dutch gold (which is fittest for these experiments on account of its great strength) into the form of Figure 10, the upper corner a right angle, the two next obtuse angles, and the lowest a very acute one; and bring this on your plate under the electrified plate, in such a manner as that the right-angled part may be first raised (which is done by covering the acute part with the hollow of your hand), and you will see this leaf take place much nearer to the upper than the under plate; because, without being nearer, it cannot receive so fast at its right-angled point, as it can discharge at its acute one. Turn this leaf with the acute part uppermost, and then it takes place nearest the unelectrified plate; because, otherwise, it receives faster at its acute point, than it can discharge at its right-angled one. Thus the difference of distance is always proportioned to the difference of acuteness. Take care, in cutting your leaf, to leave no little ragged particles on the edges, which sometimes form points where you would not have them. You may make this figure so acute below, and blunt above, as to need no under plate, it discharging fast enough into the air. When it is made narrower, as the figure between the pricked lines, we call it the *golden fish*, from its manner of acting. For, if you take it by the tail, and hold it at a foot or greater horizontal distance from the prime conductor, it will, when let go, fly to it with a brisk but wavering motion, like that of an eel through the water; it will then take place under the prime conductor, at perhaps a quarter or half of an inch distance, and keep a continual shaking of its tail like a fish, so that it seems animated. Turn its tail towards the prime conductor, and then it flies to your finger, and seems to nibble it. And, if you hold a plate under it at six or eight inches distance, and cease turning the globe, when the electrical atmosphere of the conductor grows small, it will descend to the plate, and swim back again several times, with the same fish-like motion, greatly to the entertainment of spectators. By a little practice in blunting or sharpening the heads or tails of these figures, you may make them take place as desired, nearer or farther from the electrified plate.

27. It is said, in section eighth of this paper, that all kinds of common matter are supposed not to attract the electrical fluid with equal strength; and that those called electrics *per se*, as glass, &c., attract and retain it strongest, and contain the greatest quantity. This latter position may seem a paradox to some, being contrary to the hitherto received opinion; and therefore I shall now endeavour to explain it.

28. In order to this, let it first be considered, *that we cannot, by any means we are yet acquainted with, force the electrical fluid through glass.* I know it is commonly thought, that it easily pervades glass; and

the experiment of a feather suspended by a thread, in a bottle hermetically sealed, yet moved by bringing a rubbed tube near the outside of the bottle, is alleged to prove it. But, if the electrical fluid so easily pervades glass, how does the phial become *charged* (as we term it), when we hold it in our hands? Would not the fire, thrown in by the wire, pass through to our hands, and so escape into the floor? Would not the bottle in that case be left just as we found it, uncharged, as we know a metal bottle so attempted to be charged would be? Indeed, if there be the least crack, the minutest solution of continuity in the glass, though it remains so tight that nothing else we know of will pass, yet the extremely subtile electric fluid flies through such a crack with the greatest freedom, and such a bottle we know can never be charged; what then makes the difference between such a bottle and one that is sound, but this, that the fluid can pass through the one, and not through the other? *

29. It is true, there is an experiment, that at first sight would be apt to satisfy a slight observer, that the fire, thrown into the bottle by the wire, does really pass through the glass. It is this; place the bottle on a glass stand, under the prime conductor; suspend a bullet by a chain from the prime conductor, till it comes within a quarter of an inch right over the wire of the bottle; place your knuckle on the glass stand, at just the same distance from the coating of the bottle, as the bullet is from its wire. Now let the globe be turned, and you see a spark strike from the bullet to the wire of the bottle, and the same instant you see and feel an exactly equal spark striking from the coating on your knuckle, and so on, spark for spark. This looks as if

* See the first sixteen sections of the former paper, called *Farther Experimen's*, &c.

the whole received by the bottle was again discharged from it. And yet the bottle by this means is charged!* And therefore the fire that thus leaves the bottle, though the same in quantity, cannot be the very same fire that entered at the wire, for if it were, the bottle would remain uncharged.

30. If the fire that so leaves the bottle be not the same that is thrown in through the wire, it must be fire that subsisted in the bottle (that is, in the glass of the bottle) before the operation began.

31. If so, there must be a great quantity in glass, because a great quantity is thus discharged, even from very thin glass.

32. That this electrical fluid or fire is strongly attracted by glass, we know from the quickness and violence with which it is resumed by the part that had been deprived of it, when there is an opportunity. And by this, that we cannot from a mass of glass, draw a quantity of electric fire, or electrify the whole mass *minus*, as we can a mass of metal. We cannot lessen or increase its whole quantity, for the quantity it has it holds; and it has as much as it can hold. Its pores are filled with it as full as the mutual repellency of the particles will admit; and what is already in refuses, or strongly repels, any additional quantity. Nor have we any way of moving the electrical fluid in glass, but one; that is, by covering part of the two surfaces of thin glass with non-electrics, and then throwing an additional quantity of this fluid on one surface, which, spreading in the non-electric, and being bound by it to that surface, acts by its repelling force on the particles of the electrical fluid contained in the other surface, and drives them out of the glass into the non-electric on that side

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* See § 10 of *Farther Experiments*, &c.

from whence they are discharged, and then those added on the charged side can enter. But, when this is done, there is no more in the glass, nor less, than before, just as much having left it on one side as it received on the other.

33. I feel a want of terms here, and doubt much whether I shall be able to make this part intelligible. By the word *surface*, in this case, I do not mean mere length and breadth without thickness; but, when I speak of the upper or under surface of a piece of glass, the outer or inner surface of the phial, I mean length, breadth, and half the thickness, and beg the favor of being so understood. Now I suppose, that glass, in its first principles, and in the furnace, has no more of this electrical fluid than other common matter; that, when it is blown, as it cools, and the particles of common fire leave it, its pores become a vacuum; that the component parts of glass are extremely small and fine, I guess from its never showing a rough face when it breaks, but always a polish; and from the smallness of its particles I suppose the pores between them must be exceedingly small, which is the reason that *aqua fortis*, nor any other menstruum we have, can enter to separate them and dissolve the substance; nor is any fluid we know of, fine enough to enter, except common fire, and the electric fluid. Now the departing fire, leaving a vacuum, as aforesaid, between these pores, which air nor water are fine enough to enter and fill, the electric fluid (which is everywhere ready in what we call the non-electrics, and in the non-electric mixtures that are in the air,) is attracted in; yet does not become fixed with the substance of the glass, but subsists there as water in a porous stone, retained only by the attraction of the fixed parts, itself still loose and a fluid. But I suppose farther, that, in the cooling of the glass, its

texture becomes closest in the middle, and forms a kinc of partition, in which the pores are so narrow, that the particles of the electrical fluid, which enter both surfaces at the same time, cannot go through, or pass and repass from one surface to the other, and so mix together; yet, though the particles of electric fluid, imbibed by each surface, cannot themselves pass through to those of the other, their repellency can, and by this means they act on one another. The particles of the electric fluid have a mutual repellency, but by the power of attraction in the glass they are condensed or forced nearer to each other. When the glass has received, and by its attraction forced closer together, so much of this electric fluid, as that the power of attracting and condensing in the one, is equal to the power of expansion in the other, it can imbibe no more, and that remains its constant whole quantity; but each surface would receive more, if the repellency of what is in the opposite surface did not resist its entrance. The quantities of this fluid in each surface being equal, their repelling action on each other is equal; and therefore those of one surface cannot drive out those of the other; but, if a greater quantity is forced into one surface than the glass would naturally draw in, this increases the repelling power on that side, and, overpowering the attraction on the other, drives out part of the fluid that had been imbibed by that surface, if there be any non-electric ready to receive it; such there is in all cases where glass is electrified to give a shock. The surface that has been thus emptied, by having its electrical fluid driven out, resumes again an equal quantity with violence, as soon as the glass has an opportunity to discharge that over quantity more than it could retain by attraction in its other surface, by the additional repellency of which the vacuum had been occasioned. For experiments favoring (if I may not say confirming) this hypothesis, I must, to avoid repetition, beg leave to refer you back to what is said of the electrical phial in my former papers.

34. Let us now see how it will account for several other appearances. Glass, a body extremely elastic (and perhaps its elasticity may be owing in some degree to the subsisting of so great a quantity of this repelling fluid in its pores), must, when rubbed, have its rubbed surface somewhat stretched, or its solid parts drawn a little farther asunder, so that the vacancies, in which the electrical fluid resides, become larger, affording room for more of that fluid, which is immediately attracted into it from the cushion or hand rubbing, they being supplied from the common stock. But the instant the parts of the glass so opened and filled, have passed the friction, they close again, and force the additional quantity out upon the surface, where it must rest till that part comes round to the cushion again, unless some non-electric (as the prime conductor) first presents to receive it.* But, if the inside of the globe be lined with a non-electric, the additional repellency of the electrical fluid, thus collected by friction on the rubbed part of the globe's outer surface, drives an equal quantity out of the inner surface into that non-electric lining, which receiving it, and carrying it away from the rubbed part into the common mass, through the axis of the globe and frame of the machine, the new-collected electrical fluid can enter and remain in the outer surface,

* In the dark, the electric fluid may be seen on the cushion in two semi-circles or half-moons, one on the fore part, the other on the back part of the cushion, just where the globe and cushion separate. In the fore crescent the fire is passing out of the cushion into the glass; in the other it is leaving the glass, and returning into the back part of the cushion. When the prime conductor is applied to take it off the glass, the back crescent disappears.

and none of it (or a very little) will be received by the prime conductor. As this charged part of the globe comes round to the cushion again, the outer surface delivers its overplus fire into the cushion, the opposite inner surface receiving at the same time an equal quantity from the floor. Every electrician knows, that a globe wet within will afford little or no fire; but the reason has not before been attempted to be given, that I know of.

35. So, if a tube lined with a non-electric be rubbed,* little or no fire is obtained from it; what is collected from the hand, in the downward rubbing stroke, entering the pores of the glass, and driving an equal quantity out of the inner surface into the non-electric lining; and the hand in passing up to take a second stroke, takes out again what had been thrown into the outer surface, and then the inner surface receives back again what it had given to the non-electric lining. Thus the particles of electrical fluid belonging to the inside surface go in and out of their pores every stroke given to the tube. Put a wire into the tube, the inward end in contact with the non-electric lining, so it will represent the Leyden bottle. Let a second person touch the wire while you rub, and the fire, driven out of the inward surface when you give the stroke, will pass through him into the common mass, and return through him when the inner surface resumes its quantity, and therefore this new kind of Leyden bottle cannot be so charged. But thus it may; after every stroke, before you pass your hand up to make another, let a second person apply his finger to the wire, take the spark, and then withdraw his finger; and so on till he has drawn a number of sparks; thus will the inner surface be

* Gilt paper with the gilt face next the glass, does well.

exhausted, and the outer surface charged; then wrap a sheet of gilt paper close round the outer surface, and grasping it in your hand you may receive a shock by applying the finger of the other hand to the wire; for now the vacant pores in the inner surface resume their quantity, and the overcharged pores in the outer surface discharge their overplus; the equilibrium being restored through your body, which could not be restored through the glass.* If the tube be exhausted of air, a non-electric lining, in contact with the wire, is not necessary; for *in vacuo* the electrical fire will fly freely from the inner surface, without a non-electric conductor; but air resists its motion; for, being itself an electric *per se*, it does not attract it, having already its quantity. So the air never draws off an electric atmosphere from any body, but in proportion to the non-electrics mixed with it; it rather keeps such an atmosphere confined, which, from the mutual repulsion of its particles, tends to dissipation, and would immediately dissipate *in vacuo*. And thus the experiment of the feather enclosed in a glass vessel hermetically sealed, but moving on the approach of the rubbed tube, is explained. When an additional quantity of the electrical fluid is applied to the side of the vessel by the atmosphere of the tube, a quantity is repelled and driven out of the inner surface of that side into the vessel, and there affects the feather, returning again into its pores, when the tube with its atmosphere is withdrawn; not that the particles of that atmosphere did themselves pass through the glass to the feather. And every other appearance I have yet seen, in which glass and electricity are concerned, are, I think, explained with equal ease by the same hypothesis. Yet, perhaps, it may not be a true

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* See *Farther Experiments*, § 15.

one, and I shall be obliged to him that affords me a better.

36. Thus I take the difference between non-electrics, and glass, an electric *per se,* to consist in these two particulars. 1st, That a non-electric easily suffers a change in the quantity of the electric fluid it contains. You may lessen its whole quantity, by drawing out a part, which the whole body will again resume; but of glass you can only lessen the quantity contained in one of its surfaces; and not that, but by supplying an equal quantity at the same time to the other surface; so that the whole glass may always have the same quantity in the two surfaces, their two different quantities being added together. And this can only be done in glass that is thin; beyond a certain thickness we have yet no power that can make this change. And, 2dly, that the electric fire freely removes from place to place, in and through the substance of a non-electric, but not so through the substance of glass. If you offer a quantity to one end of a long rod of metal, it receives it, and, when it enters, every particle that was before in the rod pushes its neighbour quite to the farther end, where the overplus is discharged; and this instantaneously, where the rod is part of the circle in the experiment of the shock. But glass, from the smallness of its pores, or stronger attraction of what it contains, refuses to admit so free a motion; a glass rod will not conduct a shock, nor will the thinnest glass suffer any particle entering one of its surfaces to pass through to the other.

37. Hence we see the impossibility of success in the experiments proposed, to draw out the effluvial virtues of a non-electric, as cinnamon, for instance, and mixing them with the electric fluid, to convey them with that into the body, by including it in the globe,

and then applying friction, &c. For, though the effluvia of cinnamon and the electric fluid should mix within the globe, they would never come out together through the pores of the glass, and so go to the prime conductor; for the electric fluid itself cannot come through; and the prime conductor is always supplied from the cushion, and that from the floor. And, besides, when the globe is filled with cinnamon, or other non-electric, no electric fluid can be obtained from its outer surface, for the reason before mentioned. I have tried another way, which I thought more likely to obtain a mixture of the electric and other effluvia together, if such a mixture had been possible. I placed a glass plate under my cushion, to cut off the communication between the cushion and floor; then brought a small chain from the cushion into a glass of oil of turpentine, and carried another chain from the oil of turpentine to the floor, taking care that the chain from the cushion to the glass should touch no part of the frame of the machine. Another chain was fixed to the prime conductor, and held in the hand of a person to be electrified. The ends of the two chains in the glass were near an inch distant from each other, the oil of turpentine between. Now the globe being turned could draw no fire from the floor through the machine, the communication that way being cut off by the thick glass plate under the cushion; it must then draw it through the chains whose ends were dipped in the oil of turpentine. And, as the oil of turpentine, being an electric *per se*, would not conduct, what came up from the floor was obliged to jump from the end of one chain to the end of the other, through the substance of that oil, which we could see in large sparks, and so it had a fair opportunity of seizing some of the finest particles of the oil in its passage, and carrying them off with it; but no such effect followed, nor could I perceive the least difference in the smell of the electric effluvia thus collected, from what it has when collected otherwise, nor does it otherwise affect the body of a person electrized. I likewise put into a phial, instead of water, a strong purgative liquid, and then charged the phial, and took repeated shocks from it, in which case every particle of the electrical fluid must, before it went through my body, have first gone through the liquid when the phial is charging, and returned through it when discharging, yet no other effect followed than if it had been charged with water. I have also smelled the electric fire when drawn through gold, silver, copper, lead, iron, wood, and the human body, and could perceive no difference; the odor is always the same, where the spark does not burn what it strikes; and therefore I imagine it does not take that smell from any quality of the bodies it passes through. And indeed, as that smell so readily leaves the electric matter, and adheres to the knuckle receiving the sparks, and to other things, I suspect that it never was connected with it, but arises instantaneously from something in the air acted upon by it. For, if it was fine enough to come with the electric fluid through the body of one person, why should it stop on the skin of another?

But I shall never have done, if I tell you all my conjectures, thoughts, and imaginations on the nature and operations of this electric fluid, and relate the variety of little experiments we have tried. I have already made this paper too long, for which I must crave pardon, not having now time to abridge it. I shall only add, that, as it has been observed here that spirits will fire by the electric spark in the summer-time, without heating them, when Fahrenheit's thermometer is above seventy; so, when colder, if the operator puts a small flat bottle of spirits in his bosom, or a close pocket, with the spoon, some little time before he uses them, the heat of his body will communicate warmth more than sufficient for the purpose.

ADDITIONAL EXPERIMENTS;

Proving that the Leyden Bottle has no more Electrical Fire in it when charged, than before; nor less when discharged; that, in discharging, the Fire does not issue from the Wire and the Coating at the same Time, as some have thought, but that the Coating always receives what is discharged by the Wire, or an equal Quantity; the outer Surface being always in a Negative State of Electricity, when the inner Surface is in a Positive State.

Place a thick plate of glass under the rubbing cushion, to cut off the communication of electrical fire from the floor to the cushion; then, if there be no fine points or hairy threads sticking out from the cushion, or from the parts of the machine opposite to the cushion, (of which you must be careful,) you can get but a few sparks from the prime conductor, which are all the cushion will part with.

Hang a phial then on the prime conductor, and it will not charge, though you hold it by the coating. But,

Form a communication by a chain from the coating to the cushion, and the phial will charge.

For the globe then draws the electric fire out of the outside surface of the phial, and forces it through the prime conductor and wire of the phial into the inside surface.

Thus the bottle is charged with its own fire, no other being to be had while the glass plate is under the cushion.

Hang two cork balls by flaxen threads to the prime conductor; then touch the coating of the bottle, and they will be electrified and recede from each other.

For, just as much fire as you give the coating, so much is discharged through the wire upon the prime conductor, whence the cork balls receive an electrical atmosphere. But,

Take a wire bent in the form of a C, with a stick of wax fixed to the outside of the curve, to hold it by; and apply one end of this wire to the coating, and the other at the same time to the prime conductor, the phial will be discharged; and, if the balls are not electrified before the discharge, neither will they appear to be so after the discharge, for they will not repel each other.

If the phial really exploded at both ends, and discharged fire from both coating and wire, the balls would be *more* electrified, and recede *farther*; for none of the fire can escape, the wax handle preventing.

But if the fire with which the inside surface is surcharged, be so much precisely as is wanted by the outside surface, it will pass round through the wire fixed to the wax handle, restore the equilibrium in the glass, and make no alteration in the state of the prime conductor.

Accordingly we find, that, if the prime conductor be electrified, and the cork balls in a state of repellency before the bottle is discharged, they continue so afterwards. If not, they are not electrified by that discharge.

TO JAMES BOWDOIN,* AT BOSTON.

Enclosing Papers on Electricity.

Philadelphia, 25 October, 1750.

Sir,

Enclosed with this I send you all my electrical papers, fairly transcribed, and I have, as you desired, examined the copy and find it correct. I shall be glad to have your observations on them; and, if in any part I have not made myself well understood, I will, on notice, endeavour to explain the obscure passages by letter. My compliments to Mr. Cooper, and the other gentlemen, who were with you here. I hope you all got safe home. I am, Sir,

Your most humble servant,

B. Franklin.

TO A FRIEND IN BOSTON.†

Account of an Accident while making an Electrical Experiment.

Philadelphia, 25 December, 1750.

I have lately made an experiment in electricity, that I desire never to repeat. Two nights ago, being about to kill a turkey by the shock from two large glass jars,

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* Mr. Bowdoin was at this time twenty-three years old. He became distinguished afterwards as a philosopher and statesman, being one f the principal founders and the first president of the Amcrican Academy of Arts and Sciences. He took an active and prominent part in the events of the American Revolution, and was subsequently governor of Massachusetts. — Editor.

† A copy of this letter was found among Governor Bowdoin's papers, without the namc of the person to whom it was addressed. — Editor.

containing as much electrical fire as forty common phials, I inadvertently took the whole through my own arms and body, by receiving the fire from the united top wires with one hand, while the other held a chain connected with the outsides of both jars. The company present (whose talking to me, and to one another, I suppose occasioned my inattention to what I was about) say, that the flash was very great, and the crack as loud as a pistol; yet, my senses being instantly gone, I neither saw the one nor heard the other; nor did I feel the stroke on my hand, though I afterwards found it raised a round swelling where the fire entered, as big as half a pistol-bullet; by which you may judge of the quickness of the electrical fire, which by this instance seems to be greater than that of sound, light, or animal sensation.

What I can remember of the matter is, that I was about to try whether the bottles or jars were fully charged, by the strength and length of the stream issuing to my hand, as I commonly used to do, and which I might safely enough have done if I had not held the chain in the other hand. I then felt what I know not how well to describe; a universal blow throughout my whole body from head to foot, which seemed within as well as without; after which the first thing I took notice of was a violent quick shaking of my body, which gradually remitting, my sense as gradually returned, and then I thought the bottles must be discharged, but could not conceive how, till at last I perceived the chain in my hand, and recollected what I had been about to do. That part of my hand and fingers, which held the chain, was left white, as though the blood had been driven out, and remained so eight or ten minutes after, feeling like dead flesh; and I had a numbness in my arms and the back of my neck, which continued till the next morning, but wore off. Nothing remains now of this shock, but a soreness in my breast-bone, which feels as if it had been bruised. I did not fall, but suppose I should have been knocked down, if I had received the stroke in my head. The whole was over in less than a minute.

You may communicate this to Mr. Bowdoin, as a caution to him, but do not make it more public, for I am ashamed to have been guilty of so notorious a blunder; a match for that of the Irishman, whom my sister told me of, who, to divert his wife, poured the bottle of gunpowder on the live coal; or of that other, who, being about to steal powder, made a hole in the cask with a hot iron. I am yours, &c.

B. Franklin.

P. S. The jars hold six gallons each.

TO JAMES BOWDOIN.

Introducing Mr. Kinnersley as a Lecturer on Electricity

Philadelphia, 5 September, 1751.

Sir,

As you are curious in electricity, I take the freedom of introducing to you, my friend Mr. Kinnersley, who visits Boston with a complete apparatus for experimental lectures on that subject. He has given great satisfaction to all that have heard him here, and I believe you will be pleased with his performance. He is quite a stranger in Boston; and, as you will find him a sensible, worthy man, I hope he will be favored with your countenance, and the encouragement which that must procure him among your friends. I am, Sir, with great respect,

Your most humble servant,

B. Franklin.

TO CADWALLADER COLDEN,* AT NEW YORK

COMMUNICATED TO MR. COLLINSON.

Unlimited Nature of the Electric Force.

Philadelphia, 1751.

SIR,

I enclose you answers, such as my present hurry of business will permit me to make, to the principal queries contained in yours of the 28th instant, and beg leave to refer you to the latter piece in the printed collection of my papers, for farther explanation of the difference between what are called *electrics per se* and *non-electrics.* When you have had time to read and consider these papers, I will endeavour to make any new experiments you shall propose, that you think may afford farther light or satisfaction to either of us; and shall be much obliged to you for such remarks, objections, &c., as may occur to you.

I forget whether I wrote to you, that I have melted brass pins and steel needles, inverted the poles of the magnetic needle, given a magnetism and polarity to needles that had none, and fired dry gunpowder by the electric spark. I have five bottles that contain eight or nine gallons each, two of which charged are sufficient for those purposes; but I can charge and discharge them altogether. There are no bounds (but what expense and labor give) to the force man may raise and use in the electrical way; for bottle may be added to

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* Afterwards lieutenant-governor of New York. He was highly distinguished for his attainments in medicine, the mathematics, botany, and the philosophical sciences, and wrote several papers on those subjects, which were published in Europe. He also wrote a history of the Five Nations of Indians. He lived to an advanced age, and died at the beginning of the American Revolution. — EDITOR.

bottle *in infinitum*, and all united and discharged together as one, the force and effect proportioned to their number and size. The greatest known effects of common lightning may, I think, without much difficulty, be exceeded in this way, which a few years since could not have been believed, and even now may seem to many a little extravagant to suppose. So we are got beyond the skill of Rabelais's devils of two years old, who, he humorously says, had only learned to thunder and lighten a little round the head of a cabbage.

I am, with sincere respect,

Your most obliged humble servant,

B. FRANKLIN.

QUERIES AND ANSWERS REFERRED TO IN THE FOREGOING LETTER.

The Terms "Electric per se" and "Non-electric" improper. — New Relation between Metals and Water. — Effects of Air in Electrical Experiments. — Experiment for discovering more of the Qualities of the Electric Fluid.

Query. Wherein consists the difference between an *electric* and a *non-electric* body?

Answer. The terms *electric per se* and *non-electric*, were first used to distinguish bodies, on a mistaken supposition, that those called electrics *per se* alone contained electric matter in their substance, which was capable of being excited by friction, and of being produced or drawn from them, and communicated to those called non-electrics, supposed to be destitute of it; for the glass, &c., being rubbed, discovered signs of having it, by snapping to the finger, attracting, repelling, &c.,

and could communicate those signs to metals and water Afterwards it was found, that rubbing of glass would not produce the electric matter, unless a communication was preserved between the rubber and the floor; and subsequent experiments proved, that the electric matter was really drawn from those bodies that at first were thought to have none in them. Then it was doubted whether glass, and other bodies called *electrics per se*, had really any electric matter in them, since they apparently afforded none but what they first extracted from those which had been called non-electrics. But some of my experiments show, that glass contains it in great quantity, and I now suspect it to be pretty equally diffused in all the matter of this terraqueous globe. If so, the terms *electric per se* and *non-electric* should be laid aside as improper; and (the only difference being this, that some bodies will conduct electric matter, and others will not,) the terms *conductor* and *non-conductor* may supply their place. If any portion of electric matter is applied to a piece of conducting matter, it penetrates and flows through it, or spreads equally on its surface; if applied to a piece of non-conducting matter, it will do neither. Perfect conductors of electric matter are only metals and water; other bodies conducting only as they contain a mixture of those, without more or less of which they will not conduct at all.* This (by the way) shows a new relation between metals and water heretofore unknown.

To illustrate this by a comparison, which, however, can only give a faint resemblance. Electric matter passes through conductors, as water passes through a porous stone, or spreads on their surfaces as water spreads on a wet stone; but, when applied to non-

* This proposition is since found to be too general; Mr. Wilson having discovered, that melted wax and rosin will also conduct.

conductors, it is like water dropped on a greasy stone, it neither penetrates, passes through, nor spreads on the surface, but remains in drops where it falls. See farther on this head, in my last printed piece, entitled *Opinions and Conjectures*, &c. 1749.

Query. What are the effects of air in electrical experiments?

Answer. All I have hitherto observed are these. Moist air receives and conducts the electrical matter in proportion to its moisture, quite dry air not at all; air is therefore to be classed with the non-conductors. Dry air assists in confining the electrical atmosphere to the body it surrounds, and prevents its dissipating; for *in vacuo* it quits easily, and points operate stronger, that is, they throw off or attract the electrical matter more freely, and at greater distances; so that air intervening obstructs its passage from body to body in some degree. A clean electrical phial and wire, containing air instead of water, will not be charged, nor give a shock, any more than if it was filled with powder of glass; but exhausted of air, it operates as well as if filled with water. Yet an electric atmosphere and air do not seem to exclude each other, for we breathe freely in such an atmosphere, and dry air will blow through it without displacing or driving it away. I question whether the strongest dry north-wester * would dissipate it. I once electrified a large cork ball at the end of a silk thread three feet long, the other end of which I held in my fingers, and whirled it round, like a sling, one hundred times in the air, with the swiftest motion I could possibly give it; yet it retained its electric atmosphere, though it must have passed through eight hundred yards of air, allowing my arm in giving the motion to

* A cold dry wind of North America.

add a foot to the semidiameter of the circle. By quite dry air, I mean the dryest we have; for perhaps we never have any perfectly free from moisture. An electrical atmosphere raised round a thick wire, inserted in a phial of air, drives out none of the air, nor on withdrawing that atmosphere will any air rush in, as I have found by a curious experiment * accurately made, whence we concluded that the air's elasticity was not affected thereby.

An Experiment towards discovering more of the Qualities of the Electric Fluid.

From the prime conductor, hang a bullet by a wire hook; under the bullet, at half an inch distance, place a bright piece of silver to receive the sparks; then let the wheel be turned, and in a few minutes (if the repeated sparks continually strike in the same spot) the silver will receive a blue stain, nearly the color of a watch-spring.

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* The experiment here mentioned was thus made. An empty phial was stopped with a cork. Through the cork passed a thick wire, as usual in the Leyden experiment, which wire almost reached the bottom. Through another part of the cork passed one leg of a small glass siphon, the other leg on the outside came down almost to the bottom of the phial. This phial was first held a short time in the hand, which, warming and of course rarefying the air within, drove a small part of it out through the siphon. Then a little red ink in a tea-spoon was applied to the opening of the outer leg of the siphon; so that as the air within cooled, a little of the ink might rise in that leg. When the air within the bottle came to be of the same temperature of that without, the drop of red ink would rest in a certain part of the leg. But the warmth of a finger applied to the phial would cause that drop to descend, as the least outward coolness applied would make it ascend. When it had found its situation, and was at rest, the wire was electrified by a communication from the prime conductor. This was supposed to give an electric atmosphere to the wire within the bottle, which might likewise rarefy the included air, and of course depress the drop of ink in the siphon. But no such effect followed.

A bright piece of iron will also be spotted, but not with that color; it rather seems corroded.

On gold, brass, or tin, I have not perceived it makes any impression. But the spots on the silver or iron will be the same, whether the bullet be lead, brass, gold, or silver.

On a silver bullet there will also appear a small spot, as well as on the plate below it.

FROM JAMES BOWDOIN TO BENJAMIN FRANKLIN.

On the Causes of the crooked Direction of Lightning. — Objections to the Hypothesis that the Sea is the Source of Lightning. — On the Swiftness of the Electrical Fire.

Boston, 21 December, 1751.

SIR,

The experiments Mr. Kinnersley has exhibited here, have been greatly pleasing to all sorts of people, that have seen them; and I hope, by the time he returns to Philadelphia, his tour this way will turn to good account. His experiments are very curious, and I think prove most effectually your doctrine of electricity; that it is a real element annexed to, and diffused among, all bodies we are acquainted with; that it differs in nothing from lightning, the effects of both being similar, and their properties, so far as they are known, the same.

The remarkable effect of lightning on iron lately discovered in giving it the magnetic virtue, and the same effect produced on small needles by the electrical fire, are a further and convincing proof that they are both the same element; but, which is very unaccountable, Mr. Kinnersley tells me it is necessary, to produce this effect, that the direction of the needle and the electrical fire should be north and south, from either to the other; and that, just so far as they deviate therefrom, the magnetic power in the needle is less, till, their direction being at right angles with north and south, the effect entirely ceases.

We made at Faneuil Hall, where Mr. Kinnersley's apparatus is, several experiments to give some small needles the magnetic virtue, previously examining, by putting them in water, on which they will be supported, whether or not they had any of that virtue; and I think we found all of them to have some small degree of it, their points turning to the north. We had nothing to do then, but to invert the poles, which accordingly was done by sending through them the charge of two large glass jars; the eye of the needle turning to the north, as the point before had done. That end of the needle, which the fire is thrown upon, Mr. Kinnersley tells me, always points to the north.

The electrical fire, passing through the air, has the same crooked direction as lightning.* This appearance I endeavour to account for thus. Air is an electric *per se;* therefore there must be a mutual repulsion between air and the electrical fire. A column or cylinder of air, having the diameter of its base equal to the diameter of the electrical spark, intervenes between that part of the body which the spark is drawn from and that of the body it aims at. The spark acts upon this column, and is acted upon by it, more strongly than any other neighbouring portion of air. The column, being thus acted upon, becomes more dense, and, being more dense, repels the spark more strongly; its repellency being in proportion to its density. Having acquired, by

* This is most easily observed in large strong sparks, taken at some inches distance.

being condensed, a degree of repellency greater than its natural, it turns the spark out of its straight course; the neighbouring air, which must be less dense, and therefore has a smaller degree of repellency, giving it a more ready passage. The spark having taken a new direction must now act on, or most strongly repel, the column of air which lies in that direction, and consequently must condense that column in the same manner as the former, when the spark must again change its course, which course will be repeatedly changed, till the spark reaches the body that attracted it.

To this account one objection occurs; that, as air is very fluid and elastic, and so endeavours to diffuse itself equally, the supposed accumulated air within the column aforesaid would be immediately diffused among the contiguous air, and circulate to fill the space it was driven from, and consequently that the said column, on the greater density of which the phenomenon is supposed to depend, would not repel the spark more strongly than the neighbouring air.

This might be an objection, if the electrical fire was as sluggish and inactive as air. Air takes a sensible time to diffuse itself equally, as is manifest from winds, which often blow for a considerable time together from the same point, and with a velocity, even in the greatest storms, not exceeding, as it is said, sixty miles an hour; but the electrical fire seems propagated instantaneously, taking up no perceptible time in going very great distances. It must be, then, an inconceivably short time in its progress from an electrified to an unelectrified body, which, in the present case, can be but a few inches apart. But this small portion of time is not sufficient for the elasticity of the air to exert itself, and therefore the column aforesaid must be in a denser state than its neighbouring air.

About the velocity of the electrical fire more is said below, which perhaps may more fully obviate this objection. But let us have recourse to experiments. Experiments will obviate all objections, or confound the hypothesis. The electrical spark, if the foregoing be true, will pass through a vacuum in a right line.

To try this, let a wire be fixed perpendicular on the plate of an air-pump, having a leaden ball on its upper end; let another wire, passing through the top of a receiver, have on each end a leaden ball; let the leaden balls within the receiver, when put on the air-pump, be within two or three inches of each other; the receiver being exhausted, the spark given from a charged phial to the upper wire will pass through rarefied air, nearly approaching to a vacuum, to the lower wire, and I suppose in a right line, or nearly so; the small portion of air remaining in the receiver, which cannot be entirely exhausted, may possibly cause it to deviate a little, but perhaps not sensibly, from a right line. The spark also might be made to pass through air greatly condensed, which perhaps would give it a still more crooked direction. I have not had an opportunity to make any experiments of this sort, not knowing of an air-pump nearer than Cambridge; but you can easily make them at your State-house, where there is one. If these experiments answer, I think the crooked direction of lightning will be also accounted for.

With respect to your letters on electricity, it will be no new thing to you to be told, that they are very curious and entertaining, and by far the best and most rational that have been written on that subject. Your hypothesis, in particular, for explaining the phenomena of lightning is very ingenious. That some clouds are highly charged with electrical fire, and that their communicating it to those that have less, to mountains, and other eminences, makes it visible and audible, when it is denominated lightning and thunder, is highly probable; but that the sea, which you suppose the grand source of it, can collect it, I think admits of a doubt; for, though the sea be composed of salt and water, an electric *per se* and a non-electric; and though the friction of electrics *per se* and non-electrics will collect that fire; yet it is only under certain circumstances, which water will not admit; for it seems necessary, that the electrics *per se* and non-electrics, rubbing one another, should be of such substances as will not adhere to, or incorporate with, each other. Thus a glass or sulphur sphere turned in water, and so a friction between them, will not collect any fire; nor, I suppose, would a sphere of salt revolving in water; the water adhering to, or incorporating with, those electrics *per se*.

But, granting that the friction between the salt and water would collect the electric fire, that fire, being so extremely subtile and active, would be immediately communicated either to those lower parts of the sea, from which it was drawn, and so only perform quick revolutions, or be communicated to the adjacent islands or continent, and so be diffused instantaneously through the general mass of the earth. I say instantaneously; for the greatest distances we can conceive within the limits of our globe, even that of the two most opposite points, it will take no sensible time in passing through; and therefore it seems a little difficult to conceive how there can be any accumulation of the electric fire upon the surface of the sea, or how the vapors arising from the sea should have a greater share of that fire than other vapors.

That the progress of the electrical fire is so amazingly swift, seems evident from an experiment you yourself (not out of choice) made, when two or three large glass jars were discharged through your body. You neither heard the crack, were sensible of the stroke, nor, which is more extraordinary, saw the light; which gave you just reason to conclude, that it was swifter than sound, than animal sensation, and even light itself. Now light, as astronomers have demonstrated, is about six minutes passing from the sun to the earth; a distance, they say, of more than eighty millions of miles. The greatest rectilinear distance within the compass of the earth is about eight thousand miles, equal to its diameter. Supposing, then, that the velocity of the electrical fire be the same as that of light, it will go through a space equal to the earth's diameter in about two sixtieths of one second of a minute. It seems inconceivable, then, that it should be accumulated upon the sea in its present state, which, as it is a non-electric, must give the fire an instantaneous passage to the neighbouring shores, and they convey it to the general mass of the earth. But such accumulation seems still more inconceivable, when the electrical fire has but a few feet depth of water to penetrate, to return to the place from whence it is supposed to be collected. Your thoughts on these remarks I shall receive with a great deal of pleasure. I take notice, that in the printed copies of your letters several things are wanting, which are in the manuscript you sent me, particularly what relates to Mr. Watson.

I understand by your son, that you had written, or was writing a paper on the effects of the electrical fire on loadstones, needles, &c., which I would ask the favor of a copy of, as well as of any other papers on electricity written since I had the manuscript; for which I repeat my obligations to you. I am, with great esteem,

Sir, your most obedient humble servant,

James Bowdoin.

TO JAMES BOWDOIN.

Observations on the Subjects of the preceding Letter. Reasons for supposing the Sea to be the grand Source of Lightning. — Reasons for doubting this Hypothesis. — Improvement in a Globe for raising the Electric Fire.

READ AT THE ROYAL SOCIETY, MAY 27TH, 1756.

Philadelphia, 24 January, 1752.

SIR,

I am glad to learn, by your favor of the 21st past, that Mr. Kinnersley's lectures have been acceptable to the gentlemen of Boston, and are like to prove serviceable to himself.

I thank you for the countenance and encouragement you have so kindly afforded my fellow-citizen.

I send you enclosed an extract of a letter containing the substance of what I observed concerning the communication of magnetism to needles by electricity. The minutes I took at the time of the experiments are mislaid. I am very little acquainted with the nature of magnetism. Dr. Gawin Knight, inventor of the steel magnets, has wrote largely on that subject; but I have not yet had leisure to peruse his writings with the attention necessary to become master of his doctrine.

Your explication of the crooked direction of lightning appears to me both ingenious and solid. When we can account as satisfactorily for the electrification of clouds, I think that branch of natural philosophy will be nearly complete.

The air, undoubtedly, obstructs the motion of the electric fluid. Dry air prevents the dissipation of an electric atmosphere, the denser the more, as in cold weather. I question whether such an atmosphere can be retained by a body *in vacuo*. A common electrical phial requires a non-electric communication from the wire to every part of the charged glass; otherwise, being dry and clean, and filled with air only, it charges slowly, and discharges gradually by sparks, without a shock; but, exhausted of air, the communication is so open and free between the inserted wire and surface of the glass, that it charges as readily, and shocks as smartly as if filled with water; and I doubt not, but that, in the experiment you propose, the sparks would not only be near straight *in vacuo*, but strike at a greater distance than in the open air, though perhaps there would not be a loud explosion. As soon as I have a little leisure, I will make the experiment, and send you the result.

My supposition, that the sea might possibly be the grand source of lightning, arose from the common observation of its luminous appearance in the night, on the least motion; an appearance never observed in fresh water. Then I knew, that the electric fluid may be pumped up out of the earth, by the friction of a glass globe, on a non-electric cushion; and that, notwithstanding the surprising activity and swiftness of that fluid, and the non-electric communication between all parts of the cushion and the earth, yet quantities would be snatched up by the revolving surface of the globe, thrown on the prime conductor, and dissipated in air. How this was done, and why that subtile, active spirit did not immediately return again from the globe into some part or other of the cushion, and so into the earth, was difficult to conceive; but, whether from its being opposed by a current setting upwards to the cushion, or from whatever other cause, that it did not so return was an evident fact. Then I considered the separate particles of water as so many hard spherules, capable of touching the salt only in points, and imagined a particle of salt could therefore no more be wet by a particle of water, than a globe by a cushion; that there might therefore be such a friction between these originally constituent particles of salt and water, as in a sea of globes and cushions; that each particle of water on the surface might obtain, from the common mass, some particles of the universally diffused, much finer, and more subtile electric fluid, and, forming to itself an atmosphere of those particles, be repelled from the then generally electrified surface of the sea, and fly away with them into the air. I thought, too, that possibly the great mixture of particles electric *per se*, in the ocean water, might, in some degree, impede the swift motion and dissipation of the electric fluid through it to the shores, &c. But, having since found, that salt in the water of an electric phial does not lessen the shock; and having endeavoured in vain to produce that luminous appearance from a mixture of salt and water agitated; and observed, that even the sea-water will not produce it after some hours standing in a bottle; I suspect it to proceed from some principle yet unknown to us (which I would gladly make some experiments to discover, if I lived near the sea), and I grow more doubtful of my former supposition, and more ready to allow weight to that objection (drawn from the activity of the electric fluid, and the readiness of water to conduct), which you have indeed stated with great strength and clearness.

In the mean time, before we part with this hypothesis, let us think what to substitute in its place. I have sometimes queried, whether the friction of the air, an electric *per se*, in violent winds, among trees, and against the surface of the earth, might not pump up, as so many glass globes, quantities of the electric fluid, which the rising vapors might receive from the air, and retain in the clouds they form; on which I should be glad to have your sentiments. An ingenious friend of mine supposes the land clouds more likely to be electrified than the sea clouds. I send his letter for your perusal, which please to return me.

I have wrote nothing lately on electricity, nor observed any thing new that is material, my time being much taken up with other affairs. Yesterday I discharged four jars through a fine wire, tied up between two strips of glass; the wire was in part melted, and the rest broke into small pieces, from half an inch long, to half a quarter of an inch. My globe raises the electric fire with greater ease, in much greater quantities, by the means of a wire extended from the cushion, to the iron pin of a pump-handle behind my house, which communicates by the pump-spear with the water in the well.

By this post I send to Dr. Perkins, who is curious in that way, some meteorological observations and conjectures, and desire him to communicate them to you, as they may afford you some amusement, and I know you will look over them with a candid eye. By throwing our occasional thoughts on paper, we more readily discover the defects of our opinions, or we digest them better, and find new arguments to support them. This I sometimes practise; but such pieces are fit only to be seen by friends.

I am, with great respect, &c.

B Franklin

FROM E. KINNERSLEY TO BENJAMIN FRANKLIN.

New Experiments. — Paradoxes inferred from them. — Difference in the Electricity of a Globe of Glass charged, and a Globe of Sulphur. — Difficulty of ascertaining which is positive and which negative.

[Boston,] 3 February, 1752.

SIR,

I have the following experiments to communicate. I held in one hand a wire, which was fastened at the other end to the handle of a pump, in order to try whether the stroke from the prime conductor, through my arms, would be any greater than when conveyed only to the surface of the earth, but could discover no difference.

I placed the needle of a compass on the point of a long pin, and, holding it in the atmosphere of the prime conductor, at the distance of about three inches, found it to whirl round like the flyers of a jack, with great rapidity.

I suspended with silk a cork ball, about the bigness of a pea, and presented to it rubbed amber, sealing-wax, and sulphur, by each of which it was strongly repelled; then I tried rubbed glass and China, and found that each of these would attract it, until it became electrified again, and then it would be repelled as at first; and, while thus repelled by the rubbed glass or China, either of the others when rubbed would attract it. Then I electrified the ball, with the wire of a charged phial, and presented to it rubbed glass (the stopper of a decanter) and a China tea-cup, by which it was as strongly repelled as by the wire; but, when I presented either of the other rubbed electrics, it would be strongly attracted, and, when I electrified it by either of these, till it became repelled, it would be attracted by the wire of the phial, but be repelled by its coating.

These experiments surprised me very much, and have induced me to infer the following paradoxes.

1. If a glass globe be placed at one end of a prime conductor, and a sulphur one at the other end, both being equally in good order, and in equal motion, not a spark of fire can be obtained from the conductor; but one globe will draw out, as fast as the other gives in.

2. If a phial be suspended on the conductor, with a chain from its coating to the table, and only one of the globes be made use of at a time, twenty turns of the wheel, for instance, will charge it; after which, so many turns of the other wheel will discharge it; and as many more will charge it again.

3. The globes being both in motion, each having a separate conductor, with a phial suspended on one of them, and the chain of it fastened to the other, the phial will become charged; one globe charging positively, the other negatively.

4. The phial being thus charged, hang it in like manner on the other conductor; set both wheels a going again, and the same number of turns that charged it before will now discharge it; and the same number, repeated, will charge it again.

5. When each globe communicates with the same prime conductor, having a chain hanging from it to the table, one of them, when in motion, (but which I cannot say,) will draw fire up through the cushion, and discharge it through the chain; the other will draw it up through the chain, and discharge it through the cushion.

I should be glad if you would send to my house for my sulphur globe, and the cushion belonging to it, and make the trial; but must caution you not to use chalk on the cushion; some fine powdered sulphur will do better. If, as I expect, you should find the globes to charge the prime conductor differently, I hope you will be able to discover some method of determining which it is that charges positively. I am, &c.

E. Kinnersley.*

TO E. KINNERSLEY, AT BOSTON.

Probable Cause of the different Attractions and Repulsions of the two Electrified Globes mentioned in the preceding Letter.

Philadelphia, 2 March, 1752.

Sir,

I thank you for the experiments communicated. I sent immediately for your brimstone globe, in order to make the trials you desired, but found it wanted centres, which I have not time now to supply; but, the first leisure, I will get it fitted for use, try the experiments, and acquaint you with the result.

In the mean time I suspect, that the different attractions and repulsions you observed, proceeded rather from the greater or smaller quantities of the fire you obtained from different bodies, than from its being of a different *kind*, or having a different *direction*. In haste,

I am, &c.

B. Franklin.

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* The Reverend Ebenezer Kinnersley was a professor in the College of Philadelphia. — Editor.

FROM JAMES BOWDOIN TO BENJAMIN FRANKLIN.

Effect of Lightning on Captain Waddel's Compass, and on the Dutch Church at New York.

READ AT THE ROYAL SOCIETY, JUNE 3D, 1756.

Boston, 2 March, 1752.

SIR,

I have received your favor of the 24th of January past, enclosing an extract from your letter to Mr. Collinson, and Dr. Colden's letter to yourself, which I have read with a great deal of pleasure, and am much obliged to you for. Your extract confirms a correction Mr. Kinnersley made, a few days ago, of a mistake I was under respecting the polarity given to needles by the electrical fire, "that the end which receives the fire always points north;" and "that the needle, being situated east and west, will not have a polar direction." You find, however, the polarity strongest when the needle is shocked lying north and south; weakest when lying east and west; which makes it probable that the communicated magnetism is less, as the needle varies from a north and south situation. As to the needle of Captain Waddel's compass, if its polarity was reversed by the lightning, the effect of lightning and electricity, in regard of that, seems dissimilar; for a magnetic needle in a north and south situation (as the compass needle was), instead of having its power reversed, or even diminished, would have it confirmed or increased by the electric fire. But perhaps the lightning communicated to some nails in the binacle (where the compass is placed) the magnetic virtue, which might disturb the compass.

This I have heard was the case; if so, the seeming dissimilarity vanishes; but this remarkable circumstance (if it took place) I should think would not be omitted in Captain Waddel's account.

I am very much pleased that the explication I sent you, of the crooked direction of lightning, meets with your approbation.

As to your supposition about the source of lightning, the luminous appearance of the sea in the night, and the similitude between the friction of the particles of salt and water, as you considered them in their original separate state, and the friction of the globe and cushion, very naturally led you to the ocean, as the grand source of lightning; but the activity of lightning, or the electric element, and the fitness of water to conduct it, together with the experiments you mention of salt and water, seem to make against it, and to prepare the way for some other hypothesis. Accordingly you propose a new one, which is very curious, and not so liable, I think, to objections as the former. But there is not as yet, I believe, a sufficient variety of experiments to establish any theory, though this seems the most hopeful of any I have heard of.

The effect which the discharge of your four glass jars had upon a fine wire, tied between two strips of glass, puts me in mind of a very similar one of lightning, that I observed at New York, October, 1750, a few days after I left Philadelphia. In company with a number of gentlemen, I went to take a view of the city from the Dutch church steeple, in which is a clock about twenty or twenty-five feet below the bell. From the clock went a wire through two floors, to the clock-hammer near the bell, the holes in the floor for the wire being perhaps about a quarter of an inch diameter. We were told, that in the spring of 1750, the lightning struck the clock-hammer, and descended along the wire to the clock, melting in its way several spots of the wire, from three to nine inches long, through one third of its substance, till coming within a few feet of the lower end, it melted the wire quite through, in several places, so that it fell down in several pieces; which spots and pieces we saw. When it got to the end of the wire, it flew off to the hinge of a door, shattered the door, and dissipated. In its passage through the holes of the floors it did not do the least damage, which evidences that wire is a good conductor of lightning (as it is of electricity), provided it be substantial enough, and might, in this case, had it been continued to the earth, have conducted it without damaging the building.*

Your information about your globe's raising the electric fire in greater quantities, by means of a wire extending from the cushion to the earth, will enable me, I hope, to remedy a great inconvenience I have been under, to collect the fire with the electrifying glass I use, which is fixed in a very dry room, three stories from the ground. When you send your meteorological observations to Dr. Perkins, I hope I shall have the pleasure of seeing them. I am, &c.

JAMES BOWDOIN.

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* The wire mentioned in this account was replaced by a small brass chain. In the summer of 1763, the lightning again struck that steeple, and from the clock-hammer near the bell, it pursued the chain as it had before done the wire, went off to the same hinge, and again shattered the same door. In its passage through the same holes of the same floors, it did no damage to the floors, nor to the building during the whole extent of the chain. But the chain itself was destroyed, being partly scattered about in fragments of two or three links, melted and stuck together, and partly blown up or reduced to smoke, and dissipated. [See an account of the same effect of lightning on a wire at Newbury, p. 357.] The steeple, when repaired, was guarded by an iron conductor, or rod, extending from the foot of the vane-spindle, down the outside of the building, into the earth. The newspapers have mentioned, that in 1765, the lightning fell a third time on the same steeple, and was safely conducted by the rod; but the particulars are not come to hand.

FROM JAMES BOWDOIN TO BENJAMIN FRANKLIN.

Remarks on Dr. Colden's Letter respecting the Electricity of the Clouds.

Boston, 16 March, 1752.

SIR,

According to promise in my last, I now return you Dr. Colden's letter; for communicating which I am greatly obliged to you. The Doctor, dissenting from you, is of opinion, that sea clouds are less electrified than land clouds, and gives the reasons of his opinion, "that salt, though an electric *per se*, is never raised in sea vapors; therefore sea clouds are less electrified than land clouds; that, all sulphurs (which mountains especially abound with, from whence thunder-gusts are often observed to rise,) being electrics *per se*, sulphurous vapors are more electrified than sea vapors." The conclusions from these reasons might be just, if the supposition they are formed upon was just, namely, that vapors, &c., are more or less electrified according to the quantity of electrics *per se* they contain. But that seems contrary to experience; for electricity is accumulated upon the conductor without any mixture of the electrics *per se* (glass or sulphur), which excited it.

Another reason the Doctor offers is, that electricity forwards vegetation, which makes it probable, he supposes, that vapors from the land and vegetables are more electrified than sea vapors; but, by the same way of reasoning, it is probable that land vapors have a mixture of salt (which the Doctor has denied, and justly, I believe, even of sea vapors), for salt in a suitable proportion, I have heard, promotes vegetation.

I pretend not to say what vapors are most electrified, but only that these reasons do not appear to me to support the Doctor's opinion.

The Doctor hints that he has something in speculation, which will be the means of improving all parts of natural philosophy. If he has communicated his scheme to you, or any new improvement, I shall be obliged, provided it be consistent with the laws of friendship, if you would favor me with some account of it. I have heard, that several gentlemen have desired you to procure them a number of large glass jars suitable for electrical experiments; I take the liberty of adding to your trouble, by asking the favor of you to procure half a dozen of them for me, two of them to be coated and made fit for use, the other four I shall get finished here; for which I shall take care to reimburse you. I am, with much esteem,

Sir, yours, &c.

James Bowdoin.

TO E. KINNERSLEY, AT BOSTON.

Reasons for supposing that the Glass Globe charges positively, and the Sulphur negatively. — Hint respecting a Leather Globe for Experiments when travelling.

Philadelphia, 16 March, 1752.

Sir,

Having brought your brimstone globe to work, I tried one of the experiments you proposed, and was agreeably surprised to find, that the glass globe being at one end of the conductor, and the sulphur globe at the other end, both globes in motion, no spark could be obtained from the conductor, unless when one globe turned slower, or was not in so good order as the other;

and then the spark was only in proportion to the difference, so that turning equally, or turning that slowest which worked best, would again bring the conductor to afford no spark.

I found also, that the wire of a phial charged by the glass globe, attracted a cork ball that had touched the wire of a phial charged by the brimstone globe, and *vice versâ*, so that the cork continued to play between the two phials, just as when one phial was charged through the wire, the other through the coating, by the glass globe alone. And two phials charged, the one by the brimstone globe, the other by the glass globe, would be both discharged by bringing their wires together, and shock the person holding the phials.

From these experiments one may be certain, that your second, third, and fourth proposed experiments would succeed exactly as you suppose, though I have not tried them, wanting time. I imagine it is the glass globe that charges positively, and the sulphur negatively, for these reasons. 1. Though the sulphur globe seems to work equally well with the glass one, yet it can never occasion so large and distant a spark between my knuckle and the conductor, when the sulphur one is working, as when the glass one is used; which, I suppose, is occasioned by this, that bodies of a certain bigness cannot so easily part with a quantity of electrical fluid they have and hold attracted *within* their substance, as they can receive an additional quantity *upon* their surface by way of atmosphere. Therefore so much cannot be drawn *out* of the conductor, as can be thrown *on* it. 2. I observe, that the stream or brush of fire, appearing at the end of a wire, connected with the conductor, is long, large, and much diverging, when the glass globe is used, and makes a snapping (or rattling) noise; but, when the sulphur one is used, it is short, small, and makes a hissing noise; and just the reverse of both happens, when you hold the same wire in your hand, and the globes are worked alternately; the brush is large, long, diverging, and snapping (or rattling), when the sulphur globe is turned; short, small, and hissing, when the glass globe is turned. When the brush is long, large, and much diverging, the body to which it joins seems to me to be throwing the fire out; and when the contrary appears, it seems to be drinking in. 3. I observe, that, when I hold my knuckle before the sulphur globe, while turning, the stream of fire between my knuckle and the globe seems to spread on its surface, as if it flowed from the finger; on the glass globe it is otherwise. 4. The cool wind (or what was called so), that we used to feel as coming from an electrified point, is, I think, more sensible when the glass globe is used, than when the sulphur one. But these are hasty thoughts. As to your fifth paradox, it must likewise be true, if the globes are alternately worked; but, if worked together, the fire will neither come up nor go down by the chain, because one globe will drink it as fast as the other produces it.

I should be glad to know, whether the effects would be contrary, if the glass globe is solid, and the sulphur globe is hollow; but I have no means at present of trying.

In your journeys, your glass globes meet with accidents, and sulphur ones are heavy and inconvenient. *Query.* Would not a thin plane of brimstone, cast on a board, serve on occasion as a cushion, while a globe of leather stuffed (properly mounted) might receive the fire from the sulphur, and charge the conductor positively? Such a globe would be in no danger of breaking.* I think I can conceive how it may be done; but have not time to add more than that I am,

Yours, &c.

B. Franklin.

TO CADWALLADER COLDEN.

Mistake, that only Metals and Water were Conductors, rectified. — Supposition of a Region of Electric Fire above our Atmosphere. — Theorem concerning Light. — Poke-weed a Cure for Cancers.

READ AT THE ROYAL SOCIETY, NOVEMBER 11TH. 1756.

Philadelphia, 23 April, 1752.

Sir,

In considering your favor of the 16th past, I recollected my having wrote you answers to some queries concerning the difference between electrics *per se*, and non-electrics, and the effects of air in electrical experiments, which, I apprehend, you may not have received. The date I have forgotten.

We have been used to call those bodies electrics *per se*, which would not conduct the electric fluid. We once imagined that only such bodies contained that fluid; afterwards that they had none of it, and only educed it from other bodies; but further experiments showed our mistake. It is to be found in all matter we know of; and the distinctions of electrics *per se*, and non-electrics, should now be dropped as improper, and that of *conductors* and *non-conductors* assumed in its place, as I mentioned in those answers.

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* The discoveries of the late ingenious Mr. Symmer, on the positive and negative electricity produced by the mutual friction of white and black silk, &c., afford hints for farther improvements to be made with this view.

I do not remember any experiment by which it appeared that high-rectified spirit will not conduct; perhaps you have made such. This I know, that wax, rosin, brimstone, and even glass, commonly reputed electrics *per se*, will, when in a fluid state, conduct pretty well. Glass will do it when only red-hot. So that my former position, that only metals and water were conductors, and other bodies more or less such, as they partook of metal or moisture, was too general.

Your conception of the electric fluid, that it is incomparably more subtile than air, is undoubtedly just. It pervades dense matter with the greatest ease; but it does not seem to mix or incorporate willingly with mere air, as it does with other matter. It will not quit common matter to join with air. Air obstructs, in some degree, its motion. An electric atmosphere cannot be communicated at so great a distance, through intervening air, by far, as through a vacuum. Who knows, then, but there may be, as the ancients thought, a region of this fire above our atmosphere, prevented by our air, and its own too great distance for attraction, from joining our earth? Perhaps where the atmosphere is rarest, this fluid may be densest, and nearer the earth, where the atmosphere grows denser, this fluid may be rarer; yet some of it be low enough to attach itself to our highest clouds, and thence they becoming electrified, may be attracted by, and descend towards the earth, and discharge their watery contents, together with that ethereal fire. Perhaps the *auroræ boreales* are currents of this fluid in its own region, above our atmosphere, becoming from their motion visible. There is no end to conjectures. As yet we are but novices in this branch of natural knowledge.

You mention several differences of salts in electrical experiments. Were they all equally dry? Salt is apt to acquire moisture from a moist air, and some sorts more than others. When perfectly dried by lying before a fire, or on a stove, none that I have tried will conduct any better than so much glass.

New flannel, if dry and warm, will draw the electric fluid from non-electrics, as well as that which has been worn.

I wish you had the convenience of trying the experiments you seem to have such expectations from, upon various kinds of spirits, salts, earth, &c. Frequently, in a variety of experiments, though we miss what we expected to find, yet something valuable turns out, something surprising and instructing, though unthought of.

I thank you for communicating the illustration of the theorem concerning light. It is very curious. But I must own I am much in the *dark* about *light*. I am not satisfied with the doctrine that supposes particles of matter called light, continually driven off from the sun's surface, with a swiftness so prodigious! Must not the smallest particle conceivable have, with such a motion, a force exceeding that of a twenty-four pounder, discharged from a cannon? Must not the sun diminish exceedingly by such a waste of matter; and the planents, instead of drawing nearer to him, as some have feared, recede to greater distances through the lessened attraction? Yet these particles, with this amazing motion, will not drive before them, or remove, the least and lightest dust they meet with. And the sun, for aught we know, continues of his ancient dimensions, and his attendants move in their ancient orbits.

May not all the phenomena of light be more conveniently solved, by supposing universal space filled with a subtile elastic fluid, which, when at rest, is not visible, but whose vibrations affect that fine sense in the eye, as those of air do the grosser organs of the ear? We do not, in the case of sound, imagine that any sonorous particles are thrown off from a bell, for instance, and fly in straight lines to the ear; why must we believe that luminous particles leave the sun and proceed to the eye? Some diamonds, if rubbed, shine in the dark, without losing any part of their matter. I can make an electrical spark as big as the flame of a candle, much brighter, and, therefore, visible further; yet this is without fuel; and, I am persuaded, no part of the electric fluid flies off in such case to distant places, but all goes directly, and is to be found in the place to which I destine it. May not different degrees of the vibration of the above-mentioned universal medium occasion the appearances of different colors? I think the electric fluid is always the same; yet I find that weaker and stronger sparks differ in apparent color; some white, blue, purple, red; the strongest, white; weak ones, red. Thus different degrees of vibration given to the air produce the seven different sounds in music, analogous to the seven colors, yet the medium, air, is the same.

If the sun is not wasted by expense of light, I can easily conceive, that he shall otherwise always retain the same quantity of matter; though we should suppose him made of sulphur constantly flaming. The action of fire only *separates* the particles of matter; it does not *annihilate* them. Water, by heat raised in vapor, returns to the earth in rain; and if we could collect all the particles of burning matter that go off in smoke, perhaps they might, with the ashes, weigh as much as the body before it was fired; and, if we could put them into the same position with regard to each other, the mass would be the same as before, and might be burnt over again. The chemists have analyzed sulphur, and find it composed, in certain proportions, of oil, salt, and earth; and, having by the analysis discovered those proportions, they can, of those ingredients, make sulphur. So we have only to suppose, that the parts of the sun's sulphur, separated by fire, rise into his atmosphere, and there being freed from the immediate action of the fire, they collect into cloudy masses, and, growing by degrees, too heavy to be longer supported, they descend to the sun, and are burnt over again. Hence the spots appearing on his face, which are observed to diminish daily in size, their consuming edges being of particular brightness.

It is well we are not, as poor Galileo was, subject to the Inquisition for *philosophical heresy*. My whispers against the orthodox doctrine, in private letters, would be dangerous; but your writing and printing would be highly criminal. As it is, you must expect some censure; but one heretic will surely excuse another.

I am heartily glad to hear more instances of the success of the poke-weed, in the cure of that horrible evil to the human body, a cancer. You will deserve highly of mankind for the communication. But I find in Boston they are at a loss to know the right plant, some asserting it is what they call *mechoachan*, others other things. In one of their late papers it is publicly requested, that a perfect description may be given of the plant, its places of growth, &c. I have mislaid the paper, or would send it to you. I thought you had described it pretty fully.* I am, Sir, &c.

B. Franklin.

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* As the poke-weed, though out of place, is introduced here, we shall translate and insert two extracts of letters from Dr. Franklin to M. Dubourg, the French translator of his works, on the same subject. — *Editor of Johnson and Longman's Edition.*

"London, 27 March, 177?.

"I apprehend that our poke-weed is what the botanists term *phytolacca*. This plant bears berries as large as peas; the skin is black, but it contains

M. DALIBARD'S ACCOUNT OF AN ELECTRICAL EXPERIMENT AT MARLY.*

Extrait d'un Mémoire de M. Dalibard.

LU À L'ACADÉMIE ROYALE DES SCIENCES LE 13 MAI, 1752.

En suivant la route que M. Franklin nous a tracée, j'ai obtenu une satisfaction complette. Voici les préparatifs, le procédé, et le succès.

1°. J'ai fait faire à Marly-la-ville, située à six lieues de Paris au milieu d'une belle plaine dont le sol est fort élevé, une verge de fer ronde, d'environ un pouce de diamètre, longue de quarante pieds, et fort pointue par son extrémité supérieure; pour lui ménager une pointe plus fine, je l'ai fait armer d'acier trempé et ensuite brunir, au défaut de dorure, pour la préserver de la rouille; outre cela, cette verge de fer est courbée vers son extrémité inférieure en deux coudes à angles aigus quoiqu'arrondis; le premier coude est éloigné de deux pieds du bout inférieur, et le second est en sens contraire à trois pieds du premier.

2°. J'ai fait planter dans un jardin trois grosses perches de vingt-huit à vingt-neuf pieds, disposées en triangle, et éloignées les unes des autres d'environ huit

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a crimson juice. It is this juice, thickened by evaporation in the sun, which was employed. It caused great pain, but some persons were said to have been cured. I am not quite certain of the facts; all that I know is, that Dr. Colden had a good opinion of the remedy."

"London, 23 April, 1773.

"You will see, by the annexed paper by Dr. Solander, that this herb, poke-weed, in which has been found a specific remedy for cancers, is the most common species of *phytolacca*. (*Phytolacca decandra*, L.)"

* The above account of the circumstances and success of this extraordinary experiment was laid before the Royal Academy of Sciences at Paris, three days afterwards, in a Memorial by M. Dalibard.

pieds; deux de ces perches sont contre un mur, et la troisième est au-dedans du jardin. Pour les affermir toutes ensemble, l'on a cloué sur chacune des entretoises à vingt pieds de hauteur; et comme le grand vent agitoit encore cette espèce d'édifice, l'on a attaché au haut de chaque perche de longs cordages, qui tenant lieu d'aubans, répondent par le bas à de bons piquets fortement enfoncés en terre à plus de vingt pieds des perches.

3°. J'ai fait construire entre les deux perches voisines du mur, et adosser contre ce mur, une petite guérite de bois capable de contenir un homme et une table.

4°. J'ai fait placer au milieu de la guérite une petite table d'environ un demi-pied de hauteur; et sur cette table j'ai fait dresser et affermir un tabouret électrique. Ce tabouret n'est autre chose qu'une petite planche quarrée, portée sur trois bouteilles à vin; il n'est fait de cette matière que pour suppléer au défaut d'un gâteau de résine qui me manquoit.

5°. Tout étant ainsi préparé, j'ai fait élever perpendiculairement la verge de fer au milieu des trois perches, et je l'ai affermie en l'attachant à chacune des perches avec de forts cordons de soie par deux endroits seulement. Les premiers liens sont au haut des perches, environ trois pouces au-dessous de leurs extrémités supérieures; les seconds vers la moitié de leur hauteur. Le bout inférieur de la verge de fer est solidement appuyé sur le milieu du tabouret électrique, où j'ai fait creuser un trou propre à le recevoir.

6°. Comme il étoit important de garantir de la pluie le tabouret et les cordons de soie, parce qu'ils laisseroient passer la matière électrique s'ils étoient mouillés, j'ai pris les précautions nécessaires pour en empêcher. C'est dans cette vue que j'ai mis mon tabouret sous la guérite, et que j'avois fait courber ma verge de fer à angles aigus; afin que l'eau qui pourroit couler le long de cette verge, ne pût arriver jusques sur le tabouret. C'est aussi dans le même dessein que j'ai fait clouer sur le haut et au milieu de mes perches, à trois pouces au-dessus des cordons de soie, des espèces de boîtes formées de trois petites planches d'environ quinze pouces de long, qui couvrent par-dessus et par les côtés une pareille longueur des cordons de soie, sans leur toucher.

Il s'agissoit de faire, dans le tems de l'orage, deux observations sur cette verge de fer ainsi disposée; l'une étoit de remarquer à sa pointe une aigrette lumineuse, semblable à celle que l'on apperçoit à la pointe d'une aiguille, quand on l'oppose assez près d'un corps actuellement électrisé; l'autre étoit de tirer de la verge de fer des étincelles, comme on en tire du canon de fusil dans les expériences électriques; et afin de se garantir des piqûres de ces étincelles, j'avois attaché le tenon d'un fil d'archal au cordon d'une longue fiole pour lui servir de manche. . . . . .

Le Mercredi, 10 Mai, 1752, entre deux et trois heures après midi, le nommé Coiffier, ancien dragon, que j'avois chargé de faire les observations en mon absence, ayant entendu un coup de tonnerre assez fort, vole aussitôt à la machine, prend la fiole avec le fil d'archal, présente le tenon du fil à la verge, en voit sortir une petite étincelle brillante, et en entend le pétillement; il tire une seconde étincelle plus forte que la première et avec plus de bruit! il appelle ses voisins, et envoie chercher M. le Prieur. Celui-ci accourt de toutes ses forces; les paroissiens, voyant la précipitation de leur curé, s'imaginent que le pauvre Coiffier a éte tué du tonnerre; l'alarme se répand dans le village; la grêle qui survient n'empêche point le troupeau de suivre son pasteur

Cet honnête ecclésiastique arrive près de la machine, et voyant qu'il n'y avoit point de danger, met lui-même la main à l'œuvre et tire de fortes étincelles. La nuée d'orage et de grêle ne fut pas plus d'un quart-d'heure à passer au zénith de notre machine, et l'on n'entendit que ce seul coup de tonnerre. Sitôt que le nuage fut passé, et qu'on ne tira plus d'étincelles de la verge de fer, M. le Prieur de Marly fit partir le sieur Coiffier lui-même, pour m'apporter la lettre suivante, qu'il m'écrivit à la hâte.

"Je vous annonce, Monsieur, ce que vous attendez; l'expérience est complette. Aujourd'hui à deux heures vingt minutes après midi, le tonnerre a grondé directement sur Marly; le coup a été assez fort. L'envie de vous obliger et la curiosité m'ont tiré de mon fauteuil, où j'étois occupé à lire; je suis allé chez Coiffier, qui déjà m'avoit dépêché un enfant que j'ai rencontré en chemin, pour me prier de venir; j'ai doublé le pas à travers un torrent de grêle. Arrivé à l'endroit où est placée la tringle coudée, j'ai présenté le fil d'archal, en avançant successivement vers la tringle, à un pouce et demi, ou environ; il est sorti de la tringle une petite colonne de feu bleuâtre sentant le soufre, qui venoit frapper avec une extrême vivacité le tenon du fil d'archal, et occasionnoit un bruit semblable à celui qu'on feroit en frappant sur la tringle avec une clef. J'ai répété l'expérience au moins six fois dans l'espace d'environ quatre minutes, en présence de plusieurs personnes, et chaque expérience que j'ai faite a duré l'espace d'un *pater* et d'un *ave*. J'ai voulu continuer; l'action du feu s'est ralentie peu à peu; j'ai approché plus près, et n'ai plus tiré que quelques étincelles, et enfin rien n'a paru.

"Le coup de tonnerre qui a occasionné cet événement, n'a été suivi d'aucun autre; tout s'est terminé par une abondance de grêle. J'étois si occupé dans le moment de l'expérience de ce que je voyois, qu'ayant été frappé au bras un peu au-dessus du coude, je ne puis dire si c'est en touchant au fil d'archal ou à la tringle; je ne me suis pas plaint du mal que m'avoit fait le coup dans le moment que je l'ai reçu; mais comme la douleur continuoit, de retour chez moi, j'ai découvert mon bras en présence de Coiffier, et nous avons apperçu une meurtrissure tournante autour du bras, semblable à celle que feroit un coup de fil d'archal, si j'en avois été frappé à nud. En revenant de chez Coiffier, j'ai rencontré M. le Vicaire, M. de Milly, et le Maître d'école, à qui j'ai rapporté ce qui venoit d'arriver; ils se sont plaints tous les trois qu'ils sentoient une odeur de soufre qui les frappoit davantage à mesure qu'ils s'approchoient de moi; j'ai porté chez moi la même odeur, et mes domestiques s'en sont apperçus sans que je leur aie rien dit.

"Voilà, Monsieur, un récit fait à la hâte, mais naïf et vrai, que j'atteste, et vous pouvez assurer que je suis prêt à rendre témoignage de cet événement dans toutes les occasions. Coiffier a été le premier qui a fait l'expérience et l'a répétée plusieurs fois; ce n'est qu'à l'occasion de ce qu'il a vu qu'il m'a envoyé prier de venir. S'il étoit besoin d'autres témoins que de lui et de moi, vous les trouveriez. Coiffier presse pour partir.

"Je suis, avec une respectueuse considération, Monsieur, votre, &c.

(Signé) "RAULET, *Prieur de Marly.*

"10 *Mai*, 1752."

On voit, par le détail de cette lettre, que le fait est assez bien constaté pour ne laisser aucun doute à ce sujet. Le porteur m'a assuré de vive voix qu'il avoit tiré pendant près d'un quart-d'heure avant que M. le Prieur arrivât, en présence de cinq ou six personnes, des étincelles plus fortes et plus bruyantes que celles dont il est parlé dans la lettre. Ces premières personnes, arrivant successivement, n'osoient approcher qu'à dix ou douze pas de la machine; et à cette distance, malgré le plein soleil, ils voyoient les étincelles et entendoient le bruit. . . . . .

Il résulte de toutes les expériences et observations que j'ai rapportées dans ce mémoire, et surtout de la dernière expérience faite à Marly-la-ville, que la matière du tonnerre est incontestablement la même que celle de l'électricité. L'idée qu'en a eu M. Franklin cesse d'être une conjecture; la voilà devenue une réalité, et j'ose croire que plus on approfondira tout ce qu'il a publié sur l'électricité, plus on reconnoîtra combien la physique lui est redevable pour cette partie.

THE ABBÉ MAZÉAS TO STEPHEN HALES.*

Giving a further Account of the Electrical Experiment at Marly.

READ AT THE ROYAL SOCIETY, MAY 28TH, 1752.

SIR,

The Philadelphian experiments, that Mr. Collinson, a member of the Royal Society, was so kind as to communicate to the public, having been universally admired in France, the King desired to see them performed. Wherefore the Duke d'Ayen offered his Majesty his country-house at St. Germain, where M. de Lor, master of experimental philosophy, should put

* The early letters of Dr. Franklin on electricity having been translated into French, and printed at Paris, the Abbé Mazéas, in a letter to Dr. Stephen Hales, dated St. Germain, May 20th, 1752, gives the above account (printed in the "Philosophical Transactions") of the experiment made at Marly, in pursuance of that proposed by Mr. Franklin.

those of Philadelphia in execution. His Majesty saw them with great satisfaction, and greatly applauded Messieurs Franklin and Collinson. These applauses of his Majesty having excited in Messieurs de Buffon, Dalibard, and de Lor a desire of verifying the conjectures of Mr. Franklin, upon the analogy of thunder and electricity, they prepared themselves for making the experiment.

M. Dalibard chose for this purpose a garden, situated at Marly, where he placed upon an electrical body a pointed bar of iron, of forty feet high. On the 10th of May, twenty minutes past two in the afternoon, a stormy cloud having passed over the place where the bar stood, those that were appointed to observe it, drew near and attracted from it sparks of fire, perceiving the same kind of commotions as in the common electrical experiments.

M. de Lor, sensible of the good success of this experiment, resolved to repeat it at his house in the Estrapade, at Paris. He raised a bar of iron ninety-nine feet high, placed upon a cake of resin, two feet square, and three inches thick. On the 18th of May, between four and five in the afternoon, a stormy cloud having passed over the bar, where it remained half an hour, he drew sparks from the bar, like those from the gun-barrel, when, in the electrical experiments, the globe is only rubbed by the cushion, and they produced the same noise, the same fire, and the same crackling. They drew the strongest sparks at the distance of nine lines, while the rain, mingled with a little hail, fell from the cloud, without either thunder or lightning; this cloud being, according to all appearance, only the consequence of a storm, which happened elsewhere.

I am, with a profound respect,

Your most humble and obedient servant,

G. Mazéas.

TO PETER COLLINSON.

Electrical Kite.

READ AT THE ROYAL SOCIETY, DECEMBER 21ST, 1752.

Philadelphia, 19 October, 1752.

SIR,

As frequent mention is made in public papers from Europe, of the success of the Philadelphia experiment for drawing the electric fire from clouds by means of pointed rods of iron erected on high buildings, &c., it may be agreeable to the curious to be informed, that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner, which is as follows.

Make a small cross of two light strips of cedar, the arms so long as to reach to the four corners of a large thin silk handkerchief when extended; tie the corners of the handkerchief to the extremities of the cross, so you have the body of a kite; which, being properly accommodated with a tail, loop, and string, will rise in the air, like those made of paper; but this being of silk is fitter to bear the wet and wind of a thunder-gust without tearing. To the top of the upright stick of the cross is to be fixed a very sharp-pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon, and where the silk and twine join, a key may be fastened. This kite is to be raised when a thunder-gust appears to be coming on, and the person who holds the string must stand within a door or window, or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine does not touch the frame of the door or window. As soon as any of the thunder-clouds come over the kite, the pointed wire will draw the electric fire from them, and the kite, with all the twine, will be electrified, and the loose filaments of the twine will stand out every way, and be attracted by an approaching finger. And when the rain has wetted the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle. At this key the phial may be charged; and from electric fire thus obtained, spirits may be kindled, and all the other electric experiments be performed, which are usually done by the help of a rubbed glass globe or tube, and thereby the sameness of the electric matter with that of lightning completely demonstrated.

B. FRANKLIN.

FROM W. WATSON* TO THE ROYAL SOCIETY.

Concerning the Electrical Experiments in England upon Thunder-clouds.

READ AT THE ROYAL SOCIETY, DECEMBER 21ST, 1752.

GENTLEMEN,

After the communications, which we have received from several of our correspondents in different parts of the continent, acquainting us with the success of their experiments last summer, in endeavouring to extract the electricity from the atmosphere during a thunder-storm, in consequence of Mr. Franklin's hypothesis, it may be thought extraordinary, that no accounts have been yet laid before you, of our success here from

* A member of the Royal Society, and afterwards Sir William Watson. He was distinguished for his great acquirements in botany, and other natural sciences, and particularly for his experiments and discoveries in electricity. — EDITOR.

the same experiments. That no want of attention, therefore, may be attributed to those here, who have been hitherto conversant in these inquiries, I thought proper to apprize you, that, though several members of the Royal Society, as well as myself, did, upon the first advices from France, prepare and set up the necessary apparatus for this purpose, we were defeated in our expectations, from the uncommon coolness and dampness of the air here, during the whole summer. We had only at London one thunder-storm, namely, on July 20th; and then the thunder was accompanied with rain, so that, by wetting the apparatus, the electricity was dissipated too soon to be perceived upon touching those parts of the apparatus which served to conduct it. This, I say, in general prevented our verifying Mr. Franklin's hypothesis; but our worthy brother, Mr. Canton, was more fortunate. I take the liberty, therefore, of laying before you an extract of a letter, which I received from that gentleman, dated from Spital Square, July 21st, 1752.

"I had yesterday, about five in the afternoon, an opportunity of trying Mr. Franklin's experiment of extracting the electrical fire from the clouds, and succeeded, by means of a tin tube, between three and four feet in length, fixed to the top of a glass one, of about eighteen inches. To the upper end of the tin tube, which was not so high as a stack of chimneys on the same house, I fastened three needles with some wire; and to the lower end was soldered a tin cover to keep the rain from the glass tube, which was set upright in a block of wood. I attended this apparatus as soon after the thunder began as possible, but did not find it in the least electrified, till between the third and fourth clap; when, applying my knuckle to the edge of the cover, I felt and heard an electrical spark; and, approaching it a second time, I received the spark at the distance of about half an inch, and saw it distinctly. This I repeated four or five times in the space of a minute, but the sparks grew weaker and weaker; and in less than two minutes the tin tube did not appear to be electrified at all. The rain continued during the thunder, but was considerably abated at the time of making the experiment." Thus far Mr. Canton.

Mr. Wilson likewise of the Society, to whom we are much obliged for the trouble he has taken in these pursuits, had an opportunity of verifying Mr. Franklin's hypothesis. He informed me, by a letter from near Chelmsford, in Essex, dated August 12th, 1752, that, on that day about noon, he perceived several electrical snaps, during, or rather at the end of a thunder-storm, from no other apparatus than an iron curtain-rod, one end of which he put into the neck of a glass phial, and held this phial in his hand. To the other end of the iron he fastened three needles with some silk. This phial, supporting the rod, he held in one hand, and drew snaps from the rod with a finger of his other. This experiment was not made upon any eminence, but in the garden of a gentleman, at whose house he then was.

Dr. Bevis observed, at Mr. Cave's, at St. John's Gate, nearly the same phenomena as Mr. Canton, of which an account has been already laid before the public.

Trifling as the effects here mentioned are, when compared with those which we have received from Paris and Berlin, they are the only ones that the last summer here has produced; and, as they were made by persons worthy of credit, they tend to establish the authenticity of those transmitted from our correspondents.

I flatter myself, that this short account of these matters will not be disagreeable to you; and am,

With the most profound respect,

Your most obedient humble servant,

W. Watson.

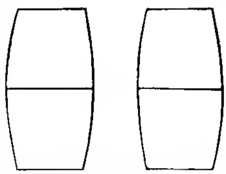
TO JAMES BOWDOIN.

On the Mode of coating Electrical Jars.

Philadelphia, 12 April, 1753.

Sir,

I have shipped eighteen glass jars in casks well packed, on board Captain Branscombe for Boston; six of them are for you, the rest I understand are for the College. Leaf tin, such as they use in silvering looking-glasses, is best to coat them with; they should be coated to within about four or five inches of the brim. Cut the tin into pieces of the form here represented, and they will comply better with the bellying of the glass; one piece only should be round to cover the bottom; the same shapes will serve the inside. I had not conveniency to coat



them for you, and feared to trust anybody else, Mr. Kinnersley being abroad in the West Indies. To make the pieces comply the better, they may be cut in two where the cross lines are. They reach from the top to the edge of the round piece which covers the bottom. I place them in loose rims of scabboard, something like a small sieve, in which they stand very well. If you charge more than one or two together, pray take care how you expose your head to an accidental stroke; for, I can assure you from experience, one is sufficient to knock a stout man down; and I believe a stroke from two or three, in the head, would kill him.

Has Dr. Colden's new book reached you in Boston? If not, I will send it to you.

With great respect, I am, Sir,

Your most humble servant,

B. FRANKLIN.

P. S. The glass-maker being from home, I cannot now get the account. The tin is laid on with common paste, made of flour and water boiled together, and the pieces may lap over each other a little.

TO PETER COLLINSON.

Hypothesis of the Sea being the grand Source of Lightning retracted. — Positive, and sometimes negative, Electricity of the Clouds discovered. — New Experiments and Conjectures in Support of this Discovery. — Observations recommended for ascertaining the Direction of the Electric Fluid. — Size of Rods for Conductors to Buildings. — Appearance of a Thunder-cloud described.

Philadelphia, September, 1753.

SIR,

In my former paper on this subject, written first in 1747, enlarged and sent to England in 1749, I considered the sea as the grand source of lightning, imagining its luminous appearance to be owing to electric fire, produced by friction between the particles of water and those of salt. Living far from the sea, I had then no opportunity of making experiments on the sea water, and so embraced this opinion too hastily.

For, in 1750 and 1751, being occasionally on the seacoast, I found, by experiments, that sea water in a bottle, though at first it would by agitation appear luminous, yet in a few hours it lost that virtue; *hence and from this*, that I could not by agitating a solution of sea salt in water produce any light, I first began to doubt of my former hypothesis, and to suspect, that the luminous appearance in sea water must be owing to some other principles.

I then considered whether it were not possible, that the particles of air, being electrics *per se*, might, in hard gales of wind, by their friction against trees, hills, buildings, &c., as so many minute electric globes, rubbing against non-electric cushions, draw the electric fire from the earth, and that the rising vapors might receive that fire from the air, and by such means the clouds become electrified.

If this were so, I imagined that by forcing a constant violent stream of air against my prime conductor, by bellows, I should electrify it *negatively;* the rubbing particles of air drawing from it part of its natural quantity of the electric fluid. I accordingly made the experiment, but it did not succeed.

In September, 1752, I erected an iron rod to draw the lightning down into my house, in order to make some experiments on it, with two bells to give notice when the rod should be electrified; a contrivance obvious to every electrician.

I found the bells rang sometimes when there was no lightning or thunder, but only a dark cloud over the rod; that sometimes, after a flash of lightning, they would suddenly stop; and at other times, when they had not rung before, they would, after a flash, suddenly begin to ring; that the electricity was sometimes very faint, so that, when a small spark was obtained, another could not be got for some time after; at other times the sparks would follow extremely quick, and once I had a continual stream from bell to bell, the size of a crow-quill; even during the same gust there were considerable variations.

In the winter following I conceived an experiment, to try whether the clouds were electrified *positively* or *negatively;* but my pointed rod, with its apparatus, becoming out of order, I did not refit it till towards the spring, when I expected the warm weather would bring on more frequent thunder-clouds.

The experiment was this; to take two phials; charge one of them with lightning from the iron rod, and give the other an equal charge by the electric glass globe, through the prime conductor; when charged, to place them on a table within three or four inches of each other, a small cork ball being suspended by a fine silk thread from the ceiling, so as it might play between the wires. If both bottles then were electrified *positively,* the ball, being attracted and repelled by one, must be also repelled by the other. If the one *positively,* and the other *negatively,* then the ball would be attracted and repelled alternately by each, and continue to play between them as long as any considerable charge remained.

Being very intent on making this experiment, it was no small mortification to me, that I happened to be abroad during two of the greatest thunder-storms we had early in the spring; and, though I had given orders in the family, that, if the bells rang when I was from home, they should catch some of the lightning for me in electrical phials, and they did so, yet it was mostly dissipated before my return; and, in some of the other gusts, the quantity of lightning I was able to obtain was so small, and the charge so weak, that I could not satisfy myself; yet I sometimes saw what heightened my suspicions, and inflamed my curiosity.

At last, on the 12th of April, 1753, there being a smart gust of some continuance, I charged one phial pretty well with lightning, and the other equally, as near as I could judge, with electricity from my glass globe; and, having placed them properly, I beheld, with great surprise and pleasure, the cork ball play briskly between them, and was convinced, that one bottle was electrized *negatively*.

I repeated this experiment several times during the gust, and in eight succeeding gusts, always with the same success; and being of opinion (for reasons I formerly gave in my letter to Mr. Kinnersley, since printed in London), that the glass globe electrizes *positively*, I concluded, that the clouds are *always* electrized *negatively*, or have always in them less than their natural quantity of the electric fluid.

Yet, notwithstanding so many experiments, it seems I concluded too soon; for at last, June the 6th, in a gust which continued from five o'clock, P. M., to seven, I met with one cloud that was electrized *positively*, though several that passed over my rod before, during the same gust, were in the *negative* state. This was thus discovered.

I had another concurring experiment, which I often repeated, to prove the negative state of the clouds, viz., while the bells were ringing, I took the phial, charged from the glass globe, and applied its wire to the erected rod, considering, that if the clouds were electrized *positively*, the rod, which received its electricity from them, must be so too; and then the additional *positive* electricity of the phial would make the bells ring faster; but, if the clouds were in a *negative* state, they must exhaust the electric fluid from my rod, and bring that into the same negative state with themselves, and then the wire of a positively charged phial, supplying the rod with what it wanted (which it was obliged otherwise to draw from the earth by means of the pendulous brass ball playing between the two bells), the ringing would cease till the bottle was discharged.

In this manner I quite discharged into the rod several phials, that were charged from the glass globe, the electric fluid streaming from the wire to the rod, till the wire would receive no spark from the finger; and, during this supply to the rod from the phial, the bells stopped ringing; but, by continuing the application of the phial wire to the rod, I exhausted the natural quantity from the inside surface of the same phials, or, as I call it, charged them *negatively*.

At length, while I was charging a phial by my glass globe, to repeat this experiment, my bells of themselves stopped ringing, and, after some pause, began to ring again. But now, when I approached the wire of the charged phial to the rod, instead of the usual stream, that I expected from the wire to the rod, there was no spark; not even when I brought the wire and the rod to touch; yet the bells continued ringing vigorously, which proved to me, that the rod was then *positively* electrified, as well as the wire of the phial, and equally so; and, consequently, that the particular cloud then over the rod was in the same positive state. This was near the end of the gust.

But this was a single experiment, which, however, destroys my first too general conclusion, and reduces me to this; *That the clouds of a thunder-gust are most commonly in a negative state of electricity, but sometimes in a positive state.*

The latter I believe is rare; for, though I, soon after the last experiment, set out on a journey to Boston, and was from home most part of the summer, which prevented my making farther trials and observations;

yet Mr. Kinnersley, returning from the Islands just as I left home, pursued the experiments during my absence, and informs me, that he always found the clouds in the *negative* state.

So that, for the most part, in thunder-strokes, *it is the earth that strikes into the clouds, and not the clouds that strike into the earth.*

Those who are versed in electric experiments, will easily conceive, that the effects and appearances must be nearly the same in either case; the same explosion, and the same flash between one cloud and another, and between the clouds and mountains, &c., the same rending of trees, walls, &c., which the electric fluid meets with in its passage, and the same fatal shock to animal bodies; and that pointed rods fixed on buildings, or masts of ships, and communicating with the earth or sea, must be of the same service in restoring the equilibrium silently between the earth and clouds, or in conducting a flash or stroke, if one should be, so as to save harmless the house or vessel; for points have equal power to throw off, as to draw on, the electric fire, and rods will conduct up as well as down.

But, though the light gained from these experiments makes no alteration in the practice, it makes a considerable one in the theory. And now we as much need an hypothesis to explain by what means the clouds become negatively, as before to show how they became positively, electrified.

I cannot forbear venturing some few conjectures on this occasion; they are what occur to me at present, and, though future discoveries should prove them not wholly right, yet they may in the mean time be of some use, by stirring up the curious to make more experiments, and occasion more exact disquisitions.

I conceive, then, that this globe of earth and water, with its plants, animals, and buildings, have diffused throughout their substance, a quantity of the electric fluid, just as much as they can contain, which I call the *natural quantity.*

That this natural quantity is not the same in all kinds of common matter under the same dimensions, nor in the same kind of common matter in all circumstances; but a solid foot, for instance, of one kind of common matter may contain more of the electric fluid than a solid foot of some other kind of common matter; and a pound weight of the same kind of common matter may, when in a rarer state, contain more of the electric fluid than when in a denser state.

For, the electric fluid being attracted by any portion of common matter, the parts of that fluid (which have among themselves a mutual repulsion) are brought so near to each other, by the attraction of the common matter that absorbs them, as that their repulsion is equal to the condensing power of attraction in common matter; and then such portion of common matter will absorb no more.

Bodies of different kinds, having thus attracted and absorbed what I call their *natural quantity,* that is, just as much of the electric fluid as is suited to their circumstances of density, rarity, and power of attracting, do not then show any signs of electricity among each other.

And, if more electric fluid be added to one of these bodies, it does not enter, but spreads on the surface, forming an atmosphere; and then such body shows signs of electricity.

I have, in a former paper, compared common matter to a sponge, and the electric fluid to water; I beg leave once more to make use of the same comparison, to illustrate farther my meaning in this particular.

When a sponge is somewhat condensed by being squeezed between the fingers, it will not receive and retain so much water as when in its more loose and open state.

If *more* squeezed and condensed, some of the water will come out of its inner parts, and flow on the surface.

If the pressure of the fingers be entirely removed, the sponge will not only resume what was lately forced out, but attract an additional quantity.

As the sponge in its rarer state will *naturally* attract and absorb *more* water, and in its denser state will *naturally* attract and absorb *less* water; we may call the quantity it attracts and absorbs in either state, its *natural quantity*, the state being considered.

Now what the sponge is to water, the same is water to the electric fluid.

When a portion of water is in its common dense state, it can hold no more electric fluid than it has; if any be added, it spreads on the surface.

When the same portion of water is rarefied into vapor, and forms a cloud, it is then capable of receiving and absorbing a much greater quantity; there is room for each particle to have an electric atmosphere.

Thus water, in its rarefied state, or in the form of a cloud, will be in a negative state of electricity; it will have less than its *natural quantity;* that is, less than it is naturally capable of attracting and absorbing in that state.

Such a cloud, then, coming so near the earth as to be within the striking distance, will receive from the earth a flash of the electric fluid; which flash, to supply a great extent of cloud, must sometimes contain a very great quantity of that fluid.

Or such a cloud, passing over woods of tall trees, may, from the points and sharp edges of their moist top leaves, receive silently some supply.

A cloud, being by any means supplied from the earth, may strike into other clouds that have not been supplied, or not so much supplied; and those to others, till an equilibrium is produced among all the clouds that are within striking distance of each other.

The cloud thus supplied, having parted with much of what it first received, may require and receive a fresh supply from the earth, or from some other cloud, which by the wind is brought into such a situation as to receive it more readily from the earth.

Hence repeated and continual strokes and flashes, till the clouds have all got nearly their natural quantity as clouds, or till they have descended in showers, and are united again with this terraqueous globe, their original.

Thus, thunder-clouds are generally in a negative state of electricity compared with the earth, agreeable to most of our experiments; yet, as by one experiment we found a cloud electrized positively, I conjecture, that, in that case, such cloud, after having received what was, in its rare state, only its *natural quantity,* became compressed by the driving winds, or some other means, so that part of what it had absorbed was forced out, and formed an electric atmosphere around it in its denser state. Hence it was capable of communicating positive electricity to my rod.

To show that a body in different circumstances of dilatation and contraction is capable of receiving and retaining more or less of the electric fluid on its surface, I would relate the following experiment. I placed a clean wine-glass on the floor, and on it a small silver can. In the can I put about three yards of brass chain; to one end of which I fastened a silk thread, which went right up to the ceiling, where it passed over a pulley, and came down again to my hand, that I might at pleasure draw the chain up out of the can, extending it till within a foot of the ceiling, and let it gradually sink into the can again. From the ceiling, by another thread of fine raw silk, I suspended a small light lock of cotton, so as that when it hung perpendicularly, it came in contact with the side of the can. Then, approaching the wire of a charged phial to the can, I gave it a spark, which flowed round in an electric atmosphere; and the lock of cotton was repelled from the side of the can to the distance of about nine or ten inches. The can would not then receive another spark from the wire of the phial; but, as I gradually drew up the chain, the atmosphere of the can diminished by flowing over the rising chain, and the lock of cotton accordingly drew nearer and nearer to the can; and then, if I again brought the phial wire near the can, it would receive another spark, and the cotton fly off again to its first distance; and thus, as the chain was drawn higher, the can would receive more sparks; because the can and extended chain were capable of supporting a greater atmosphere than the can with the chain gathered up into its belly. And that the atmosphere round the can was diminished by raising the chain, and increased again by lowering, is not only agreeable to reason, since the atmosphere of the chain must be drawn from that of the can, when it rose, and returned to it again when it fell; but was also evident to the eye, the lock of cotton always approaching the can when the chain was drawn up, and receding when it was let down again.

Thus we see, that increase of surface makes a body capable of receiving a greater electric atmosphere; but this experiment does not, I own, fully demonstrate my new hypothesis; for the brass and silver still continue in their solid state, and are not rarefied into vapor, as the water is in clouds. Perhaps some future experiments on vaporized water may set this matter in a clearer light.

One seemingly material objection arises to the new hypothesis, and it is this; if water, in its rarefied state, as a cloud, requires and will absorb more of the electric fluid than when in its dense state as water, why does it not acquire from the earth all its wants at the instant of its leaving the surface, while it is yet near, and but just rising in vapor? To this difficulty I own I cannot at present give a solution satisfactory to myself. I thought, however, that I ought to state it in its full force, as I have done, and submit the whole to examination.

And I would beg leave to recommend it to the curious in this branch of natural philosophy, to repeat with care and accurate observation the experiments I have reported in this and former papers relating to *positive* and *negative* electricity, with such other relative ones as shall occur to them, that it may be certainly known whether the electricity communicated by a glass globe be *really positive*. And also I would request all, who may have an opportunity of observing the recent effects of lightning on buildings, trees, &c., that they would consider them particularly with a view to discover the direction. But in these examinations, this one thing is always to be understood, viz., that, a stream of the electric fluid passing through wood, brick, metal, &c., while such fluid passes in *small quantity*, the mutually repulsive power of its parts is confined and overcome by the cohesion of the parts of the body it passes through, so as to prevent an explosion; but, when the fluid comes in a quantity too great to be confined by such cohesion, it explodes, and rends or fuses the body that endeavoured to confine it. If it be wood, brick, stone, or the like, the splinters will fly off on that side where there is least resistance. And thus, when a hole is struck through pasteboard by the electrified jar, if the surfaces of the pasteboard are not confined or compressed, there will be a bur raised all round the hole on both sides the pasteboard; but if one side be confined, so that the bur cannot be raised on that side, it will be all raised on the other, which way soever the fluid was directed. For the bur round the outside of the hole is the effect of the explosion every way from the centre of the stream, and not an effect of the direction.

In every stroke of lightning, I am of opinion that the stream of the electric fluid, moving to restore the equilibrium between the cloud and the earth, does always previously find its passage, and mark out, as I may say, its own course, taking in its way all the conductors it can find, such as metals, damp walls, moist wood, &c., and will go considerably out of a direct course, for the sake of the assistance of good conductors; and that, in this course, it is actually moving, though silently and imperceptibly, before the explosion, in and among the conductors; which explosion happens only when the conductors cannot discharge it as fast as they receive it, by reason of their being incomplete, disunited, too small, or not of the best materials for conducting. Metalline rods, therefore, of sufficient thickness, and extending from the highest part of an edifice to the ground, being of the best materials and complete conductors, will, I think, secure the building from damage, either by restoring the equilibrium so fast as to prevent a stroke, or by conducting it in the substance of the rod as far as the rod goes, so that there shall be no explosion but what is above its point, between that and the clouds.

If it be asked, What thickness of a metalline rod may be supposed sufficient? in answer, I would remark, that five large glass jars, such as I have described in my former papers, discharge a very great quantity of electricity, which nevertheless will be all conducted round the corner of a book, by the fine filleting of gold on the cover, it following the gold the farthest way about, rather than take the shorter course through the cover, that not being so good a conductor. Now, in this line of gold, the metal is so extremely thin as to be little more than the color of gold, and on an octavo book is not in the whole an inch square, and therefore not the thirty-sixth part of a grain, according to M. Réaumur; yet it is sufficient to conduct the charge of five large jars, and how many more I know not. Now, I suppose a wire of a quarter of an inch diameter to contain about five thousand times as much metal as there is in that gold line; and, if so, it will conduct the charge of twenty-five thousand such glass jars, which is a quantity, I imagine, far beyond what was ever contained in any one stroke of natural lightning. But a rod of half an inch diameter would conduct four times as much as one of a quarter.

And with regard to conducting, though a certain thickness of metal be required to conduct a great quantity of electricity, and, at the same time, keep its own substance firm and unseparated; and a less quantity, as a very small wire, for instance, will be destroyed by the explosion; yet such small wire will have answered the end of conducting that stroke, though it become incapable of conducting another. And, considering the extreme rapidity with which the electric fluid moves without exploding, when it has a free passage, or complete metal communication, I should think a vast quantity would be conducted in a short time, either to or from a cloud, to restore its equilibrium with the earth, by means of a very small wire; and therefore thick rods should seem not so necessary. However, as the quantity of lightning discharged in one stroke cannot well be measured, and in different strokes is certainly very various, in some much greater than in others; and as iron (the best metal for the purpose, being least apt to fuse) is cheap, it may be well enough to provide a larger canal to guide that impetuous blast than we imagine necessary; for, though one middling wire may be sufficient, two or three can do no harm. And time, with careful observations well compared, will at length point out the proper size to greater certainty.

Pointed rods erected on edifices may likewise often prevent a stroke, in the following manner. An eye so situated as to view horizontally the under side of a thunder-cloud, will see it very ragged, with a number of separate fragments, or petty clouds, one under another, the lowest sometimes not far from the earth. These, as so many stepping-stones, assist in conducting a stroke between the clond and a building. To represent these by an experiment, take two or three locks of fine, loose cotton; connect one of them with the prime conductor by a fine thread of two inches (which may be spun out of the same lock by the fingers), another to that, and the third to the second, by like threads. Turn the globe, and you will see these locks extend themselves towards the table (as the lower small clouds do towards the earth), being attracted by it; but, on presenting a sharp point erect under the lowest, it will shrink up to the second, the second to the first, and all together to the prime conductor, where they will continue as long as the point continues under them. May not, in like manner, the small electrized clouds, whose equilibrium with the earth is soon restored by the point, rise up to the main body, and by that means occasion so large a vacancy, as that the grand cloud cannot strike in that place?

These thoughts, my dear friend, are many of them crude and hasty; and, if I were merely ambitious of acquiring some reputation in philosophy, I ought to keep them by me, till corrected and improved by time and farther experience. But since even short hints and imperfect experiments in any new branch of science, being communicated, have oftentimes a good effect, in exciting the attention of the ingenious to the subject, and so become the occasion of more exact disquisition, and more complete discoveries, you are at liberty to communicate this paper to whom you please; it being of more importance that knowledge should increase, than that your friend should be thought an accurate philosopher.

B. Franklin.

TO PETER COLLINSON.

Notice of another Packet of Letters.

Philadelphia, 23 November, 1753.

Dear Friend,

In my last, *viâ* Virginia, I promised to send you per next ship, a small philosophical packet; but now, having got the materials (old letters and rough drafts) before me, I fear you will find it a great one. Nevertheless, as I am like to have a few days leisure before this ship sails, which I may not have again in a long time, I shall transcribe the whole, and send it; for you will be under no necessity of reading it all at once, but may take it a little at a time, now and then of a winter evening. When you happen to have nothing else to do (if that ever happens), it may afford you some amusement.*

B. Franklin

Proposal of an Experiment to measure the Time taken up by an Electric Spark in moving through any given Space. By James Alexander, of New York.†

READ AT THE ROYAL SOCIETY, DECEMBER 26TH, 1756.

If I remember right, the Royal Society made one experiment to discover the velocity of the electric fire, by a wire of about four miles in length, supported by silk, and by turning it forwards and backwards in a field, so that the beginning and end of the wire were at only the distance of two people, the one holding the Leyden bottle and the beginning of the wire, and the other holding the end of the wire and touching the ring of the bottle; but by this experiment no discov-

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* These letters and papers are a philosophical correspondence between Mr. Franklin and some of his American friends. Mr. Collinson communicated them to the Royal Society, where they were read at different meetings during the year 1756. But, Mr. Franklin having particularly requested that they might not be printed, none of them were inserted in the Transactions. Mr. Franklin had at that time an intention of revising them, and pursuing some of the inquiries farther; but, finding that he is not like to have sufficient leisure, he has at length been induced, imperfect as they are, to permit their publication, as some of the hints they contain may possibly be useful to others in their philosophical researches. — *Note in Mr. Collinson's edition.*

As some of the papers transmitted in the above letter to Mr. Collinson do not relate to electricity, they are transferred to the parts of the work in which they belong, according to their subjects. They are all inserted, as far as it can be ascertained, in the order of their dates. — Editor.

† This paper and the following one were among those communicated to Mr. Collinson, November 23d, 1753. Their dates are uncertain. — Editor.

ery was made, except that the velocity was extremely quick.

As water is a conductor as well as metals, it is to be considered, whether the velocity of the electric fire might not be discovered by means of water; whether a river, or lake, or sea, may not be made part of the circuit through which the electric fire passes, instead of the circuit all of wire, as in the above experiment.

Whether in a river, lake, or sea, the electric fire will not dissipate, and not return to the bottle? or, will it proceed in straight lines through the water the shortest course possible back to the bottle?

If the last, then suppose one brook that falls into Delaware doth head very near to a brook that falls into Schuylkill; and let a wire be stretched and supported as before, from the head of one brook to the head of the other; and let the one end communicate with the water; and let one person stand in the other brook, holding the Leyden bottle; and let another person hold that end of the wire not in the water, and touch the ring of the bottle. If the electric fire will go as in the last question, then will it go down the one brook to Delaware or Schuylkill, and down one of them to their meeting, and up the other and the other brook; the time of its doing this may possibly be observable, and the farther upwards the brooks are chosen, the more observable it would be.

Should this be not observable, then suppose the two brooks falling into Susquehanna and Delaware, and proceeding as before, the electric fire may, by that means, make a circuit round the North Cape of Virginia, and go many hundreds of miles, and in doing that, it would seem, it must take some observable time.

If still no observable time is found in that experiment, then suppose the brooks falling the one into the

Ohio, and the other into Susquehanna or Potomac; in that the electric fire would have a circuit of some thousands of miles to go down Ohio to Mississippi, to the Bay of Mexico, round Florida, and round the South Cape of Virginia; which, I think, would give some observable time, and discover exactly the velocity.

But, if the electric fire dissipates or weakens in the water, as I fear it does, these experiments will not answer.

Answer to the Foregoing.

READ AT THE ROYAL SOCIETY, DECEMBER 26TH, 1756.

Suppose a tube of any length, open at both ends, and containing a movable wire of just the same length, that fills its bore. If I attempt to introduce the end of another wire into the same tube, it must be done by pushing forward the wire it already contains; and the instant I press and move one end of that wire, the other end is also moved; and, in introducing one inch of the same wire, I extrude, at the same time, an inch of the first, from the other end of the tube.

If the tube be filled with water, and I inject an additional inch of water at one end, I force out an equal quantity at the other, in the very same instant.

And the water forced out at one end of the tube is not the very same water that was forced in at the other end at the same time; it was only in motion at the same time.

The long wire, made use of in the experiment to discover the velocity of the electric fluid, is itself filled with what we call its natural quantity of that fluid, before the hook of the Leyden bottle is applied to one end of it.

The outside of the bottle being, at the time of such application, in contact with the other end of the wire, the whole quantity of electric fluid contained in the wire is, probably, put in motion at once.

For, at the instant the hook connected with the inside of the bottle *gives out*, the coating, or outside of the bottle, *draws in*, a portion of that fluid.

If such long wire contains precisely the quantity that the outside of the bottle demands, the whole will move out of the wire to the outside of the bottle, and the over quantity which the inside of the bottle contained, being exactly equal, will flow into the wire, and remain there, in the place of the quantity the wire had just parted with to the outside of the bottle.

But, if the wire be so long as that one tenth (suppose) of its natural quantity is sufficient to supply what the outside of the bottle demands, in such case the outside will only receive what is contained in one tenth of the wire's length, from the end next to it; though the whole will move so as to make room at the other end for an equal quantity issuing, at the same time, from the inside of the bottle.

So that this experiment only shows the extreme facility with which the electric fluid moves in metal; it can never determine the velocity.

And, therefore, the proposed experiment (though well imagined and very ingenious) of sending the spark round through a vast length of space, by the waters of Susquehanna, or Potomac, and Ohio, would not afford the satisfaction desired, though we could be sure that the motion of the electric fluid would be in that tract, and not under ground in the wet earth by the shortest way.

B FRANKLIN.

*Remarks on the Abbé Nollet's Letters to Benjamin Franklin on Electricity. By David Colden, of New York.**

Coldenham, in New York, 4 December, 1753.

SIR,

In considering the Abbé Nollet's letters to Mr. Franklin, I am obliged to pass by all the experiments which are made with, or in, bottles hermetically sealed, or exhausted of air; because, not being able to repeat the experiments, I could not second any thing which occurs

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* The Abbé Nollet published in Paris a volume entitled, "*Lettres sur l'Electricité, dans lesquelles on examine les Découvertes qui ont été faites sur cette Matière depuis l'Année* 1752, *et les Conséquences que l'on en peut tirer.*" These letters were directed to various persons. One volume only was published originally, but the work was afterwards extended to three. In the first volume were six letters directed to Franklin. The author, having formed a theory of his own on electricity, attempted to confute the doctrines and hypotheses of the American philosopher. The following is an extract from the preface to the edition of the Abbé Nollet's work published in 1764.

"Le Livre de M. Franklin est devenu célèbre par le goût qu'on a pris aux expériences curieuses qu'il contient, et par les nouvelles merveilles qu'il nous a fait découvrir; cet ouvrage est entre les mains de tout le monde, et, la doctrine qu'il renferme étant par bien des endroits opposée a celle que j'ai enseignée jusqu'à présent sur les mémes matières, si je n'en disois rien, mon silence pourroit passer pour un abandon que je ferois de mes opinions. Ne fût-ce qu'en reconnoissance de l'honneur que l'Académie des Sciences m'a fait de les insérer dans ses Mémoires, et de l'accueil favorable que le public a bien voulu leur faire, je me suis cru obligé de les examiner de nouveau, et d'en prendre la défense, quand j'ai vu que je le pouvois faire par de bonnes raisons et malgré les prétentions de l'Ecole de Philadelphie. Voilà encore ce qui a donné lieu aux Lettres que je publie aujourd'hui; elles doivent moins passer pour une critique de la doctrine de M. Franklin, que pour une défense de la mienne; cet auteur n'a commencé à écrire qu'après moi.

"Ce n'est pas que je croie que M. Franklin ait eu dessein de me critiquer; il ne savoit peut-être pas que j'existois; mais, quand il auroit connu mes ouvrages, et qu'il les auroit eu en vue en écrivant le contraire de ce qu'ils contiennent, je ne lui en saurois pas plus mauvais gré, s'il a cru, comme je n'en doute pas, opposer des vérités à des erreurs. Au reste, je ne me suis point borné à disputer contre ce physicien; j'ai to me thereon, by experimental proof. Wherefore, the first point wherein I can dare to give my opinion, is in the Abbé's fourth Letter, (p. 66,) where he undertakes to prove, that the electric matter passes from one surface to another through the entire thickness of the glass. He takes Mr. Franklin's experiment of the magical picture, and writes thus of it. "When you electrize a pane of glass coated on both sides with metal, it is

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applaudi très-sincérement aux endroits de son ouvrage qui m'ont paru solidement établis, ou ingénieusement pensés, et c'est ce que j'ai fait avec le plus de plaisir."

Franklin never answered the Abbé's book, though he says, in a letter to Mr. Bowdoin, that he had collected and methodized short hints for that purpose. And in his autobiography he thus speaks of the subject, after alluding to the publication of his papers on electricity.

"A copy of them happening to fall into the hands of the Count de Buffon, (a philosopher deservedly of great reputation in France, and indeed all over Europe,) he prevailed with Monsieur Dubourg to translate them into French; and they were printed at Paris. The publication offended the Abbé Nollet, preceptor in Natural Philosophy to the royal family, and an able experimenter, who had formed and published a theory of electricity, which then had the general vogue. He could not at first believe that such a work came from America, and said it must have been fabricated by his enemies at Paris to oppose his system. Afterwards, having been assured that there really existed such a person as Franklin at Philadelphia, (which he had doubted,) he wrote and published a volume of Letters chiefly addressed to me, defending his theory, and denying the verity of my experiments, and of the positions deduced from them. I once purposed answering the Abbé, and actually began the answer; but, on consideration that my writings contained a description of experiments, which any one might repeat and verify; and, if not to be verified, could not be defended; or of observations offered as *conjectures*, and not delivered dogmatically, therefore not laying me under any obligation to defend them; and reflecting, that a dispute between two persons, written in different languages, might be lengthened greatly by mistranslations, and thence misconceptions of one another's meaning, (much of one of the Abbé's letters being founded on an error in the translation;) I concluded to let my papers shift for themselves; believing it was better to spend what time I could spare from public business in making new experiments, than in disputing about those already made. I therefore never answered Monsieur Nollet; and the event gave me no cause to repent my silence; for my friend, Monsieur Le Roy, of the Royal Academy of Sciences, took up my cause and refuted him."

David Colden was a son of Cadwallader Colden, and devoted to the study of electricity. — EDITOR.

evident, that whatever is placed on the side opposite to that which receives the electricity from the conductor, receives also an evident electrical virtue." Which, Mr. Franklin says, is that equal quantity of electric matter, driven out of this side, by what is received from the conductor on the other side; and which will continue to give an electrical virtue to any thing in contact with it, till it is entirely discharged of its electrical fire. To which the Abbé thus objects; "Tell me," says he, (p. 68,) "I pray you, how much time is necessary for this pretended discharge? I can assure you, that, after having maintained the electrization for hours, this surface, which ought, as it seems to me, to be entirely discharged of its electrical matter, considering either the vast number of sparks that were drawn from it, or the time that this matter had been exposed to the action of the expulsive cause; this surface, I say, appeared rather better electrized thereby, and more proper to produce all the effects of an actual electric body."

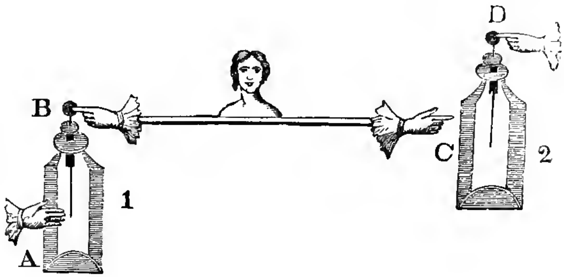
The Abbé does not tell us what those effects were; all the effect I could never observe, and those that are to be observed can easily be accounted for, by supposing that side to be entirely destitute of electric matter. The most sensible effect of a body charged with electricity is, that, when you present your finger to it, a spark will issue from it to your finger; now, when a phial prepared for the Leyden experiment is hung to the gun-barrel or prime conductor, and you turn the globe in order to charge it, as soon as the electric matter is excited, you can observe a spark to issue from the external surface of the phial to your finger, which, Mr. Franklin says, is the natural electric matter of the glass, driven out by that received by the inner surface from the conductor. If it be only drawn out by sparks, a vast number of them may be drawn; but, if you take hold of the external surface with your hand, the phial will soon receive all the electric matter it is capable of, and the outside will then be entirely destitute of its electric matter, and no spark can be drawn from it by the finger; here, then, is a want of that effect which all bodies charged with the electricity have. Some of the effects of an electric body, which I suppose the Abbé has observed in the exterior surface of a charged phial are, that all light bodies are attracted by it. This is an effect which I have constantly observed, but do not think that it proceeds from an attractive quality in the exterior surface of the phial, but in those light bodies themselves, which seem to be attracted by the phial. It is a constant observation, that, when one body has a greater charge of electric matter in it than another (that is, in proportion to the quantity they will hold), this body will attract that which has less; now, I suppose, and it is a part of Mr. Franklin's system, that all those light bodies, which appear to be attracted, have more electric matter in them than the external surface of the phial has; wherefore they endeavour to attract the phial to them, which is too heavy to be moved by the small degree of force they exert, and yet, being greater than their own weight, moves them to the phial. The following experiment will help the imagination in conceiving this. Suspend a cork ball, or a feather, by a silk thread, and electrize it; then bring this ball nigh to any fixed body, and it will appear to be attracted by that body, for it will fly to it; now, by the consent of electricians, the attractive cause is in the ball itself, and not in the fixed body to which it flies; this is a similar case with the apparent attraction of light bodies, to the external surface of a charged phial.

The Abbé says, (p. 69,) "that he can electrize a hundred men, standing on wax, if they hold hands, and if one of them touch one of these surfaces (the exterior) with the end of his finger." This I know he can, while the phial is charging; but, after the phial is charged, I am as certain he cannot; that is, hang a phial, prepared for the Leyden experiment, to the conductor, and let a man, standing on the floor, touch the coating with his finger, while the globe is turned, till the electric matter spews out of the hook of the phial, or some part of the conductor, which I take to be the certainest sign that the phial has received all the electric matter it can; after this appears, let the man, who before stood on the floor, step on a cake of wax, where he may stand for hours, and the globe all that time turned, and yet have no appearance of being electrized. After the electric matter was spewed out as above from the hook of the phial prepared for the Leyden experiment, I hung another phial, in like manner prepared, to a hook fixed in the coating of the first, and held this other phial in my hand; now, if there was any electric matter transmitted through the glass of the first phial, the second one would certainly receive and collect it; but, having kept the phials in this situation for a considerable time, during which the globe was continually turned, I could not perceive that the second phial was in the least charged, for, when I touched the hook with my finger, as in the Leyden experiment, I did not feel the least commotion, nor perceive any spark to issue from the hook.

I likewise made the following experiment; having charged two phials (prepared for the Leyden experiment) through their hooks, two persons took each one of these phials in their hand; one held his phial by the coating, the other by the hook, which he could do by removing the communication from the bottom before he took hold of the hook. These persons placed themselves one on each side of me, while I stood on a cake of wax, and took hold of the hook of that phial which was held by its coating (upon which a spark issued, but the phial was not discharged, as I stood on wax); keeping hold of the hook, I touched the coating of the phial that was held by its hook with my other hand, upon which there was a large spark to be seen between my finger and the coating, and both phials were instantly discharged. If the Abbé's opinion be right, that the exterior surface, communicating with the coating, is charged, as well as the interior, communicating with the hook; how can I, who stand on wax, discharge both these phials, when it is well known I could not discharge one of them singly? Nay, suppose I have drawn the electric matter from both of them, what becomes of it? For I appear to have no additional quantity in me when the experiment is over, and I have not stirred off the wax; wherefore this experiment fully convinces me, that the exterior surface is not charged; and not only so, but that it wants as much electric matter as the inner has of excess; for by this supposition, which is a part of Mr. Franklin's system, the above experiment is easily accounted for, as follows.

When I stand on wax, my body is not capable of receiving all the electric matter from the hook of one phial, which it is ready to give; neither can it give as much to the coating of the other phial as it is ready to take, when one is only applied to me; but, when both are applied, the coating takes from me what the hook gives; thus I receive the fire from the first phial at *B*, the exterior surface of which is supplied from the hand at *A*; I give the fire to the second phial at *C*, whose interior surface is discharged by the hand at *D*. This discharge at *D* may be made evident by receiving that fire into the hook of a third phial, which is done thus.

In place of taking the hook of the second phial in your hand, r ın the wire of a third phial, prepared as for the Leyden experiment, through it, and hold this third phial in your hand, the second one hanging to it, by the ends of the hooks run through each other; when the experiment is performed, this third phial receives the fire at *D*, and will be charged.



When this experiment is considered, I think, it must fully prove, that the exterior surface of a charged phial wants electric matter, while the inner surface has an excess of it. One thing more worthy of notice in this experiment is, that I feel no commotion or shock in my arms, though so great a quantity of electric matter passes them instantaneously; I only feel a pricking in the ends of my fingers. This makes me think the Abbé has mistook, when he says, that there is no difference between the shock felt in performing the Leyden experiment, and the pricking felt on drawing simple sparks, except that of greater to less. In the last experiment, as much electric matter went through my arms, as would have given me a very sensible shock, had there been an immediate communication, by my arms, from the hook to the coating of the same phial; because, when it was taken into a third phial, and that phial discharged singly through my arms, it gave me a sensible shock. If these experiments prove, that the electric matter does not pass through the entire thickness of the glass, it is a necessary consequence that it must always come out where it entered.

The next thing I meet with is in the Abbé's fifth letter, (p. 88,) where he differs from Mr. Franklin, who thinks that the whole power of giving a shock is in the glass itself, and not in the non-electrics in contact with it. The experiments which Mr. Franklin gave to prove this opinion, in his *Observations on the Leyden Bottle*, (p. 189,) convinced me that he was in the right; and what the Abbé has asserted, in contradiction thereto, has not made me think otherwise. The Abbé, perceiving, as I suppose, that the experiments, as Mr. Franklin had performed them, must prove his assertion, alters them without giving any reason for it, and makes them in a manner that proves nothing. Why will he have the phial, into which the water is to be decanted from a charged phial, held in a man's hand? If the power of giving a shock is in the water contained in the phial, it should remain there, though decanted into another phial, since no non-electric body touched it to take that power off. The phial being placed on wax is no objection, for it cannot take the power from the water, if it had any, but it is a necessary means to try the fact; whereas, that phial's being charged when held in a man's hand, only proves, that water will conduct the electric matter. The Abbé owns, (p. 94,) that he had heard this remarked, but says, Why is not a conductor of electricity an electric subject? This is not the question; Mr. Franklin never said, that water was not an electric subject; he said, that the power of giving a shock was in the glass, and not in the water; and this his experiments fully prove; so fully, that it may appear impertinent to offer any more; yet, as I do not know that the following has been taken notice of by anybody before, my inserting of it in this place may be excused. It is this; hang a phial, prepared for the Leyden experiment, to the conductor, by its hook, and charge it; which done, remove the communication from the bottom of the phial. Now the conductor shows evident signs of being electrized; for if a thread be tied round it, and its ends left about two inches long, they will extend themselves out like a pair of horns; but, if you touch the conductor, a spark will issue from it, and the threads will fall, nor does the conductor show the least sign of being electrized after this is done. I think, that, by this touch, I have taken out all the charge of electric matter that was in the conductor, the hook of the phial, and water or filings of iron contained in it; which is no more than we see all non-electric bodies will receive; yet the glass of the phial retains its power of giving a shock, as any one will find that pleases to try. This experiment fully evidences, that the water in the phial contains no more electric matter than it would do in an open basin, and has not any of that great quantity which produces the shock, and is only retained by the glass. If, after the spark is drawn from the conductor, you touch the coating of the phial (which all this while is supposed to hang in the air, free from any non-electric body), the threads on the conductor will instantly start up, and show that the conductor is electrized. It receives this electrization from the inner surface of the phial, which, when the outer surface can receive what it wants from the hand applied to it, will give as much as the bodies in contact with it can receive, or, if they be large enough, all that it has of excess. It is diverting to see how the threads will rise and fall by touching the coating and conductor of the phial alternately. May it not be, that, the difference between the charged side of the glass, and the outer or emptied side, being lessened by touching the hook or the conductor, the outer side can receive from the hand which touched it, and, by its receiving, the inner side cannot retain so much; and, for that reason, so much as it cannot contain electrizes the water, or filings, and conductor. For it seems to be a rule, that the one side must be emptied in the same proportion that the other is filled; though this from experiment appears evident, yet it is still a mystery not to be accounted for.

I am, in many places of the Abbé's book, surprised to find, that experiments have succeeded so differently at Paris, from what they did with Mr. Franklin, and as I have always observed them to do. The Abbé, in making experiments to find the difference between the two surfaces of a charged glass, will not have the phial placed on wax; "for," says he, "don't you know, that, being placed on a body originally electric, it quickly loses its virtue?" I cannot imagine what should have made the Abbé think so; it certainly is contradictory to the notions commonly received of electrics *per se;* and by experiment I find it entirely otherwise; for, having several times left a charged phial, for that purpose, standing on wax for hours, I found it to retain as much of its charge as another that stood at the same time on a table. I left one standing on wax from ten o'clock at night till eight the next morning, when I found it to retain a sufficient quantity of its charge to give me a sensible commotion in my arms, though the room in which the phial stood had been swept in that time, which must have raised much dust to facilitate the discharge of the phial.

I find that a cork ball suspended between two bottles, the one fully and the other but little charged, will not play between them, but is driven into a situation that makes a triangle with the hooks of the phials; though the Abbé has asserted the contrary of this, (p. 101,) in order to account for the playing of a cork ball between the wire thrust into the phial, and one that rises up from its coating. The phial which is least charged must have more electric matter given to it, in proportion to its bulk, than the cork ball receives from the hook of the full phial.

The Abbé says, (p. 103,) "That a piece of metal leaf, hung to a silk thread and electrized, will be repelled by the bottom of a charged phial held by its hook in the air;" this I find constantly otherwise; it is with me always first attracted and then repelled. It is necessary, in charging the leaf, to be careful that it does not fly off to some non-electric body, and so discharge itself, when you think it is charged; it is difficult to keep it from flying to your own wrist, or to some part of your body.

The Abbé (p. 108) says, "that it is not impossible, as Mr. Franklin says it is, to charge a phial while there is a communication formed between its coating and its hook." I have always found it impossible to charge such a phial so as to give a shock; indeed, if it hang on the conductor without a communication from it, you may draw a spark from it, as you may from any body that hangs there; but this is very different from being charged in such a manner as to give a shock. The Abbé, in order to account for the little quantity of electric matter that is to be found in the phial, says, "that it rather follows the metal than the glass, and that it spewed out into the air from the coating of the phial." I wonder how it comes not to do so too, when it sifts through the glass, and charges the exterior surface, according to the Abbé's system!

The Abbé's objections against Mr. Franklin's two last experiments, I think, have little weight in them; he seems, indeed, much at a loss what to say, wherefore he taxes Mr. Franklin with having concealed a material part of the experiment; a thing too mean for any gentleman to be charged with, who has not shown as great a partiality in relating experiments, as the Abbé has done.

ELECTRICAL EXPERIMENTS,

With an Attempt to account for their several Phenomena. Together with some Observations on Thunder-clouds, in further Confirmation of Mr. Franklin's Observations on the Positive and Negative Electrical State of the Clouds. By John Canton, M. A., F. R. S.

6 December, 1753.

EXPERIMENT I.

From the ceiling, or any convenient part of a room, let two cork balls, each about the bigness of a small pea, be suspended by linen threads of eight or nine inches in length, so as to be in contact with each other. Bring the excited glass tube under the balls, and they will be separated by it, when held at the distance of three or four feet; let it be brought nearer, and they will stand farther apart; entirely withdraw it, and they will immediately come together. This experiment may be made with very small brass balls hung by silver wire; and will succeed as well with sealing-wax made electrical, as with glass.

EXPERIMENT II.

If two cork balls be suspended by dry silk threads, the excited tube must be brought within eighteen inches before they will repel each other; which they will continue to do, for some time, after the tube is taken away.

As the balls in the first experiment are not insulated, they cannot properly be said to be electrified; but when they hang within the atmosphere of the excited tube, they may attract and condense the electrical fluid round about them, and be separated by the repulsion of its particles. It is conjectured also, that the balls at this time contain less than their common share of the electrical fluid, on account of the repelling power of that which surrounds them; though some, perhaps, is continually entering and passing through the threads. And, if that be the case, the reason is plain why the balls hung by silk, in the second experiment, must be in a much more dense part of the atmosphere of the tube, before they will repel each other. At the approach of an excited stick of wax to the balls, in the first experiment, the electrical fire is supposed to come through the threads into the balls, and be condensed there, in its passage towards the wax; for, according to Mr. Franklin, excited glass *emits* the electrical fluid, but excited wax *receives* it.

EXPERIMENT III.

Let a tin tube, of four or five feet in length, and about two inches in diameter, be insulated by silk; and from one end of it let the cork balls be suspended by linen threads. Electrify it, by bringing the excited glass tube near the other end, so as that the balls may stand an inch and a half, or two inches, apart; then, at the approach of the excited tube, they will, by degrees, lose their repelling power, and come into contact; and, as the tube is brought still nearer, they will separate again to as great a distance as before; in the return of the tube, they will approach each other till they touch, and then repel as at first. If the tin tube be electrified by wax, or the wire of a charged phial, the balls will be affected in the same manner at the approach of excited wax, or the wire of the phial.

EXPERIMENT IV.

Electrify the cork balls, as in the last experiment, by glass, and at the approach of an excited stick of wax their repulsion will be increased. The effect will be the same, if the excited glass be brought towards them, when they have been electrified by wax.

The bringing the excited glass to the end or edge of the tin tube, in the third experiment, is supposed to electrify it positively, or to add to the electrical fire it before contained; and therefore some will be running off through the balls, and they will repel each other. But, at the approach of excited glass, which likewise *emits* the electrical fluid, the discharge of it from the balls will be diminished; or part will be driven back, by a force acting in a contrary direction; and they will come nearer together. If the tube be held at such a distance from the balls, that the excess of the density of the fluid round about them, above the common quantity in air, be equal to the excess of the density of that within them, above the common quantity contained in cork, their repulsion will be quite destroyed. But, if the tube be brought nearer, the fluid without being more dense than that within the balls, it will be attracted by them, and they will recede from each other again.

When the apparatus has lost part of its natural share of this fluid, by the approach of excited wax to one end of it, or is electrified negatively, the electrical fire is attracted and imbibed by the balls to supply the deficiency; and that more plentifully at the approach of excited glass, or a body positively electrified, than before; whence the distance between the balls will be increased, as the fluid surrounding them is augmented. And, in general, whether by the approach or recess of any body, if the difference between the density of the internal and external fluid be increased, or diminished, the repulsion of the balls will be increased, or diminished, accordingly.

EXPERIMENT V.

When the insulated tin tube is not electrified, bring the excited glass tube towards the middle of it, so as to be nearly at right angles with it, and the balls at the end will repel each other; and the more so, as the excited tube is brought nearer. When it has been held a few seconds, at the distance of about six inches, withdraw it, and the balls will approach each other till they touch; and then, separating again, as the tube is moved farther off, will continue to repel when it is taken quite away. And this repulsion between the balls will be increased by the approach of excited glass, but diminished by excited wax; just as if the apparatus had been electrified by wax, after the manner described in the third experiment.

EXPERIMENT VI.

Insulate two tin tubes, distinguished by *A* and *B*, so as to be in a line with each other, and about half an inch apart; and, at the remote end of each, let a pair of cork balls be suspended. Towards the middle of *A*, bring the excited glass tube, and holding it a short time, at the distance of a few inches, each pair of balls will be observed to separate; withdraw the tube, and the balls of *A* will come together, and then repel each other again; but those of *B* will hardly be affected. By the approach of the excited glass tube, held under the balls of *A*, their repulsion will be increased; but if the tube be brought, in the same manner, towards the balls of *B*, their repulsion will be diminished.

In the fifth experiment, the common stock of electrical matter in the tin tube is supposed to be attenuated about the middle, and to be condensed at the ends, by the repelling power of the atmosphere of the excited glass tube, when held near it. And perhaps the tin tube may lose some of its natural quantity of the electrical fluid, before it receives any from the glass; as that fluid will more readily run off from the ends and edges of it, than enter at the middle; and accordingly, when the glass tube is withdrawn, and the fluid is again equally diffused through the apparatus, it is found to be electrified negatively; for excited glass brought under the balls will increase their repulsion.

In the sixth experiment, part of the fluid driven out of one tin tube enters the other; which is found to be electrified positively, by the decreasing of the repulsion of its balls at the approach of excited glass.

EXPERIMENT VII.

Let the tin tube, with a pair of balls at one end, be placed three feet at least from any part of the room, and the air rendered very dry by means of a fire; electrify the apparatus to a considerable degree; then touch the tin tube with a finger, or any other conductor, and the balls will, notwithstanding, continue to repel each other, though not at so great a distance as before.

The air surrounding the apparatus, to the distance of two or three feet, is supposed to contain more or less of the electrical fire, than its common share, as the tin tube is electrified positively or negatively; and, when very dry, may not part with its overplus, or have its deficiency supplied so suddenly, as the tin; but may continue to be electrified, after that has been touched for a considerable time.

EXPERIMENT VIII.

Having made the Torricellian vacuum about five feet long, after the manner described in the *Philosophical Transactions*, Vol. XLVII. p. 370, if the excited tube be brought within a small distance of it, a light will be seen through more than half its length; which soon vanishes, if the tube be not brought nearer; but will appear again, as that is moved farther off. This may be repeated several times, without exciting the tube afresh.

This experiment may be considered as a kind of ocular demonstration of the truth of Mr. Franklin's hypothesis; that, when the electrical fluid is condensed on one side of thin glass, it will be repelled from the other, if it meets with no resistance. According to which, at the approach of the excited tube, the fire is supposed to be repelled from the inside of the glass surrounding the vacuum, and to be carried off through the columns of mercury; but, as the tube is withdrawn, the fire is supposed to return.

EXPERIMENT IX.

Let an excited stick of wax, of two feet and a half in length, and about an inch in diameter, be held near its middle. Excite the glass tube, and draw it over one half of it; then, turning it a little about its axis, let the tube be excited again, and drawn over the same half; and let this operation be repeated several times; then will that half destroy the repelling power of balls electrified by glass, and the other half will increase it.

By this experiment it appears, that wax also may be electrified positively and negatively. And it is probable, that all bodies whatsoever may have the quantity they contain of the electrical fluid increased or diminished. The clouds, I have observed, by a great number of experiments, to be some in a positive, and others in a negative, state of electricity. For the cork balls, electrified by them, will sometimes close at the approach of excited glass; and at other times be separated to a greater distance. And this change I have known to happen five or six times in less than half an hour; the balls coming together each time and remaining in contact a few seconds, before they repel each other again. It may likewise easily be discovered, by a charged phial, whether the electrical fire be drawn out of the apparatus by a negative cloud, or forced into it by a positive one; and by whichsoever it be electrified, should that cloud either part with its overplus, or have its deficiency supplied suddenly, the apparatus will lose its electricity; which is frequently observed to be the case, immediately after a flash of lightning. Yet, when the air is very dry, the apparatus will continue to be electrized for ten minutes, or a quarter of an hour, after the clouds have passed the zenith; and sometimes till they appear more than half-way towards the horizon. Rain, especially when the drops are large, generally brings down the electrical fire; and hail, in summer, I believe never fails. When the apparatus was last electrified, it was by the fall of thawing snow, which happened so lately as on the 12th of November; that being the twenty-sixth day and sixty-first time it has been electrified, since it was first set up, which was about the middle of May. And, as Fahrenheit's thermometer was but seven degrees above freezing, it is supposed the winter will not entirely put a stop to observations of this sort. At London, no more than two thunder-storms have happened during the whole summer; and the apparatus was sometimes so strongly electrified in one of them, that the bells, which have been frequently rung by the clouds, so loud as to be heard in every room of the house (the doors being open), were silenced by the almost constant stream of dense electrical fire, between each bell and the brass ball, which would not suffer it to strike.

I shall conclude this paper, already too long, with the following queries.

1. May not air, suddenly rarefied, give electrical fire to, and air, suddenly condensed, receive electrical fire from, clouds and vapors passing through it?

2. Is not the *aurora borealis* the flashing of electrical fire from positive towards negative clouds, at a great distance, through the upper part of the atmosphere, where the resistance is least?

TO JAMES BOWDOIN.

Concerning the Light emitted by Salt Water. — The Abbé Nollet's Letters on Electricity.

Philadelphia, 13 December, 1753.

Dear Sir,

I received your favor of the 12th ultimo, with the law of your province for regulating the Indian trade, for which I thank you, and for the remarks that accompany it, which clearly evince the usefulness of the law, and I hope will be sufficient to induce our Assembly to follow your example.

I have yet received no particulars of the unhappy gentleman's death at Petersburg, (whose fate I lament.)

One of the papers says, that all the letters from thence confirm the account, and mentions his name, (Professor Richmann,) but nothing farther. No doubt we shall have a minute account of the accident with all its circumstances, in some of the magazines or the Transactions of the Royal Society.*

The observation you made of the sea water emitting more and less light, in different tracts passed through by your boat, is new; and your manner of accounting for it ingenious. It is indeed very possible, that an extremely small animalcule, too small to be visible even by the best glasses, may yet give a visible light. I remember to have taken notice, in a drop of kennel water, magnified by the solar microscope to the bigness of a cart-wheel, there were numbers of visible animalcules of various sizes swimming about; but I was sure there were likewise some which I could not see, even with that magnifier; for the wake they made in swimming to and fro was very visible, though the body that made it was not so. Now, if I could see the wake of an invisible animalcule, I imagine I might much more easily see its light, if it were of the luminous kind. For how small is the extent of a ship's wake, compared with that of the light of her lantern.

My barometer will not show the luminous appearance by agitating the mercury in the dark, but I think yours does. Please to try whether it will, when agitated, attract a fine thread hung near the top of the tube.

As to the answer to Nollet, if I were going on with

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* Professor Richmann was killed at Petersburg, on the 26th of July, 1753, while repeating Franklin's experiment for bringing electricity from the clouds. He received a shock, which caused instantaneous death A full account of the circumstances attending his death is contained in the *Philosophical Transactions*, Vol. XLVIII. p. 765; and Vol. XLIX. p. 61. – EDITOR.

it, I should be extremely glad of your peeping into it (as you say) now and then, that I might correct it by your advice. The materials in short hints have been long collected and methodized; they only want to be clothed with expression. But, soon after my return from New England, I received the enclosed from Monsieur Dalibard, wherein he tells me, that he is preparing an answer, not only to the Abbé, but to some others that have wrote against my doctrine, which will be published the beginning of this winter. This, with a good deal of business, and a little natural indolence, has made me neglect finishing my answer, till I shall see what is done by him. Perhaps it may then appear unnecessary for me to do any thing farther in it. And will not one's vanity be more gratified in seeing one's adversary confuted by a disciple, than even by one's self? I am, however, a little concerned for Dalibard, when I find by his letter, that he has been so far imposed on by the Abbé's confident assertion, that a charged bottle placed on an electric *per se* loses its electricity, as to attempt to account for it, when the thing is absolutely not fact. I have in answer wrote him my sentiments on that and some other particulars of the Abbé's book, which I hope will get to hand before his answer is published.

I am, with the greatest esteem and regard,

Dear Sir, your most obliged humble servant,

B. Franklin.

TO PETER COLLINSON.

Additional Proofs of the Positive and Negative State of Electricity in the Clouds. — New Method of ascertaining it.

Philadelphia, 18 April, 1754.

Sir,

Since September last, having been abroad on two long journeys, and otherwise much engaged, I have made but few observations on the *positive* and *negative* state of electricity in the clouds. But Mr. Kinnersley kept his rod and bells in good order, and has made many.

Once this winter the bells rang a long time during a fall of snow, though no thunder was heard, or lightning seen. Sometimes the flashes and cracks of the electric matter between bell and bell were so large and loud as to be heard all over the house; but, by all his observations, the clouds were constantly in a negative state, till about six weeks ago, when he found them once to change in a few minutes from the negative to the positive. About a fortnight after that, he made another observation of the same kind; and last Monday afternoon, the wind blowing hard at southeast, and veering round to northeast, with many thick, driving clouds, there were five or six successive changes from negative to positive, and from positive to negative, the bells stopping a minute or two between every change. Besides the methods mentioned in my paper of September last, of discovering the electrical state of the clouds, the following may be used. When your bells are ringing, pass a rubbed tube by the edge of the bell, connected with your pointed rod; if the cloud is then in a negative state, the ringing will stop; if in a positive state, it will continue, and perhaps be quicker. Or, suspend a very small cork ball by a fine silk thread, so that it may hang close to the edge of the rod-bell; then, whenever the bell is electrified, whether positively or negatively, the little ball will be repelled, and continue at some distance from the bell. Have ready a round-headed glass stopper of a decanter, rub it on your side till it is electrified, then present it to the cork ball. If the electricity in the ball is positive, it will be repelled from the glass stopper, as well as from the bell; if negative, it will fly to the stopper.

B. Franklin.

EXPERIMENTS

Made in Pursuance of those made by Mr. Canton, dated December 6th, 1753; with Explanations, by Benjamin Franklin.

READ AT THE ROYAL SOCIETY, DECEMBER 18TH, 1755.

Philadelphia, 14 March, 1755

PRINCIPLES.

I. Electric atmospheres that flow round non-electric bodies, being brought near each other, do not readily mix and unite into one atmosphere, but remain separate, and repel each other.

This is plainly seen in suspended cork balls, and other bodies electrified.

II. An electric atmosphere not only repels another electric atmosphere, but will also repel the electric matter contained in the substance of a body approaching it; and, without joining or mixing with it, force it to other parts of the body that contained it.

This is shown by some of the following experiments.

III. Bodies electrified negatively, or deprived of their natural quantity of electricity, repel each other (or at least appear to do so, by a mutual receding), as well as those electrified positively, or which have electric atmospheres.

This is shown by applying the negatively charged wire of a phial to two cork balls, suspended by silk threads, and many other experiments.

PREPARATION.

Fix a tassel of fifteen or twenty threads, three inches long, at one end of a tin prime conductor (mine is about five feet long and four inches diameter), supported by silk lines.

Let the threads be a little damp, but not wet.

EXPERIMENT I.

Pass an excited glass tube near the other end of the prime conductor, so as to give it some sparks, and the threads will diverge.

Because each thread, as well as the prime conductor, has acquired an electric atmosphere, which repels and is repelled by the atmospheres of the other threads; if those several atmospheres would readily mix, the threads might unite, and hang in the middle of one atmosphere, common to them all.

Rub the tube afresh, and approach the prime conductor therewith, crosswise, near that end, but not nigh enough to give sparks; and the threads will diverge a little more.

Because the atmosphere of the prime conductor is pressed by the atmosphere of the excited tube, and driven towards the end where the threads are, by which each thread acquires more atmosphere.

Withdraw the tube, and they will close as much.

They close as much, and no more; because the atmosphere of the glass tube, not having mixed with the atmosphere of the prime conductor, is withdrawn entire, having made no addition to, or diminution from it.

Bring the excited tube under the tuft of threads, and they will close a little.

They close, because the atmosphere of the glass tube repels their atmospheres, and drives part of them back on the prime conductor.

Withdraw it, and they will diverge as much.

For the portion of atmosphere which they had lost, returns to them again.

EXPERIMENT II.

Excite the glass tube, and approach the prime conductor with it, holding it across, near the end opposite to that on which the threads hang, at the distance of five or six inches. Keep it there a few seconds, and the threads of the tassels will diverge. Withdraw it, and they will close.

They diverge, because they have received electric atmospheres from the electric matter before contained in the substance of the prime conductor; but which is now repelled and driven away, by the atmosphere of the glass tube, from the parts of the prime conductor opposite and nearest to that atmosphere, and forced out upon the surface of the prime conductor at its other end, and upon the threads hanging thereto. Were it any part of the atmosphere of the glass tube that flowed over and along the prime conductor to the threads, and gave them atmospheres (as is the case when a spark is given to the prime conductor from the glass tube), such part of the tube's atmosphere would have remained, and the threads continue to diverge; but they close on withdrawing the tube, because the tube takes with it *all its own atmosphere*, and the electric matter, which had been driven out of the substance of the prime conductor, and formed atmospheres round the threads, is thereby permitted to return to its place.

Take a spark from the prime conductor near the threads, when they are diverged as before, and they will close.

For by so doing you take away their atmospheres, composed of the electric matter driven out of the substance of the prime conductor, as aforesaid, by the repellency of the atmosphere of the glass tube. By taking this spark you rob the prime conductor of part of its natural quantity of the electric matter; which part so taken is not supplied by the glass tube, for, when that is afterwards withdrawn, it takes with it its whole atmosphere, and leaves the prime conductor electrized negatively, as appears by the next operation.

Then withdraw the tube, and they will open again.

For now, the electric matter in the prime conductor returning to its equilibrium, or equal diffusion, in all parts of its substance, and the prime conductor having lost some of its natural quantity, the threads connected with it lose part of theirs, and so are electrized negatively, and therefore repel each other, by *Principle* III.

Approach the prime conductor with the tube, near the same place as at first, and they will close again.

Because the part of their natural quantity of electric fluid, which they had lost, is now restored to them again, by the repulsion of the glass tube forcing that fluid to them, from other parts of the prime conductor; so they are now again in their natural state.

Withdraw it, and they will open again.

For what had been restored to them, is now taken from them again, flowing back into the prime conductor, and leaving them once more electrized negatively.

Bring the excited tube under the threads, and they will diverge more.

Because more of their natural quantity is driven from them into the prime conductor, and thereby their negative electricity increased.

EXPERIMENT III.

The prime conductor not being electrified, bring the excited tube under the tassel, and the threads will diverge.

Part of their natural quantity is thereby driven out of them into the prime conductor, and they become negatively electrized, and therefore repel each other.

Keeping the tube in the same place with one hand, attempt to touch the threads with the finger of the other hand, and they will recede from the finger.

Because the finger being plunged into the atmosphere of the glass tube, as well as the threads, part of its natural quantity is driven back through the hand and body by that atmosphere, and the finger becomes, as well as the threads, negatively electrized, and so repels, and is repelled by them. To confirm this, hold a slender, light lock of cotton, two or three inches long, near a prime conductor, that is electrified by a glass globe or tube. You will see the cotton stretch itself out towards the prime conductor. Attempt to touch it with the finger of the other hand, and it will be repelled by the finger. Approach it with a positively charged wire of a bottle, and it will fly to the wire. Bring it near a negatively charged wire of a bottle, it will recede from that wire in the same manner that did from the finger; which demonstrates the finger to be negatively electrized, as well as the lock of cotton so situated.

Turkey killed by Electricity. — Effect of a Shock on the Operator in making the Experiment.

As Mr. Franklin, in a former letter to Mr. Collinson, mentioned his intending to try the power of a very strong electrical shock upon a turkey, that gentleman accordingly has been so very obliging as to send an account of it, which is to the following purpose.

He made first several experiments on fowls, and found, that two large, thin glass jars gilt, holding each about six gallons, were sufficient, when fully charged, to kill common hens outright; but the turkeys, though thrown into violent convulsions, and then lying as dead for some minutes, would recover in less than a quarter of an hour. However, having added three other such to the former two, though not fully charged, he killed a turkey of about ten pounds weight, and believes that they would have killed a much larger. He conceited, as himself says, that the birds killed in this manner eat uncommonly tender.

In making these experiments, he found, that a man could, without great detriment, bear a much greater shock than he had imagined; for he inadvertently received the stroke of two of these jars through his arms and body, when they were very near fully charged. It seemed to him a universal blow throughout the body from head to foot, and was followed by a violent, quick trembling in the trunk, which went off gradually, in a few seconds. It was some minutes before he could recollect his thoughts, so as to know what was the matter; for he did not see the flash, though his eye was on the spot of the prime conductor, from whence it struck the back of his hand; nor did he hear the crack, though the by-standers said it was a loud one; nor did he particularly feel the stroke on his hand, though he afterwards found it had raised a swelling there, of the bigness of half a pistol-bullet. His arms and the back of the neck felt somewhat numbed the remainder of the evening, and his breast was sore for a week after, as if it had been bruised. From this experiment may be seen the danger, even under the greatest caution, to the operator, when making these experiments with large jars; for it is not to be doubted, but several of these fully charged would as certainly, by increasing them in proportion to the size, kill a man, as they before did a turkey.

N. B. The original of this letter, which was read at the Royal Society, has been mislaid.*

TO JOHN LINING, AT CHARLESTON, SOUTH CAROLINA.

Differences in the Qualities of Glass. — Account of Domien, an Electrician and Traveller. — Conjectures respecting the Pores of Glass. — Origin of the Author's Idea of drawing down Lightning. — No satisfactory Hypothesis respecting the Manner in which Clouds become electrified. — Six Men knocked down at once by an Electrical Shock. — Reflections on the Spirit of Invention.

Philadelphia, 18 March, 1755.

Sir,

I send you enclosed a paper containing some new experiments I have made, in pursuance of those by Mr. Canton, that are printed with my last letters. I hope

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* See Franklin's letter "to a Friend in Boston," p. 255, giving an account of the same accident

these, with my explanation of them, will afford you some entertainment.*

In answer to your several inquiries. The tubes and globes we use here, are chiefly made here. The glass has a greenish cast, but is clear and hard, and, I think, better for electrical experiments than the white glass of London, which is not so hard. There are certainly great differences in glass. A white globe I had made here some years since, would never, by any means, be excited. Two of my friends tried it, as well as myself, without success. At length, putting it on an electric stand, a chain from the prime conductor being in contact with it, I found it had the properties of a non-electric; for I could draw sparks from any part of it, though it was very clean and dry.

All I know of Domien is, that by his own account he was a native of Transylvania, of Tartar descent, but a priest of the Greek Church; he spoke and wrote Latin very readily and correctly. He set out from his own country with an intention of going round the world, as much as possible by land. He travelled through Germany, France, and Holland, to England. Resided some time at Oxford. From England he came to Maryland; thence went to New England; returned by land to Philadelphia; and from hence travelled through Maryland, Virginia, and North Carolina to you. He thought it might be of service to him, in his travels, to know something of electricity. I taught him the use of the tube, how to charge the Leyden phial, and some other experiments. He wrote to me from Charleston, that he lived eight hundred miles upon electricity; it had been meat, drink, and clothing to him. His last letter to me was, I think, from Jamaica,

* See page 330, for the paper here mentioned.

desiring me to send the tubes you mention, to meet him at the Havana, from whence he expected to get a passage to La Vera Cruz; designed travelling over land through Mexico to Acapulco; thence to get a passage to Manilla, and so through China, India, Persia, and Turkey, home to his own country; proposing to support himself chiefly by electricity. A strange project! But he was, as you observe, a very singular character. I was sorry the tubes did not get to the Havana in time for him. If they are still in being, please to send for them, and accept of them. What became of him afterwards, I have never heard. He promised to write to me as often as he could on his journey, and as soon as he should get home after finishing his tour. It is now seven years since he was here. If he is still in New Spain, as you imagine from that loose report, I suppose it must be that they confine him there, and prevent his writing; but I think it more likely that he may be dead.

The questions you ask about the pores of glass, I cannot answer, otherwise than that I know nothing of their nature; and suppositions, however ingenious, are often mere mistakes. My hypothesis, that they were smaller near the middle of the glass, too small to admit the passage of electricity, which could pass through the surface till it came near the middle, was certainly wrong. For, soon after I had written that letter, I did, in order to *confirm* the hypothesis, (which indeed I ought to have done before I wrote it,) make an experiment. I ground away five-sixths of the thickness of the glass, from the side of one of my phials, expecting that, the supposed denser part being so removed, the electric fluid might come through the remainder of the glass, which I had imagined more open; but I found myself mistaken. The bottle charged as well after the grinding as before. I am now, as much as ever, at a loss to know how or where the quantity of electric fluid, on the positive side of the glass, is disposed of.

As to the difference of conductors, there is not only this, that some will conduct electricity in small quantities, and yet do not conduct it fast enough to produce the shock; but, even among those that will conduct a shock, there are some that do it better than others. Mr. Kinnersley has found, by a very good experiment, that when the charge of a bottle hath an opportunity of passing two ways, that is, straight through a trough of water ten feet long, and six inches square, or round about through twenty feet of wire, it passes through the wire, and not through the water, though that is the shortest course; the wire being the better conductor. When the wire is taken away, it passes through the water, as may be felt by a hand plunged in the water; but it cannot be felt in the water when the wire is used at the same time. Thus, though a small phial containing water will give a smart shock, one containing the same quantity of mercury will give one much stronger, the mercury being the better conductor; while one containing oil only, will scarce give any shock at all.

Your question, how I came first to think of proposing the experiment of drawing down the lightning, in order to ascertain its sameness with the electric fluid, I cannot answer better than by giving you an extract from the minutes I used to keep of the experiments I made, with memorandums of such as I purposed to make, the reasons for making them, and the observations that arose upon them, from which minutes my letters were afterwards drawn. By this extract you will see, that the thought was not so much "an out-of-the-way one," but that it might have occurred to an electrician.

"*November 7th*, 1749. Electrical fluid agrees with lightning in these particulars. 1. Giving light. 2. Color of the light. 3. Crooked direction. 4. Swift motion. 5. Being conducted by metals. 6. Crack or noise in exploding. 7. Subsisting in water or ice. 8. Rending bodies it passes through. 9. Destroying animals. 10. Melting metals. 11. Firing inflammable substances. 12. Sulphureous smell. The electric fluid is attracted by points. We do not know whether this property is in lightning. But since they agree in all the particulars wherein we can already compare them, is it not probable they agree likewise in this? Let the experiment be made."

I wish I could give you any satisfaction in the article of clouds. I am still at a loss about the manner in which they become charged with electricity; no hypothesis I have yet formed perfectly satisfying me. Some time since, I heated very hot a brass plate, two feet square, and placed it on an electric stand. From the plate a wire extended horizontally four or five feet, and, at the end of it, hung, by linen threads, a pair of cork balls. I then repeatedly sprinkled water over the plate, that it might be raised from it in vapor, hoping, that, if the vapor either carried off the electricity of the plate, or left behind it that of the water, (one of which I supposed it must do, if, like the clouds, it became electrized itself, either positively or negatively,) I should perceive and determine it by the separation of the balls, and by finding whether they were positive or negative; but no alteration was made at all, nor could I perceive that the steam was itself electrized, though I have still some suspicion that the steam was not fully examined, and I think the experiment should be repeated. Whether the first state of electrized clouds is positive or negative, if I could find the cause of that, I should be at no loss about the other; for either is easily deduced from the other, as one state is easily produced by the other. A strongly positive cloud may drive out of a neighbouring cloud much of its natural quantity of the electric fluid, and, passing by it, leave it in a negative state. In the same way, a strongly negative cloud may occasion a neighbouring cloud to draw into itself from others an additional quantity, and, passing by it, leave it in a positive state. How these effects may be produced, you will easily conceive, on perusing and considering the experiments in the enclosed paper; and from them too it appears probable, that every change from positive to negative, and from negative to positive, that, during a thunder-gust, we see in the cork balls annexed to the apparatus, is not owing to the presence of clouds in the same state, but often to the absence of positive or negative clouds, that, having just passed, leave the rod in the opposite state.

The knocking down of the six men was performed with two of my large jars not fully charged. I laid one end of my discharging-rod upon the head of the first; he laid his hand on the head of the second; the second his hand on the head of the third, and so to the last, who held, in his hand, the chain that was connected with the outside of the jars. When they were thus placed, I applied the other end of my rod to the prime conductor, and they all dropped together. When they got up, they all declared they had not felt any stroke, and wondered how they came to fall; nor did any of them either hear the crack, or see the light of it. You suppose it a dangerous experiment; but I had once suffered the same myself, receiving, by accident, an equal stroke through my head, that struck me down, without hurting me. And I had seen a young woman, that was about to be electrified through the feet (for some indisposition), receive a greater charge through the head, by inadvertently stooping forward to look at the placing of her feet, till her forehead (as she was very tall) came too near my prime conductor; she dropped, but instantly got up again, complaining of nothing. A person so struck, sinks down doubled, or folded together, as it were, the joints losing their strength and stiffness at once, so that he drops on the spot where he stood, instantly, and there is no previous staggering, nor does he ever fall lengthwise. Too great a charge might, indeed, kill a man, but I have not yet seen any hurt done by it. It would certainly, as you observe, be the easiest of all deaths.

The experiment you have heard so imperfect an account of, is merely this; I electrified a silver pint can, on an electric stand, and then lowered into it a cork ball, of about an inch diameter, hanging by a silk string, till the cork touched the bottom of the can. The cork was not attracted to the inside of the can, as it would have been to the outside; and, though it touched the bottom, yet, when drawn out, it was not found to be electrified by that touch, as it would have been by touching the outside. The fact is singular. You require the reason; I do not know it. Perhaps you may discover it, and then you will be so good as to communicate it to me.* I find a frank acknowledgment of one's ignorance is, not only the easiest way to get rid of a difficulty, but the likeliest way to obtain information, and therefore I practise it; I think it an honest policy. Those who affect to be thought to know every thing, and so undertake to explain every thing, often remain

* Mr. Franklin has since thought, that possibly the mutual repulsion of the inner opposite sides of the electrical can may prevent the accumulating an electric atmosphere upon them, and occasion it to stand chiefly on the outside; but recommends it to the farther examination of the curious.

long ignorant of many things that others could and would instruct them in, if they appeared less conceited.

The treatment your friend has met with is so common, that no man, who knows what the world is and ever has been, should expect to escape it. There are everywhere a number of people, who, being totally destitute of any inventive faculty themselves, do not readily conceive that others may possess it; they think of inventions as of miracles; there might be such formerly, but they are ceased. With these, every one who offers a new invention is deemed a pretender; he had it from some other country, or from some book; a man of *their own acquaintance*, one who has no more sense than themselves, could not possibly, in their opinion, have been the inventor of any thing. They are confirmed, too, in these sentiments, by frequent instances of pretensions to invention, which vanity is daily producing. That vanity, too, though an incitement to invention, is, at the same time, the pest of inventors. Jealousy and envy deny the merit or the novelty of your invention; but vanity, when the novelty and merit are established, claims it for its own. The smaller your invention is, the more mortification you receive in having the credit of it disputed with you by a rival, whom the jealousy and envy of others are ready to support against you, at least so far as to make the point doubtful. It is not in itself of importance enough for a dispute; no one would think your proofs and reasons worth their attention; and yet, if you do not dispute the point, and demonstrate your right, you not only lose the credit of being in that instance *ingenious*, but you suffer the disgrace of not being *ingenuous;* not only of being a plagiary, but of being plagiary for trifles. Had the invention been greater, it would have disgraced you less; for men have not so contemptible an idea of him that robs for gold on the highway, as of him that can pick pockets for half-pence and farthings. Thus, through envy, jealousy, and the vanity of competitors for fame, the origin of many of the most extraordinary inventions, though produced within but a few centuries past, is involved in doubt and uncertainty. We scarce know to whom we are indebted for the *compass*, and for *spectacles*, nor have even *paper* and *printing*, that record every thing else, been able to preserve with certainty the name and reputation of their inventors. One would not, therefore, of all faculties or qualities of the mind, wish, for a friend or a child, that he should have that of invention. For his attempts to benefit mankind in that way, however well imagined, if they do not succeed, expose him, though very unjustly, to general ridicule and contempt; and, if they do succeed, to envy, robbery, and abuse.

I am, &c.

B. Franklin.

TO M. DALIBARD, AT PARIS, ENCLOSED IN A LETTER TO PETER COLLINSON.

Beccaria's Work on Electricity. — Sentiments of Franklin on pointed Rods, not fully understood in Europe. — Effect of Lightning on the Church of Newbury, in New England. — Remarks on the Subject.

READ AT THE ROYAL SOCIETY, DECEMBER 18TH, 1755.

Philadelphia, 29 June, 1755.

Sir,

You desire my opinion of Père Beccaria's Italian book.* I have read it with much pleasure, and think

* This work is written conformably to Mr. Franklin's theory, upon artificial and natural electricity, which compose the two parts of it. It was

it one of the best pieces on the subject, that I have seen in any language. Yet, as to the article of *Water-spouts*, I am not at present of his sentiments; though I must own, with you, that he has handled it very ingeniously. Mr. Collinson has my opinion of whirlwinds and water-spouts at large, written some time since. I know not whether they will be published; if not, I will get them transcribed for your perusal.* It does not appear to me that Père Beccaria doubts of the *absolute impermeability of glass* in the sense I meant it; for the instances he gives of holes made through glass, by the electric stroke, are such as we have all experienced, and only show, that the electric fluid could not pass without making a hole. In the same manner we say, glass is impermeable to water, and yet a stream from a fire-engine will force through the strongest panes of a window. As to the effect of points in drawing the electric matter from the clouds, and thereby securing buildings, &c., which, you say, he seems to doubt, I must own I think he only speaks modestly and judiciously. I find I have been but partly understood in that matter. I have mentioned it in several of my letters, and, except once, always in the *alternative*, viz. that pointed rods erected on buildings, and communicating with the moist earth, would either *prevent* a stroke, *or*, if not prevented, would *conduct* it, so as that the building should suffer no damage. Yet, whenever my opinion is examined in Europe, nothing is consid-

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printed in Italian, at Turin, in quarto, 1753; between the two parts is a letter to the Abbé Nollet, in defence of Mr. Franklin's system.— J. Bevis.

* These papers will be found among the papers on *Philosophical Subjects.* Beccaria wrote a long letter to Franklin, dated at Turin, December 24th, 1757, giving an account of several experiments made by him in electricity, illustrative of Franklin's principles. The letter, written in Latin, is contained in the *Philosophical Transactions*, Vol. LI. p. 514· and also in the Appendix to this volume.—Editor.

ered but the probability of those rods *preventing* a stroke or explosion, which is only a *part* of the use I proposed for them; and the other part, their conducting a stroke, which they may happen not to prevent, seems to be totally forgotten, though of equal importance and advantage.

I thank you for communicating M. de Buffon's relation of the effect of lightning at Dijon, on the 7th of June last. In return, give me leave to relate an instance I lately saw of the same kind. Being in the town of Newbury in New England, in November last, I was shown the effect of lightning on their church, which had been struck a few months before. The steeple was a square tower of wood, reaching seventy feet up from the ground to the place where the bell hung, over which rose a taper spire, of wood likewise, reaching seventy feet higher, to the vane of the weather-cock. Near the bell was fixed an iron hammer to strike the hours; and from the tail of the hammer a wire went down through a small gimlet-hole in the floor that the bell stood upon, and through a second floor in like manner; then horizontally under and near the plastered ceiling of that second floor, till it came near a plastered wall; then down by the side of that wall to a clock, which stood about twenty feet below the bell. The wire was not bigger than a common knitting-needle. The spire was split all to pieces by the lightning, and the parts flung in all directions over the square in which the church stood, so that nothing remained above the bell.

The lightning passed between the hammer and the clock in the abovementioned wire, without hurting either of the floors, or having any effect upon them (except making the gimlet-holes, through which the wire passed, a little bigger), and without hurting the plastered wall, or any part of the building, so far as the aforesaid wire and the pendulum-wire of the clock extended; which latter wire was about the thickness of a goose-quill. From the end of the pendulum, down quite to the ground, the building was exceedingly rent and damaged, and some stones in the foundation-wall torn out, and thrown to the distance of twenty or thirty feet. No part of the aforementioned long, small wire, between the clock and the hammer, could be found, except about two inches that hung to the tail of the hammer, and about as much that was fastened to the clock; the rest being exploded, and its particles dissipated in smoke and air, as gunpowder is by common fire, and had only left a black smutty track on the plastering, three or four inches broad, darkest in the middle, and fainter towards the edges, all along the ceiling, under which it passed, and down the wall. These were the effects and appearances; on which I would only make the few following remarks, viz.

1. That lightning, in its passage through a building, will leave wood to pass as far as it can in metal, and not enter the wood again till the conductor of metal ceases.

And the same I have observed in other instances, as to walls of brick or stone.

2. The quantity of lightning that passed through this steeple must have been very great, by its effects on the lofty spire above the bell, and on the square tower, all below the end of the clock-pendulum.

3. Great as this quantity was, it was conducted by a small wire and a clock-pendulum, without the least damage to the building so far as they extended.

4. The pendulum rod, being of a sufficient thickness, conducted the lightning without damage to itself; but the small wire was utterly destroyed.

5. Though the small wire was itself destroyed, yet

it had conducted the lightning with safety to the building.

6. And from the whole it seems probable, that, if even such a small wire had been extended from the spindle of the vane to the earth, before the storm, no damage would have been done to the steeple by that stroke of lightning, though the wire itself had been destroyed.

B. FRANKLIN.

TO JOHN PRINGLE.*

On the Effects of Electricity in Paralytic Cases.

Craven Street, 21 December, 1757.

SIR,

In compliance with your request, I send you the following account of what I can at present recollect relating to the effects of electricity in paralytic cases, which have fallen under my observation.

Some years since, when the newspapers made mention of great cures performed in Italy and Germany by means of electricity, a number of paralytics were brought to me from different parts of Pennsylvania, and the neighbouring provinces, to be electrized, which I did for them at their request. My method was, to place the patient first in a chair, on an electric stool, and draw a number of large strong sparks from all parts of the affected limb or side. Then I fully charged two six gallon glass jars, each of which had about three square feet of surface coated; and I sent the united shock of these through the affected limb or limbs, repeating the stroke commonly three times each day. The first thing observed, was an immediate greater

* Afterwards Sir John Pringle, and President of the Royal Society —EDITOR

sensible warmth in the lame limbs that had received the stroke than in the others; and the next morning the patients usually related, that they had in the night felt a pricking sensation in the flesh of the paralytic limbs; and would sometimes show a number of small red spots, which they supposed were occasioned by those prickings. The limbs, too, were found more capable of voluntary motion, and seemed to receive strength. A man, for instance, who could not the first day lift the lame hand from off his knee, would the next day raise it four or five inches, the third day higher; and, on the fifth day was able, but with a feeble, languid motion, to take off his hat. These appearances gave great spirits to the patients, and made them hope a perfect cure; but I do not remember, that I ever saw any amendment after the fifth day; which the patients perceiving, and finding the shocks pretty severe, they became discouraged, went home, and in a short time relapsed; so that I never knew any advantage from electricity in palsies, that was permanent. And how far the apparent, temporary advantage might arise from the exercise in the patients' journey, and coming daily to my house, or from the spirits given by the hope of success, enabling them to exert more strength in moving their limbs, I will not pretend to say.

Perhaps some permanent advantage might have been obtained, if the electric shocks had been accompanied with proper medicine and regimen, under the direction of a skilful physician. It may be, too, that a few great strokes, as given in my method, may not be so proper as many small ones; since, by the account from Scotland of a case, in which two hundred shocks from a phial were given daily, it seems, that a perfect cure has been made. As to any uncommon strength supposed to be in the machine used in that case, I imagine it could have no share in the effect produced; since the strength of the shock from charged glass is in proportion to the quantity of surface of the glass coated; so that my shocks from those large jars must have been much greater than any that could be received from a phial held in the hand.

I am, with great respect, Sir,

Your most obedient servant,

B. Franklin.

TO THOMAS HUBBARD, AT BOSTON.

Electrical Apparatus. — Description of a Battery.

London, 28 April, 1758.

Sir,

In pursuance of Mr. Winthrop's memorandum, which I lately received from you, through the hands of Mr. Mico, I have procured and delivered to him the following things, viz.

A mahogany case lined with lead, containing thirty-five square glass bottles, in five rows, seven in a row.

A glass globe of the same size and kind with that I used at Philadelphia, and mounted in the same manner.

A large glass cylinder, mounted on an iron axis with brass caps; this form being most used here, and thought better than the globe, as a long, narrow cushion will electrify a greater surface at the same time.

The bottles have necks, which I think better than to be quite open; for so they would either be exposed to the dust and damp of the air, if they had no stoppers, or the stoppers would be too near together to admit of electrifying a single bottle, or row of bottles; there is only a little more difficulty in lining the inside with tinfoil, but that is chiefly got over by cutting it into narrow strips, and guiding them in with a stick flat at one end, to apply the more conveniently to the pasted side of the glass. I would have coated them myself, if the time had not been too short. I send the tinfoil, which I got made of a proper breadth for the purpose; they should be coated nine inches high, which brings the coating just even with the edge of the case. The tinfoil is ten inches broad, which allows for lapping over the bottom.

I have bored the holes in all the stoppers for the communicating wires, provided all the wires, and fixed one or two to show the manner. Each wire, to go into a bottle, is bent so that the two ends go in and spring against the inside coating or lining. The middle of the wire goes up into the stopper, with an eye, through which the long communicating wires pass, that connect all the bottles in one row.

To form occasional communications with more rows, there must be, on the long wires of the second and fourth rows, four other movable wires, which I call cross-wires, about two inches and a half long, with a small ball of any metal about the size of a pistol-bullet at each end. The ball of one end is to have a hole through the middle, so that it may be slipped on the long wire; and one of these cross-wires is to be placed between the third and fourth bottles of the row at each end; and on each of the abovementioned rows, that is, two to each row, they must be made to turn easy on the wires, so that when you would charge only the middle row, you turn two of them back on the first, and two on the fifth row, then the middle row will be unconnected with the others. When you would charge more rows, you turn them forwards or backwards, so as to have the communication completed with just the number of rows you want.

The brass handles of the case communicate with the outside of the bottles, when you wish to make the electrical circuit.

I see, now I have wrote it, that the greatest part of this letter would have been more properly addressed to Mr. Winthrop himself; * but probably you will send it to him with the things, and that will answer the end. Be pleased to tender my best respects to him and the rest of the gentlemen of the College.

I am, with great esteem and regard, Sir,

Your most obliged humble servant,

B. FRANKLIN.

P. S. I beg the College will do me the favor to accept a Virgil, which I send in the case, thought to be the most curiously printed of any book hitherto done in the world.†

TO DR. WILLIAM HEBERDEN, AT LONDON.

On the Electricity of the Tourmalin.

Craven Street, 7 June, 1759.

SIR,

I now return the smallest of your two tourmalins, with hearty thanks for your kind present of the other, which though I value highly for its rare and wonderful properties, I shall ever esteem it more for the friendship I am honored with by the giver.

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* At that time Professor of Mathematics and Natural Philosophy in Harvard University, for which institution the electrical apparatus described in this letter was designed. — EDITOR.

† A copy of Baskerville's quarto edition of Virgil, printed the year before at Birmingham, and perhaps the most beautiful of the various works by which this celebrated type-founder and printer gained the praise of "uniting, in a singularly happy manner, the elegance of Plantin with the clearness of the Elzevirs." — EDITOR.

I hear that the negative electricity of one side of the tourmalin, when heated, is absolutely denied (and all that has been related of it ascribed to prejudice in favor of a system) by some ingenious gentlemen abroad, who profess to have made the experiments on the stone with care and exactness. The experiments have succeeded differently with me; yet I would not call the accuracy of those gentlemen in question. Possibly the tourmalins they have tried were not properly cut; so that the positive and negative powers were obliquely placed, or in some manner whereby their effects were confused, or the negative parts more easily supplied by the positive. Perhaps the lapidaries, who have hitherto cut these stones, had no regard to the situation of the two powers, but chose to make the faces of the stone where they could obtain the greatest breadth, or some other advantage in the form. If any of these stones, in their natural state, can be procured here, I think it would be right to endeavour finding, before they are cut, the two sides that contain the opposite powers, and make the faces there. Possibly, in that case, the effects might be stronger, and more distinct; for, though both these stones, that I have examined, have evidently the two properties, yet, without the full heat given by boiling water, they are somewhat confused; the virtue seems strongest towards one end of the face; and in the middle, or near the other end, scarce discernible; and the negative, I think, always weaker than the positive.

I have had the large one new cut, so as to make both sides alike, and find the change of form has made no change of power, but the properties of each side remain the same as I found them before. It is now set in a ring in such a manner as to turn on an axis, that I may conveniently, in making experiments, come at both sides of the stone. The little rim of gold it is set in, has made no alteration in its effects. The warmth of my finger, when I wear it, is sufficient to give it some degree of electricity, so that it is always ready to attract light bodies.

The following experiments have satisfied me, that M. Æpinus's account of the positive and negative states of the opposite sides of the heated tourmalin is well founded.

I heated the large stone in boiling water.

As soon as it was dry, I brought it near a very small cork ball, that was suspended by a silk thread.

The ball was attracted by one face of the stone, which I call *A*, and then repelled.

The ball in that state was also repelled by the positively charged wire of a phial, and attracted by the other side of the stone, *B*.

The stone being afresh heated, and the side *B* brought near the ball, it was first attracted, and presently after repelled, by that side.

In this second state it was repelled by the negatively charged wire of a phial.

Therefore, if the principles now generally received, relating to positive and negative electricity, are true, the side *A* of the large stone, when the stone is heated in water, is in a positive state of electricity; and the side *B*, in a negative state.

The same experiments being made with the small stone, stuck by one edge on the end of a small glass tube, with sealing-wax, the same effects are produced. The flat side of the small stone gives the signs of positive electricity; the high side gives the signs of negative electricity.

Again.

I suspended the small stone by a silk thread.

I heated it, as it hung, in boiling water.

I heated the large one in boiling water.

Then I brought the large stone near to the suspended small one;

Which immediately turned its flat side to the side *B* of the large stone, and would cling to it.

I turned the ring, so as to present the side *A* of the large stone to the flat side of the small one.

The flat side was repelled, and the small stone, turning quick, applied its high side to the side *A* of the large one.

This was precisely what ought to happen, on the supposition, that the flat side of the small stone, when heated in water, is positive, and the high side negative; the side *A* of the large stone positive, and the side *B* negative.

The effect was apparently the same as would have been produced, if one magnet had been suspended by a thread, and the different poles of another brought alternately near it.

I find that the face *A* of the large stone, being coated with leaf gold (attached by the white of an egg, which will bear dipping in hot water), becomes quicker and stronger in its effect on the cork ball, repelling it the instant it comes in contact; which I suppose to be occasioned by the united force of different parts of the face, collected and acting together through the metal.

I am, &c.

B. Franklin.

FROM E. KINNERSLEY TO BENJAMIN FRANKLIN.

Experiments on boiling Water, and Glass heated by boiling Water. — Doctrine of Repulsion in electrized Bodies doubted. — Electricity of the Atmosphere at different Heights. — Electrical Horse-race. — Electrical Thermometer. — In what Cases the Electrical Fire produces Heat. — Wire lengthened by Electricity. — Good Effect of a Rod on the House of Mr. West, of Philadelphia.

Philadelphia, 12 March, 1761.

SIR,

Having lately made the following experiments, I very cheerfully communicate them, in hopes of giving you some degree of pleasure, and exciting you to further explore your favorite, but not quite exhausted subject, *electricity.*

I placed myself on an electric stand, and, being well electrized, threw my hat to an unelectrized person, at a considerable distance, on another stand, and found that the hat carried some of the electricity with it; for, upon going immediately to the person who received it, and holding a flaxen thread near him, I perceived he was electrized sufficiently to attract the thread.

I then suspended by silk a broad plate of metal, and electrized some boiling water under it, at about four feet distance, expecting that the vapor, which ascended plentifully to the plate, would, upon the principle of the foregoing experiment, carry up some of the electricity with it; but was at length fully convinced, by several repeated trials, that it left all its share thereof behind. This I know not how to account for; but does it not seem to corroborate your hypothesis, that the vapors of which the clouds are formed, leave their share of electricity behind, in the common stock, and ascend in the negative state?

I put boiling water into a coated Florence flask, and found that the heat so enlarged the pores of the glass, that it could not be charged. The electricity passed through as readily, to all appearance, as through metal; the charge of a three-pint bottle went freely through, without injuring the flask in the least. When it became almost cold, I could charge it as usual. Would not this experiment convince the Abbé Nollet of his egregious mistake? For, while the electricity went fairly through the glass, as he contends it always does, the glass could not be charged at all.

I took a slender piece of cedar, about eighteen inches long, fixed a brass cap in the middle, thrust a pin horizontally and at right angles, through each end (the points in contrary directions), and hung it, nicely balanced, like the needle of a compass, on a pin, about six inches long, fixed in the centre of an electric stand. Then, electrizing the stand, I had the pleasure of seeing what I expected; the wooden needle turned round, carrying the pins with their heads foremost. I then electrized the stand negatively, expecting the needle to turn the contrary way, but was extremely disappointed, for it went still the same way as before. When the stand was electrized positively, I suppose that the natural quantity of electricity in the air, being increased on one side by what issued from the points, the needle was attracted by the lesser quantity on the other side. When electrized negatively, I suppose that the natural quantity of electricity in the air was diminished near the points; in consequence whereof, the equilibrium being destroyed, the needle was attracted by the greater quantity on the opposite side.

The doctrine of repulsion, in electrized bodies. I begin to be somewhat doubtful of. I think all the phenomena on which it is founded may be well enough accounted for without it. Will not cork balls, electrized negatively, separate as far as when electrized positively? And may not their separation in both cases be accounted for upon the same principle, namely, the mutual attraction of the natural quantity in the air, and that which is denser or rarer in the cork balls? it being one of the established laws of this fluid, that quantities of different densities shall mutually attract each other, in order to restore the equilibrium.

I can see no reason to conclude that the air has not its share of the common stock of electricity, as well as glass, and, perhaps, all other electrics *per se*. For, though the air will admit bodies to be electrized in it, either positively or negatively, and will not readily carry off the redundancy in the one case, or supply the deficiency in the other; yet, let a person in the negative state, out of doors in the dark, when the air is dry, hold, with his arm extended, a long sharp needle, pointing upwards, and he will soon be convinced that electricity may be drawn out of the air; not very plentifully, for, being a bad conductor, it seems loath to part with it, but yet some will evidently be collected. The air near the person's body, having less than its natural quantity, will have none to spare; but, his arm being extended, as above, some will be collected from the remoter air, and will appear luminous, as it converges to the point of the needle.

Let a person electrized negatively present the point of a needle, horizontally, to a cork ball, suspended by silk, and the ball will be attracted towards the point, till it has parted with so much of its natural quantity of electricity, as to be in the negative state in the same degree with the person who holds the needle; then it will recede from the point, being, as I suppose, attracted the contrary way by the electricity of greater density in the air behind it. But, as this opinion seems to deviate from electrical orthodoxy, I should be glad to see these phenomena better accounted for by your superior and more penetrating genius.

Whether the electricity in the air, in clear, dry weather, be of the same density at the height of two or three hundred yards, as near the surface of the earth, may be satisfactorily determined by your old experiment of the kite. The twine should have throughout a very small wire in it, and the ends of the wire, where the several lengths are united, ought to be tied down with a waxed thread, to prevent their acting in the manner of points. I have tried the experiment twice, when the air was as dry as we ever have it, and so clear that not a cloud could be seen, and found the twine each time in a small degree electrized positively. The kite had three metalline points fixed to it; one on the top, and one on each side. That the twine was electrized, appeared by the separating of two small cork balls, suspended on the twine by fine flaxen threads, just above where the silk was tied to it, and sheltered from the wind. That the twine was electrized positively, was proved by applying to it the wire of a charged bottle, which caused the balls to separate further, without first coming nearer together. This experiment showed, that the electricity in the air, at those times, was denser above than below. But that cannot be always the case; for, you know, we have frequently found the thunder-clouds in the negative state, attracting electricity from the earth; which state, it is probable, they are always in when first formed, and till they have received a sufficient supply. How they come afterwards, towards the latter end of the gust, to be in the positive state, which is sometimes the case, is a subject for further inquiry.

After the above experiments with the wooden needle, I formed a cross, of two pieces of wood of equal length, intersecting each other at right angles in the middle, hung it horizontally upon a central pin, and set a light horse, with his rider, upon each extremity; whereupon, the whole being nicely balanced, and each courser urged on by an electrized point of a pair of spurs, I was entertained with an electrical horse-race.

I have contrived an electrical air-thermometer, and made several experiments with it, that have afforded me much satisfaction and pleasure. It is extremely sensible of any alteration in the state of the included air, and fully determines that controverted point, whether there be any heat in the electric fire. By the enclosed draft, and the following description, you will readily apprehend the construction of it. (See Plate II.)

A, B is a glass tube, about eleven inches long, and one inch diameter in the bore. It has a brass ferrule cemented on each end, with a top and bottom part, *C* and *D*, to be screwed on, air-tight, and taken off at pleasure. In the centre of the bottom part, *D*, is a male screw, which goes into a brass nut, in the mahogany pedestal *E*. The wires, *F* and *G*, are for the electric fire to pass through, darting from one to the other. The wire *G* extends through the pedestal to *H*, and may be raised and lowered by means of a male screw on it. The wire *F* may be taken out, and the hook *I* be screwed into its place. *K* is a glass tube, with a small bore, open at both ends, cemented in the brass tube *L*, which screws into the top part *C*. The lower end of the tube *K* is immersed in water, colored with cochineal, at the bottom of the tube *A, B*. (I used, at first, colored spirits of wine; but, in one experiment

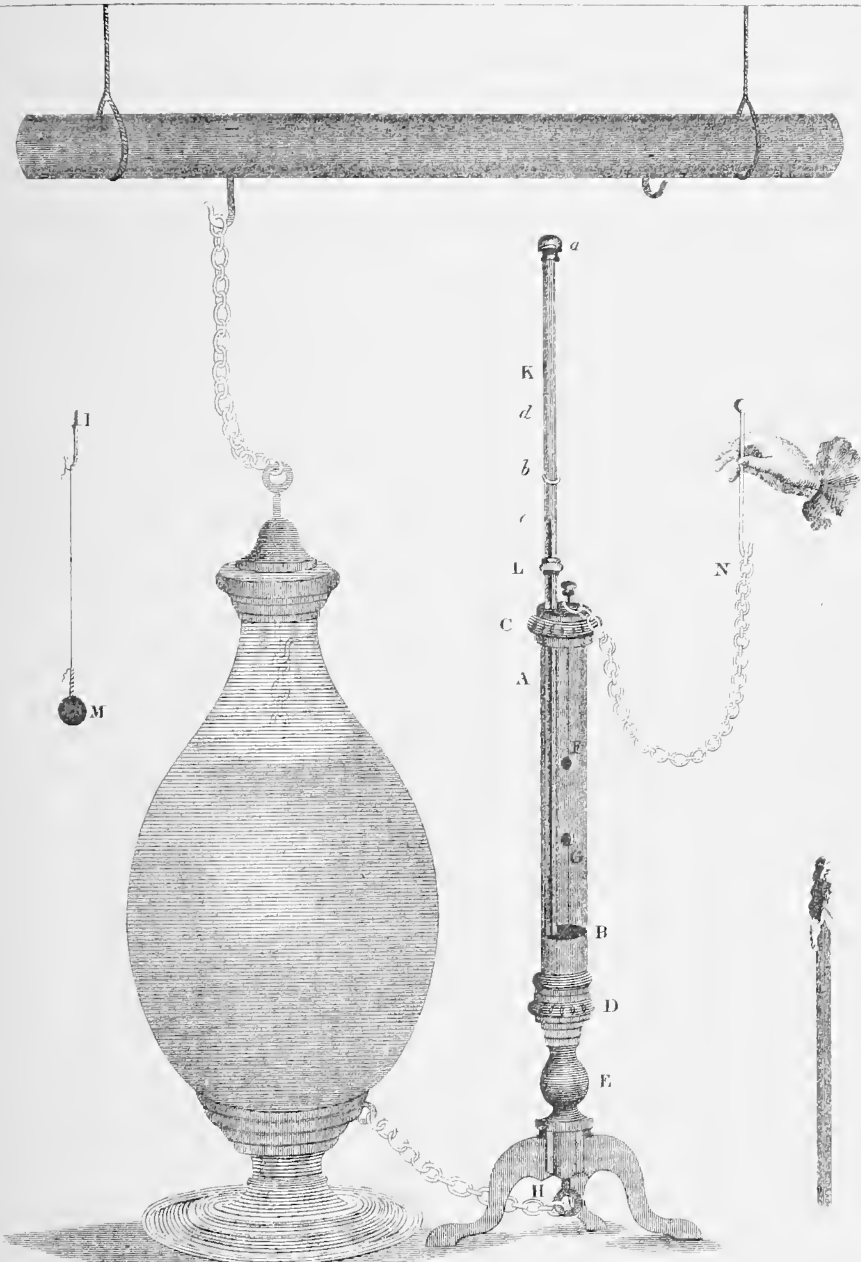
I made, it took fire.) On the top of the tube *K* is cemented, for ornament, a brass ferrule, with a head screwed on it, which has a small air-hole through its side, at *a*. The wire *b* is a small round spring, that embraces the tube *K*, so as to stay wherever it is placed. The weight *M* is to keep straight whatever may be suspended, in the tube *A*, *B*, on the hook *I*. Air must be blown through the tube *K*, into the tube *A*, *B*, till enough is intruded to raise, by its elastic force, a column of the colored water in the tube *K*, up to *c*, or thereabouts; and then, the gage-wire *b* being slipped down to the top of the column, the thermometer is ready for use.

I set the thermometer on an electric stand, with the chain *N* fixed to the prime conductor, and kept it well electrized a considerable time; but this produced no sensible effect; which shows, that the electric fire, when in a state of rest, has no more heat than the air, and other matter wherein it resides.

When the wires *F* and *G* are in contact, a large charge of electricity sent through them, even that of my case of five and thirty bottles, containing above thirty square feet of coated glass, will produce no rarefaction of the air included in the tube *A*, *B*; which shows that the wires are not heated by the fire's passing through them.

When the wires are about two inches apart, the charge of a three-pint bottle, darting from one to the other, rarefies the air very evidently; which shows, I think, that the electric fire must produce heat in itself, as well as in the air, by its rapid motion.

The charge of one of my glass jars, (which will contain about five gallons and a half, wine measure,) darting from wire to wire, will, by the disturbance it gives the air, repelling it in all directions, raise the column in


a
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the tube *K*, up to *d*, or thereabouts; and the charge of the abovementioned case of bottles will raise it to the top of the tube. Upon the air's coalescing, the column, by its gravity, instantly subsides, till it is in equilibrio with the rarefied air; it then gradually descends as the air cools, and settles where it stood before. By carefully observing at what height above the gage-wire *b* the descending column first stops, the degree of rarefaction is discovered, which, in great explosions, is very considerable.

I hung in the thermometer, successively, a strip of wet writing-paper, a wet flaxen and woollen thread, a blade of green grass, a filament of green wood, a fine silver thread, a very small brass wire, and a strip of gilt paper; and found that the charge of the abovementioned glass jar, passing through each of these, especially the last, produced heat enough to rarefy the air very perceptibly.

I then suspended, out of the thermometer, a piece of small harpsichord wire, about twenty-four inches long, with a pound weight at the lower end, and sent the charge of the case of five and thirty bottles through it, whereby I discovered a new method of wire-drawing. The wire was red-hot the whole length, well annealed, and above an inch longer than before. A second charge melted it; it parted near the middle, and measured, when the ends were put together, four inches longer than at first. This experiment, I remember, you proposed to me before you left Philadelphia; but I never tried it till now. That I might have no doubt of the wire's being *hot* as well as red, I repeated the experiment on another piece of the same wire, encompassed with a goose-quill, filled with loose grains of gunpowder; which took fire as readily as if it had been touched with a red-hot poker. Also tinder, tied to another piece of the wire, kindled by it. I tried a wire about three times as big, but could produce no such effects with that.

Hence it appears that the electric fire, though it has no sensible heat when in a state of rest, will, by its violent motion, and the resistance it meets with, produce heat in other bodies when passing through them, provided they be small enough. A large quantity will pass through a large wire without producing any sensible heat; when the same quantity, passing through a very small one, being there confined to a narrower passage, the particles crowding closer together and meeting with greater resistance, will make it red-hot, and even melt it.

Hence lightning does not melt metal by a cold fusion, as we formerly supposed; but, when it passes through the blade of a sword, if the quantity be not very great, it may heat the point so as to melt it, while the broadest and thickest part may not be sensibly warmer than before.

And, when trees or houses are set on fire by the dreadful quantity which a cloud, or the earth, sometimes discharges, must not the heat, by which the wood is first kindled, be generated by the lightning's violent motion, through the resisting combustible matter?

If lightning, by its rapid motion, produces heat in *itself*, as well as in other bodies, (and that it does, I think is evident from some of the foregoing experiments made with the thermometer), then its sometimes singeing the hair of animals killed by it, may easily be accounted for. And the reason of its not always doing so, may perhaps be this; the quantity, though sufficient to kill a large animal, may sometimes not be great enough, or not have met with resistance enough, to become, by its motion, burning hot.

We find that dwelling-houses, struck with lightning, are seldom set on fire by it; but, when it passes through barns, with hay or straw in them, or store-houses, containing large quantities of hemp, or such like matter, they seldom, if ever, escape a conflagration; which may, perhaps, be owing to such combustibles being apt to kindle with a less degree of heat than is necessary to kindle wood.

We had four houses in this city, and a vessel at one of the wharfs, struck and damaged by lightning last summer. One of the houses was struck twice in the same storm. But I have the pleasure to inform you, that your method of preventing such terrible disasters has, by a fact which had like to have escaped our knowledge, given a very convincing proof of its great utility, and is now in higher repute with us than ever.

Hearing, a few days ago, that Mr. William West, merchant in this city, suspected that the lightning, in one of the thunder-storms last summer, had passed through the iron conductor, which he had provided for the security of his house, I waited on him, to inquire what ground he might have for such suspicion. Mr. West informed me, that his family and neighbours were all stunned with a very terrible explosion, and that the flash and crack were seen and heard at the same instant. Whence he concluded, that the lightning must have been very near, and, as no house in the neighbourhood had suffered by it, that it must have passed through his conductor. Mr. White, his clerk, told me that he was sitting, at the time, by a window, about two feet distant from the conductor, leaning against the brick wall with which it was in contact; and that he felt a smart sensation, like an electric shock, in that part of his body which touched the wall. Mr. West further informed me, that a person of undoubted veracity assured him, that, being in the door of an opposite house, on the other side of Water Street (which you know is but narrow), he saw the lightning diffused over the pavement, which was then very wet with rain, to the distance of two or three yards from the foot of the conductor; and that another person of very good credit told him, that he, being a few doors off on the other side of the street, saw the lightning above, darting in such direction that it appeared to him to be directly over that pointed rod.

Upon receiving this information, and being desirous of further satisfaction, there being no traces of the lightning to be discovered in the conductor as far as we could examine it below, I proposed to Mr. West our going to the top of the house, to examine the pointed rod, assuring him, that, if the lightning had passed through it, the point must have been melted; and, to our great satisfaction, we found it so. This iron rod extended in height about nine feet and a half above a stack of chimneys to which it was fixed (though I suppose three or four feet would have been sufficient.) It was somewhat more than half an inch diameter in the thickest part, and tapering to the upper end. The conductor, from the lower end of it to the earth, consisted of square iron nail-rods, not much above a quarter of an inch thick, connected together by interlinking joints. It extended down the cedar roof to the eaves, and from thence down the wall of the house, four story and a half, to the pavement in Water Street, being fastened to the wall, in several places, by small iron hooks. The lower end was fixed to a ring, in the top of an iron stake, that was driven about four or five feet into the ground.

The abovementioned iron rod had a hole in the top of it, about two inches deep, wherein was inserted a brass wire, about two lines thick, and, when first put there, about ten inches long, terminating in a very acute point; but now its whole length was no more than seven inches and a half, and the top very blunt. Some of the metal appears to be missing, the slenderest part of the wire being, as I suspect, consumed into smoke. But some of it, where the wire was a little thicker, being only melted by the lightning, sunk down, while in a fluid state, and formed a rough, irregular cap, lower on one side than the other, round the upper end of what remained, and became intimately united therewith.

This was all the damage that Mr. West sustained by a terrible stroke of lightning; a most convincing proof of the great utility of this method of preventing its dreadful effects. Surely it will now be thought as expedient to provide conductors for the lightning, as for the rain.

Mr. West was so good as to make me a present of the melted wire, which I keep as a great curiosity, and long for the pleasure of showing it to you. In the mean time, I beg your acceptance of the best representation I can give of it, which you will find by the side of the thermometer, drawn in its full dimensions as it now appears. The dotted lines above are intended to show the form of the wire before the lightning melted it.

And now, Sir, I most heartily congratulate you on the pleasure you must have in finding your great and well-grounded expectations so far fulfilled. May this method of security from the destructive violence of one of the most awful powers of nature meet with such further success, as to induce every good and grateful heart to bless God for the important discovery! May the benefit thereof be diffused over the whole globe! May it extend to the latest posterity of mankind, and make the name of FRANKLIN, like that of NEWTON, *immortal.*

I am, Sir, with sincere respect,

Your most obedient and most humble servant,

EBEN. KINNERSLEY.

TO E. KINNERSLEY.

Answer to some of the foregoing Subjects. — How long the Leyden Bottle may be kept charged. — Heated Glass rendered permeable by the Electric Fluid. — Electrical Attraction and Repulsion. — Reply to other Subjects in the preceding Paper. — Numerous Ways of kindling Fire. — Explosion of Water. — Knobs and Points.

London, 20 February, 1762.

SIR,

I received your ingenious letter of the 12th of March last, and thank you cordially for the account you give me of the new experiments you have lately made in electricity. It is a subject that still affords me pleasure, though of late I have not much attended to it.

Your second experiment, in which you attempted, without success, to communicate positive electricity by vapor ascending from electrized water, reminds me of one I formerly made, to try if negative electricity might be produced by evaporation only. I placed a large heated brass plate, containing four or five square feet, on an electric stand; a rod of metal, about four feet long, with a bullet at its end, extended from the plate horizontally. A light lock of cotton, suspended by a fine thread from the ceiling, hung opposite to, and within an inch of, the bullet. I then sprinkled the heated plate with water, which arose fast from it in vapor. If vapor should be disposed to carry off the electrical, as it does the common, fire from bodies, I expected the plate would, by losing some of its natural quantity, become negatively electrized. But I could not perceive, by any motion in the cotton, that it was at all affected; nor, by any separation of small cork balls suspended from the plate, could it be observed that the plate was in any manner electrified.

Mr. Canton here has also found, that two tea-cups, set on electric stands, and filled, one with boiling, the other with cold water, and equally electrified, continued equally so, notwithstanding the plentiful evaporation from the hot water. Your experiment and his, agreeing, show another remarkable difference between electric and common fire. For the latter quits most readily the body that contains it, where water, or any other fluid, is evaporating from the surface of that body, and escapes with the vapor. Hence the method, long in use in the East, of cooling liquors by wrapping the bottles round with a wet cloth, and exposing them to the wind. Dr. Cullen, of Edinburgh, has given some experiments of cooling by evaporation; and I was present at one made by Dr. Hadley, then Professor of Chemistry at Cambridge, when, by repeatedly wetting the ball of a thermometer with spirit, and quickening the evaporation by the blast of a bellows, the mercury fell from sixty-five, the state of warmth in the common air, to seven, which is twenty-two degrees below freezing; and, accordingly, from some water mixed with the spirit, or from the breath of the assistants, or both, ice gathered in small *spicula* round the ball to the thickness of near a quarter of an inch. To such a degree did the mercury lose the fire it before contained, which, as I imagine, took the opportunity of escaping, in company with the evaporating particles of the spirit, by adhering to those particles.

Your experiment of the Florence flask and boiling water is very curious. I have repeated it, and found it to succeed as you describe it, in two flasks out of three. The third would not charge when filled with either hot or cold water. I repeated it, because I remembered I had once attempted to make an electric bottle of a Florence flask, filled with cold water, but could not charge it at all; which I then imputed to some imperceptible cracks in the small, extremely thin bubbles, of which that glass is full, and I concluded none of that kind would do. But you have shown me my mistake. Mr. Wilson had formerly acquainted us, that red-hot glass would conduct electricity; but that so small a degree of heat, as that communicated by boiling water, would so open the pores of extremely thin glass, as to suffer the electric fluid freely to pass, was not before known. Some experiments similar to yours have, however, been made here, before the receipt of your letter, of which I shall now give you an account.

I formerly had an opinion, that a Leyden bottle, charged and then sealed hermetically, might retain its electricity for ever; but having afterwards some suspicion that possibly that subtile fluid might, by slow, imperceptible degrees, soak through the glass, and in time escape, I requested some of my friends, who had conveniences for doing it, to make trial, whether, after some months, the charge of a bottle so sealed would be sensibly diminished. Being at Birmingham, in September, 1760, Mr. Bolton of that place opened a bottle that had been charged, and its long tube neck hermetically sealed in the January preceding. On breaking off the end of the neck, and introducing a wire into it, we found it possessed of a considerable quantity of electricity, which was discharged by a snap and spark. This bottle had lain near seven months on a shelf, in a closet, in contact with bodies that would undoubtedly have carried off all its electricity, if it could have come readily through the glass. Yet, as the quantity manifested by the discharge was not apparently so great as might have been expected from a bottle of that size well charged, some doubt remained, whether part had escaped while the neck was sealing, or had since, by degrees, soaked through the glass. But an experiment of Mr. Canton's, in which such a bottle was kept under water a week, without having its electricity in the least impaired, seems to show, that, when the glass is cold, though extremely thin, the electric fluid is well retained by it. As that ingenious and accurate experimenter made a discovery, like yours, of the effect of heat in rendering thin glass permeable by that fluid, it is but doing him justice to give you his account of it, in his own words, extracted from his letter to me, in which he communicated it, dated October 31st, 1760, viz.

"Having procured some thin glass balls, of about an inch and a half in diameter, with stems or tubes, of eight or nine inches in length, I electrified them, some positively on the inside, and others negatively, after the manner of charging the Leyden bottle, and sealed them hermetically. Soon after I applied the naked balls to my electrometer, and could not discover the least sign of their being electrical, but holding them before the fire, at the distance of six or eight inches, they became strongly electrical in a very short time, and more so when they were cooling. These balls will, every time they are heated, give the electrical fluid to, or take it from, other bodies, according to the *plus* or *minus* state of it within them. Heating them frequently, I find, will sensibly diminish their power; but keeping one of them under water a week did not appear in the least degree to impair it. That which I kept under water, was charged on the 22d of September last, was several times heated before it was kept in water, and has been heated frequently since, and yet it still retains its virtue to a very considerable degree. The breaking two of my balls accidentally gave me an opportunity of measuring their thickness, which I found to be between seven and eight parts in a thousand of an inch.

"A down feather in a thin glass ball, hermetically sealed, will not be affected by the application of an excited tube, or the wire of a charged phial, unless the ball be considerably heated; and, if a glass pane be heated till it begins to grow soft, and in that state be held between the wire of a charged phial, and the discharging wire, the course of the electrical fluid will not be through the glass, but on the surface, round by the edge of it."

By this last experiment of Mr. Canton's it appears, that, though by a moderate heat thin glass becomes, in some degree, a conductor of electricity, yet, when of the thickness of a common pane, it is not, though in a state near melting, so good a conductor as to pass the shock of a discharged bottle. There are other conductors, which suffer the electric fluid to pass through them gradually, and yet will not conduct a shock. For instance, a quire of paper will conduct through its whole length, so as to electrify a person, who, standing on wax, presents the paper to an electrified prime conductor; but it will not conduct a shock even through its thickness only; hence the shock either fails, or passes by rending a hole in the paper. Thus a seive will pass water gradually, but a stream from a fire-engine would either be stopped by it, or tear a hole through it.

It should seem, that, to make glass permeable to the electric fluid, the heat should be proportioned to the thickness. You found the heat of boiling water, which is but two hundred and ten, sufficient to render the extreme thin glass in a Florence flask permeable even to a shock. Lord Charles Cavendish, by a very ingenious experiment, has found the heat of four hundred requisite to render thicker glass permeable to the common current.

"A glass tube (see Plate III.), of which the part *C, B,* was solid, had wire thrust in each end, reaching to *B* and *C*.

"A small wire was tied on at *D*, reaching to the floor, in order to carry off any electricity, that might run along upon the tube.

"The bent part was placed in an iron pot, filled with iron filings; a thermometer was also put into the filings; a lamp was placed under the pot; and the whole was supported upon glass.

"The wire *A* being electrified by a machine, before the heat was applied, the corks at *E* separated, at first upon the principle of the Leyden phial.

"But after the part *C, B,* of the tube was heated to six hundred, the corks continued to separate, though you discharged the electricity by touching the wire at *E*, the electrical machine continuing in motion.

"Upon letting the whole cool, the effect remained till the thermometer was sunk to four hundred."

It were to be wished, that this noble philosopher would communicate more of his experiments to the world, as he makes many, and with great accuracy.

You know I have always looked upon and mentioned the equal repulsion, in cases of positive and of negative electricity, as a phenomenon difficult to be explained. I have sometimes, too, been inclined, with you, to resolve all into attraction; but, besides that attraction seems in itself as unintelligible as repulsion, there are some appearances of repulsion that I cannot so easily explain by attraction; this, for one instance. When the pair of cork balls are suspended by flaxen threads, from the end of the prime conductor, if you bring a rubbed glass tube near the conductor, but without touching it, you see the balls separate, as being electrified positively; and yet you have communicated no electricity to the conductor, for, if you had, it would have remained there, after withdrawing the tube; but the closing of the balls immediately thereupon, shows that the conductor has no more left in it than its natural quantity. Then, again approaching the conductor with the rubbed tube, if, while the balls are separated, you touch with a finger that end of the conductor to which they hang, they will come together again, as being, with that part of the conductor, brought to the same state with your finger, that is, the natural state. But the other end of the conductor, near which the tube is held, is not in that state, but in the negative state, as appears on removing the tube; for then part of the natural quantity left at the end near the balls, leaving that end to supply what is wanting at the other, the whole conductor is found to be equally in the negative state. Does not this indicate, that the electricity of the rubbed tube had repelled the electric fluid, which was diffused in the conductor while in its natural state, and forced it to quit the end to which the tube was brought near, accumulating itself on the end to which the balls were suspended? I own I find it difficult to account for its quitting that end, on the approach of the rubbed tube, but on the supposition of repulsion; for, while the conductor was in the same state with the air, that is, the natural state, it does not seem to me easy to suppose, that an attraction should suddenly

Plate III.

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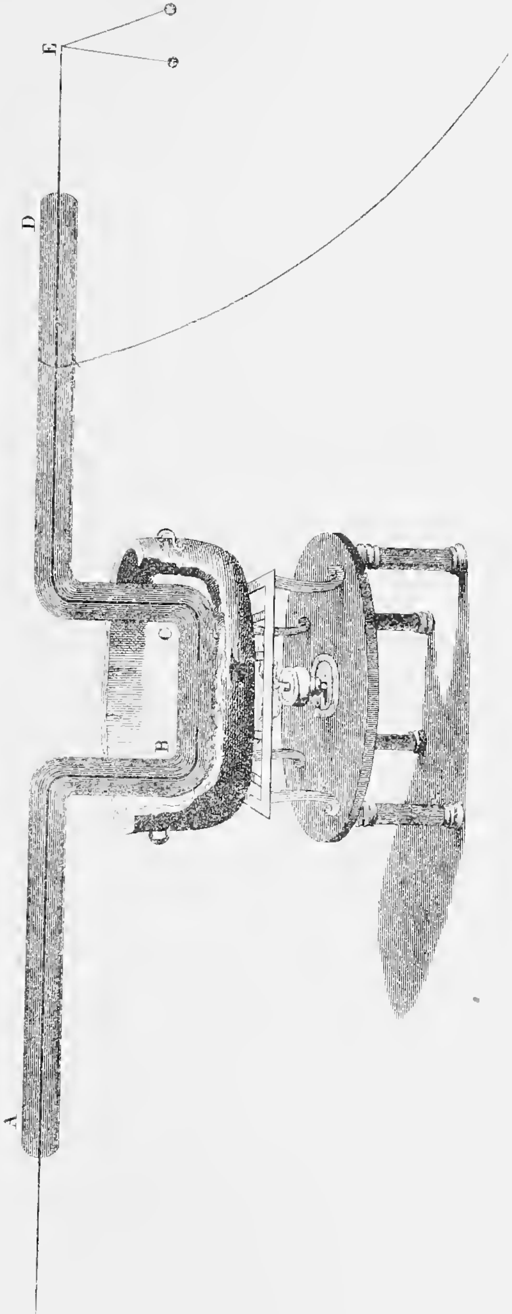

take place between the air and the natural quantity of the electric fluid in the conductor, so as to draw it to, and accumulate it on, the end opposite to that approached by the tube; since bodies, possessing only their natural quantity of that fluid, are not usually seen to attract each other, or to affect mutually the quantities of electricity each contains.

There are likewise appearances of repulsion in other parts of nature. Not to mention the violent force with which the particles of water, heated to a certain degree, separate from each other, or those of gunpowder, when touched with the smallest spark of fire, there is the seeming repulsion between the same poles of the magnet, a body containing a subtile movable fluid in many respects analogous to the electric fluid. If two magnets are so suspended by strings, as that their poles of the same denomination are opposite to each other, they will separate and continue so; or, if you lay a magnetic steel bar on a smooth table, and approach it with another parallel to it, the poles of both in the same position, the first will recede from the second, so as to avoid the contact, and may thus be pushed (or at least appear to be pushed) off the table. Can this be ascribed to the attraction of any surrounding body or matter drawing them asunder, or drawing the one away from the other? If not, and repulsion exists in nature, and in magnetism, why may it not exist in electricity? We should not, indeed, multiply causes in philosophy without necessity; and the greater simplicity of your hypothesis would recommend it to me, if I could see that all appearances would be solved by it. But I find, or think I find, the two causes more convenient than one of them alone. Thus I might solve the circular motion of your horizontal stick, supported on a pivot, with two pins at their ends, pointing contrary ways, and moving in the same direction when electrified, whether positively or negatively; when positively, the air opposite to the points, being electrized positively, repels the points; when negatively, the air opposite the points also, by their means, electrized negatively, attraction takes place between the electricity in the air behind the heads of the pins and the negative pins, and so they are, in this case drawn in the same direction that in the other they were driven. You see I am willing to meet you half way, a complaisance I have not met with in our brother Nollet, or any other hypothesis-maker, and therefore may value myself a little upon it, especially as they say I have some ability in defending even the wrong side of a question, when I think fit to take it in hand.

What you give as an established law of the electric fluid, "That quantities of different densities mutually attract each other, in order to restore the equilibrium," is, I think, not well founded, or else not well expressed. Two large cork balls, suspended by silk strings, and both well and equally electrified, separate to a great distance. By bringing into contact with one of them another ball of the same size, suspended likewise by silk, you will take from it half its electricity. It will then, indeed, hang at a less distance from the other, but the full and the half quantities will not appear to attract each other, that is, the balls will not come together. Indeed, I do not know any proof we have, that one quantity of electric fluid is attracted by another quantity of that fluid, whatever difference there may be in their densities. And, supposing in nature a mutual attraction between two parcels of any kind of matter, it would be strange if this attraction should subsist strongly while those parcels were unequal, and cease when more matter of the same kind was added to the smallest parcel, so as to make it equal to the biggest. By all the laws of attraction in matter, that we are acquainted with, the attraction is stronger in proportion to the increase of the masses, and never in proportion to the difference of the masses. I should rather think the law would be, "That the electric fluid is attracted strongly by all other matter that we know of, while the parts of that fluid mutually repel each other." Hence its being equally diffused (except in particular circumstances) throughout all other matter. But this you jokingly call "electrical orthodoxy." It is so with some at present, but not with all; and, perhaps, it may not always be orthodoxy with anybody. Opinions are continually varying, where we cannot have mathematical evidence of the nature of things; and they must vary. Nor is that variation without its use, since it occasions a more thorough discussion, whereby error is often dissipated, true knowledge is increased, and its principles become better understood and more firmly established.

Air should have, as you observe, "its share of the common stock of electricity, as well as glass, and, perhaps, all other electrics *per se*." But I suppose, that, like them, it does not easily part with what it has, or receive more, unless when mixed with some non-electric, as moisture, for instance, of which there is some in our driest air. This, however, is only a supposition; and your experiment of restoring electricity to a negatively electrized person, by extending his arm upwards into the air, with a needle between his fingers, on the point of which light may be seen in the night, is, indeed, a curious one. In this town the air is generally moister than with us, and here I have seen Mr. Canton electrify the air in one room positively, and in another, which communicated by a door, he has electrized the air negatively. The difference was easily discovered by his cork balls, as he passed out of one room into another. Père Beccaria, too, has a pretty experiment, which shows that air may be electrized. Suspending a pair of small light balls, by flaxen threads, to the end of his prime conductor, he turns his globe some time, electrizing positively, the balls diverging and continuing separate all the time. Then he presents the point of a needle to his conductor, which gradually drawing off the electric fluid, the balls approach each other, and touch, before all is drawn from the conductor; opening again as more is drawn off, and separating nearly as widely as at first, when the conductor is reduced to the natural state. By this it appears, that, when the balls came together, the air surrounding the balls was just as much electrized as the conductor at that time; and more than the conductor, when that was reduced to its natural state. For the balls, though in the natural state, will diverge, when the air that surrounds them is electrized *plus* or *minus*, as well as when that is in its natural state and they are electrized *plus* or *minus* themselves. I foresee that you will apply this experiment to the support of your hypothesis, and I think you may make a good deal of it.

It was a curious inquiry of yours, whether the electricity of the air, in clear dry weather, be of the same density at the height of two or three hundred yards, as near the surface of the earth; and I am glad you made the experiment. Upon reflection, it should seem probable, that, whether the general state of the atmosphere at any time be positive or negative, that part of it which is next the earth will be nearer the natural state, by having given to the earth in one case, or having received from it in the other. In electrizing the air of a room, that which is nearest the walls, or floor, is least altered. There is only one small ambiguity in the experiment, which may be cleared by more trials; it arises from the supposition, that bodies may be electrized positively by the friction of air blowing strongly on them, as it does on the kite and its string. If at some times the electricity appears to be negative, as that friction is the same, the effect must be from a negative state of the upper air.

I am much pleased with your electrical thermometer, and the experiments you have made with it. I formerly satisfied myself, by an experiment with my phial and siphon, that the elasticity of the air was not increased by the mere existence of an electric atmosphere within the phial; but I did not know, till you now inform me, that heat may be given to it by an electric explosion. The continuance of its rarefaction, for some time after the discharge of your glass jar and of your case of bottles, seems to make this clear. The other experiments on wet paper, wet thread, green grass, and green wood, are not so satisfactory; as possibly the reducing part of the moisture to vapor, by the electric fluid passing through it, might occasion some expansion which would be gradually reduced by the condensation of such vapor. The fine silver thread, the very small brass wire, and the strip of gilt paper, are also subject to a similar objection, as even metals, in such circumstances, are often partly reduced to smoke, particularly the gilding on paper.

But your subsequent beautiful experiment on the wire, which you made hot by the electric explosion, and in that state fired gunpowder with it, puts it out of all question, that heat is produced by our artificial electricity, and that the melting of metals in that way, is not by what I formerly called a cold fusion. A late instance here, of the melting a bell-wire, in a house struck by lightning, and parts of the wire burning holes in the floor on which they fell, has proved the same with regard to the electricity of nature. I was too easily led into that error by accounts given, even in philosophical books, and from remote ages downwards, of melting money in purses, swords in scabbards, &c., without burning the inflammable matters that were so near those melted metals. But men are, in general, such careless observers, that a philosopher cannot be too much on his guard in crediting their relations of things extraordinary, and should never build an hypothesis on any thing but clear facts and experiments, or it will be in danger of soon falling, as this does, like a house of cards.

How many ways there are of kindling fire, or producing heat in bodies! By the sun's rays, by collision, by friction, by hammering, by putrefaction, by fermentation, by mixtures of fluids, by mixtures of solids with fluids, and by electricity. And yet the fire when produced, though in different bodies it may differ in circumstances, as in color, vehemence, &c., yet in the same bodies is generally the same. Does not this seem to indicate that the fire existed in the body, though in a quiescent state, before it was by any of these means excited, disengaged, and brought forth to action and to view? May it not constitute a part, and even a principal part, of the solid substance of bodies? If this should be the case, kindling fire in a body would be nothing more than developing this inflammable principle, and setting it at liberty to act in separating the parts of that body, which then exhibits the appearances of scorching, melting, burning, &c. When a man lights a hundred candles from the flame of one, without diminishing that flame, can it be properly said to have *communicated* all that fire? When a single spark from a flint, applied to a magazine of gunpowder, is immediately attended with this consequence, that the whole is in flame, exploding with immense violence, could all this fire exist first in the spark? We cannot conceive it. And thus we seem led to this supposition, that there is fire enough in all bodies to singe, melt, or burn them, whenever it is, by any means, set at liberty, so that it may exert itself upon them, or be disengaged from them. This liberty seems to be afforded it by the passage of electricity through them, which we know can and does, of itself, separate the parts even of water; and, perhaps, the immediate appearances of fire are only the effects of such separations. If so, there would be no need of supposing that the electric fluid *heats itself* by the swiftness of its motion, or heats bodies by the resistance it meets with in passing through them. They would only be heated in proportion as such separation could be more easily made. Thus a melting heat cannot be given to a large wire in the flame of a candle, though it may to a small one; and this, not because the large wire resists *less* that action of the flame which tends to separate its parts, but because it resists it *more* than the smaller wire, or because the force being divided among more parts acts weaker on each.

This reminds me, however, of a little experiment I have frequently made, that shows, at one operation, the different effects of the same quantity of electric fluid passing through different quantities of metal. A strip of tinfoil, three inches long, a quarter of an inch wide at one end, and tapering all the way to a sharp point at the other, fixed between two pieces of glass, and having the electricity of a large glass jar sent through it, will not be discomposed in the broadest part; towards the middle will appear melted in spots;

where narrower, it will be quite melted; and about half an inch of it next the point will be reduced to smoke.

You were not mistaken in supposing, that your account of the effect of the pointed rod, in securing Mr. West's house from damage by a stroke of lightning, would give me great pleasure. I thank you for it most heartily, and for the pains you have taken in giving me so complete a description of its situation, form, and substance, with the draft of the melted point. There is one circumstance, viz. that the lightning was seen to diffuse itself from the foot of the rod over the wet pavement, which seems, I think, to indicate, that the earth under the pavement was very dry, and that the rod should have been sunk deeper, till it came to earth moister, and therefore apter to receive and dissipate the electric fluid. And although, in this instance, a conductor formed of nail-rods, not much above a quarter of an inch thick, served well to convey the lightning, yet some accounts I have seen from Carolina give reason to think, that larger may be sometimes necessary, at least for the security of the conductor itself, which, when too small, may be destroyed in executing its office, though it does, at the same time, preserve the house. Indeed, in the construction of an instrument so new, and of which we could have so little experience, it is rather lucky that we should at first be so near the truth as we seem to be, and commit so few errors.

There is another reason for sinking deeper the lower end of the rod, and also for turning it outwards under ground to some distance from the foundation; it is this, that water dripping from the eaves falls near the foundation, and sometimes soaks down there in greater quantities, so as to come near the end of the rod, though the ground about it be drier. In such case, this water may be exploded, that is, blown into vapor, whereby a force is generated, that may damage the foundation. Water reduced to vapor, is said to occupy fourteen thousand times its former space. I have sent a charge through a small glass tube, that has borne it well while empty, but, when filled first with water, was shattered to pieces, and driven all about the room. Finding no part of the water on the table, I suspected it to have been reduced to vapor; and was confirmed in that suspicion afterwards, when I had filled a like piece of tube with ink, and laid it on a sheet of clean paper, whereon, after the explosion, I could find neither any moisture nor any sully from the ink. This experiment of the explosion of water, which I believe was first made by that most ingenious electrician, Father Beccaria, may account for what we sometimes see in a tree struck by lightning, when part of it is reduced to fine splinters like a broom; the sap-vessels being so many tubes containing a watery fluid, which, when reduced to vapor, rends every tube lengthwise. And perhaps it is this rarefaction of the fluids in animal bodies killed by lightning or electricity, that, by separating its fibres, renders the flesh so tender, and apt so much sooner to putrefy. I think too, that much of the damage done by lightning to stone and brick walls may sometimes be owing to the explosion of water, found during showers, running or lodging in the joints or small cavities or cracks that happen to be in the walls.

Here are some electricians, that recommend knobs instead of points on the upper end of the rods, from a supposition that the points invite the stroke. It is true that points draw electricity at greater distances in the gradual, silent way; but knobs will draw at the greatest distance a stroke. There is an experiment that will settle this. Take a crooked wire, of the thickness of a quill, and of such a length as that, one end of it being applied to the lower part of a charged bottle, the upper may be brought near the ball on the top of the wire that is in the bottle. Let one end of this wire be furnished with a knob, and the other may be gradually tapered to a fine point. When the point is presented to discharge the bottle, it must be brought much nearer before it will receive the stroke, than the knob requires to be. Points, besides, tend to repel the fragments of an electrized cloud, knobs draw them nearer. An experiment, which, I believe, I have shown you, of cotton fleece hanging from an electrized body, shows this clearly, when a point or a knob is presented under it.

You seem to think highly of the importance of this discovery, as do many others on our side of the water. Here it is very little regarded; so little, that, though it is now seven or eight years since it was made public, I have not heard of a single house as yet attempted to be secured by it. It is true the mischiefs done by lightning are not so frequent here as with us; and those who calculate chances may perhaps find, that not one death (or the destruction of one house) in a hundred thousand happens from that cause, and that therefore it is scarce worth while to be at any expense to guard against it. But in all countries there are particular situations of buildings more exposed than others to such accidents, and there are minds so strongly impressed with the apprehension of them, as to be very unhappy every time a little thunder is within their hearing; it may therefore be well to render this little piece of new knowledge as general and as well understood as possible, since to make us *safe* is not all its advantage; it is some to make us *easy*. And, as the stroke it secures us from might have chanced, perhaps, but once in our lives, while it may relieve us a hundred times from those painful apprehensions, the latter may possibly, on the whole, contribute more to the happiness of mankind than the former.

Your kind wishes and congratulations are very obliging. I return them cordially; being, with great regard and esteem, my dear Sir, your affectionate friend and most obedient humble servant,

B. Franklin.

Accounts from Carolina (mentioned in the foregoing Letter) of the Effects of Lightning on two of the Rods commonly affixed to Houses there, for securing them against Lightning.

Charleston, 1 November, 1760.

. . . . . "It is some years since Mr. Raven's rod was struck by lightning. I hear an account of it was published at the time, but I cannot find it. According to the best information I can now get, he had fixed to the outside of his chimney a large iron rod, several feet in length, reaching above the chimney; and to the top of this rod the points were fixed. From the lower end of this rod, a small brass wire was continued down to the top of another iron rod driven into the earth. On the ground-floor in the chimney stood a gun, leaning against the back wall, nearly opposite to where the brass wire came down on the outside. The lightning fell upon the points, did no damage to the rod they were fixed to; but the brass wire, all down till it came opposite to the top of the gun-barrel, was destroyed.*

* A proof that it was not of sufficient substance to conduct with safety to itself (though with safety *so far* to the wall) so large a quantity of the electric fluid.

There the lightning made a hole through the wall, or back of the chimney, to get to the gun-barrel,* down which it seems to have passed, as, although it did not hurt the barrel, it damaged the butt of the stock, and blew up some bricks of the hearth. The brass wire below the hole in the wall remained good. No other damage, as I can learn, was done to the house. I am told the same house had formerly been struck by lightning, and much damaged, before these rods were invented."

Mr. William Maine's Account of the Effects of the Lightning on his Rod, dated at Indian Land, in South Carolina, August 28th, 1760.

. . . . . "I had a set of electrical points, consisting of three prongs, of large brass wire tipt with silver, and perfectly sharp, each about seven inches long; these were riveted at equal distances into an iron nut about three quarters of an inch square, and opened at top equally to the distance of six or seven inches from point to point, in a regular triangle. This nut was screwed very tight on the top of an iron rod of about half an inch diameter, or the thickness of a common curtain-rod, composed of several joints, annexed by hooks turned at the ends of each joint, and the whole fixed to the chimney of my house by iron staples. The points were elevated (*a*) six or seven inches above the top of the chimney; and the lower joint sunk three feet in the earth, in a perpendicular direction.

"Thus stood the points on Tuesday last, about five in the evening, when the lightning broke with a violent

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* A more substantial conductor.

explosion on the chimney, cut the rod square off just under the nut, and, I am persuaded, melted the points, nut, and top of the rod, entirely up; as, after the most diligent search, nothing of either was found (*b*), and the top of the remaining rod was cased over with a congealed solder. The lightning ran down the rod, starting almost all the staples (*c*), and unhooking the joints without affecting the rod (*d*), except on the inside of each hook where the joints were coupled, the surface of which was melted (*e*), and left as cased over with solder. No part of the chimney was damaged (*f*), only at the foundation (*g*), where it was shattered almost quite round, and several bricks were torn out (*h*). Considerable cavities were made in the earth quite round the foundation, but most within eight or nine inches of the rod. It also shattered the bottom weather-board (*i*) at one corner of the house, and made a large hole in the earth by the corner post. On the other side of the chimney, it ploughed up several furrows in the earth, some yards in length. It ran down the inside of the chimney (*k*), carrying only soot with it, and filled the whole house with its flash (*l*), smoke, and dust. It tore up the hearth in several places (*m*), and broke some pieces of China in the buffet (*n*). A copper tea-kettle standing in the chimney was beat together, as if some great weight had fallen upon it (*o*); and three holes, each about half an inch diameter, melted through the bottom (*p*). What seems to me the most surprising is, that the hearth under the kettle was not hurt, yet the bottom of the kettle was drove inward, as if the lightning proceeded from under it upwards (*q*), and the cover was thrown to the middle of the floor (*r*). The fire-dogs, an iron loggerhead, an Indian pot, an earthen cup, and a cat were all in the chimney at the time unhurt, though a great part of the hearth was torn up (*s*). My wife's sister, two children, and a negro wench were all who happened to be in the house at the time; the first and one child sat within five feet of the chimney, and were so stunned, that they never saw the lightning nor heard the explosion; the wench, with the other child in her arms, sitting at a greater distance, was sensible of both; though every one was so stunned that they did not recover for some time; however, it pleased God that no farther mischief ensued. The kitchen, at ninety feet distance, was full of negroes, who were all sensible of the shock; and some of them tell me, that they felt the rod about a minute after, when it was so hot that they could not bear it in hand."

Remarks by Benjamin Franklin.

The foregoing very sensible and distinct account may afford a good deal of instruction relating to the nature and effects of lightning, and to the construction and use of this instrument for averting the mischiefs of it. Like other new instruments, this appears to have been at first in some respects imperfect; and we find that we are, in this as in others, to expect improvement from experience chiefly; but there seems to be nothing in the account, that should discourage us in the use of it; since, at the same time that its imperfections are discovered, the means of removing them are pretty easily to be learnt from the circumstances of the account itself; and its utility upon the whole is manifest.

One intention of the pointed rod is, to *prevent* a stroke of lightning. (See pages 313, 356.) But, to have a better chance of obtaining this end, the points should not be too near to the top of the chimney or highest part of the building to which they are affixed, but should be extended five or six feet above it; otherwise their operation in silently drawing off the fire (from such fragments of cloud as float in the air between the great body of cloud and the earth) will be prevented. For the experiment with the lock of cotton hanging below the electrified prime conductor shows, that a finger under it, being a blunt body, extends the cotton, drawing its lower part downwards; when a needle, with its point presented to the cotton, makes it fly up again to the prime conductor; and that this effect is strongest when as much of the needle as possible appears above the end of the finger; grows weaker as the needle is shortened between the finger and thumb; and is reduced to nothing when only a short part below the point appears above the finger. Now, it seems, the points of Mr. Maine's rod were elevated only (*a*) *six or seven inches above the top of the chimney;* which, considering the bulk of the chimney and the house, was too small an elevation. For the great body of matter near them would hinder their being easily brought into a negative state by the repulsive power of the electrized cloud, in which negative state it is that they attract most strongly and copiously the electric fluid from other bodies, and convey it into the earth.

(*b*) *Nothing of the points, &c. could be found.* This is a common effect. (See page 358.) Where the quantity of the electric fluid passing is too great for the conductor through which it passes, the metal is either melted, or reduced to smoke and dissipated; but where the conductor is sufficiently large, the fluid passes in it without hurting it. Thus these three wires were destroyed, while the rod to which they were fixed, being of greater substance, remained unhurt; its end only, to which they were joined, being a little melted, some of the melted part of the lower ends of those wires uniting with it, and appearing on it like solder.

(*c*) (*d*) (*e*) As the several parts of the rod were connected only by the ends being bent round into hooks, the contact between hook and hook was much smaller than the rod; therefore the current through the metal, being confined in those narrow passages, melted part of the metal, as appeared on examining the inside of each hook. Where metal is melted by lightning, some part of it is generally exploded; and these explosions in the joints appear to have been the cause of unhooking them, and, by that violent action, of starting also most of the staples. We learn from hence, that a rod in one continued piece is preferable to one composed of links or parts hooked together.

(*f*) *No part of the chimney was damaged;* because the lightning passed in the rod. And this instance agrees with others in showing, that the second and principal intention of the rods is obtainable, viz. that of *conducting* the lightning. In all the instances yet known of the lightning's falling on any house guarded by rods, it has pitched down upon the point of the rod, and has not fallen upon any other part of the house. Had the lightning fallen on this chimney, unfurnished with a rod, it would probably have rent it from top to bottom, as we see, by the effects of the lightning on the points and rod, that its quantity was very great; and we know that many chimneys have been so demolished. But *no part of this was damaged, only (f) (g) (h) at the foundation, where it was shattered, and several bricks torn out.* Here we learn the principal defect in fixing this rod. The lower joint, being sunk but three feet into the earth, did not, it seems, go low enough to come at water, or a large body of earth so moist as to receive readily from its end the quantity it conducted. The electric fluid therefore, thus accumulated near the lower end of the rod, quitted it at the surface of the earth, dividing in search of other passages. Part of it tore up the surface in furrows, and made holes in it; part entered the bricks of the foundation, which being near the earth are generally moist, and, in exploding that moisture, shattered them. (See page 393.) Part went through or under the foundation, and got under the hearth, blowing up great part of the bricks (*m*) (*s*), and producing the other effects (*o*) (*p*) (*q*) (*r*). The iron dogs, loggerhead, and iron pot were not hurt, being of sufficient substance, and they probably protected the cat. The copper tea-kettle, being thin, suffered some damage. Perhaps, though found on a sound part of the hearth, it might at the time of the stroke have stood on the part blown up, which will account both for the bruising and melting.

That *it ran down the inside of the chimney* (*k*), I apprehend must be a mistake. Had it done so, I imagine it would have brought something more than soot with it; it would probably have ripped off the pargeting, and brought down fragments of plaster and bricks. The shake, from the explosion on the rod, was sufficient to shake down a good deal of loose soot. Lightning does not usually enter houses by the doors, windows, or chimneys, as open passages, in the manner that air enters them; its nature is, to be attracted by substances, that are conductors of electricity; it penetrates and passes *in* them, and, if they are not good conductors, as are neither wood, brick, stone, nor plaster, it is apt to rend them in its passage. It would not easily pass through the air from a cloud to a building, were it not for the aid afforded in its passage by intervening fragments of clouds below the main body, or by the falling rain.

It is said, that *the house was filled with its flash* (*l*). Expressions like this are common in accounts of the effects of lightning, from which we are apt to understand, that the lightning filled the house. Our language indeed seems to want a word to express the *light* of lightning, as distinct from the lightning itself. When a tree on a hill is struck by it, the lightning of that stroke exists only in a narrow vein between the cloud and tree, but its light fills a vast space many miles round; and people at the greatest distance from it are apt to say, "The lightning came into our rooms through our windows." As it is in itself extremely bright, it cannot, when so near as to strike a house, fail illuminating highly every room in it through the windows; and this I suppose to have been the case at Mr. Maine's; and that, except in and near the hearth, from the causes above mentioned, it was not in any other part of the house; *the flash* meaning no more than *the light* of the lightning. It is for want of considering this difference, that people suppose there is a kind of lightning not attended with thunder. In fact, there is probably a loud explosion accompanying every flash of lightning, and at the same instant; but as sound travels slower than light, we often hear the sound some seconds of time after having seen the light; and as sound does not travel so far as light, we sometimes see the light at a distance too great to hear the sound.

(*n*) The *breaking some pieces of China in the buffet*, may nevertheless seem to indicate that the lightning was there; but, as there is no mention of its having hurt any part of the buffet, or of the walls of the house, I should rather ascribe that effect to the concussion of the air, or shake of the house, by the explosion.

Thus to me it appears, that the house and its inhabitants were saved by the rod, though the rod itself was unjointed by the stroke; and that, if it had been made of one piece, and sunk deeper in the earth, or had entered the earth at a greater distance from the foundation, the mentioned small damages (except the melting of the points) would not have happened.

TO MISS MARY STEVENSON.

Concerning the Leyden Bottle.

London, 22 March, 1762.

I MUST retract the charge of idleness in your studies, when I find you have gone through the doubly difficult task of reading so big a book, on an abstruse subject, and in a foreign language.

In answer to your question concerning the Leyden phial. The hand that holds the bottle receives and conducts away the electric fluid that is driven out of the outside by the repulsive power of that which is forced into the inside of the bottle. As long as that power remains in the same situation, it must prevent the return of what it had expelled; though the hand would readily supply the quantity if it could be received. Your affectionate friend,

B. FRANKLIN.

Electrical Experiments on Amber.

Saturday, 3 July, 1762.

To try, at the request of a friend, whether amber finely powdered might be melted and run together again by means of the electric fluid, I took a piece of small glass tube, about two inches and a half long, the bore about one twelfth of an inch diameter, the glass itself about the same thickness. I introduced into this tube some powder of amber, and with two pieces of wire nearly fitting the bore, one inserted at one end, the other at the other, I rammed the powder hard between them in the middle of the tube, where it stuck fast, and was in length about half an inch. Then, leaving the wires in the tube, I made them part of the electric circuit, and discharged through them three rows of my case of bottles. The event was, that the glass was broke into very small pieces and those dispersed with violence in all directions. As I did not expect this, I had not, as in other experiments, laid thick paper over the glass to save my eyes, so several of the pieces struck my face smartly, and one of them cut my lip a little, so as to make it bleed. I could find no part of the amber; but the table where the tube lay was stained very black in spots, such as might be made by a thick smoke forced on it by a blast, and the air was filled with a strong smell, somewhat like that from burnt gunpowder. Whence I imagined, that the amber was burnt, and had exploded as gunpowder would have done in the same circumstances.

That I might better see the effect on the amber, I made the next experiment in a tube formed of a card rolled up and bound strongly with packthread. Its bore was about one eighth of an inch diameter. I rammed powder of amber into this as I had done into the other, and, as the quantity of amber was greater, I increased the quantity of electric fluid, by discharging through it at once five rows of my bottles. On opening the tube, I found that some of the powder had exploded; an impression was made on the tube, though it was not hurt, and most of the powder remaining was turned black, which I suppose might be by the smoke forced through it from the burned part; some of it was hard; but, as it powdered again when pressed by the fingers, I suppose that hardness not to arise from melting any parts in it, but merely from my ramming the powder when I charged the tube.

B. FRANKLIN.

FROM JOHN WINTHROP * TO BENJAMIN FRANKLIN.

New Observation relating to Electricity in the Atmosphere.

Cambridge, New England, 29 September, 1762.

SIR,

There is an observation relating to electricity in the atmosphere, which seemed new to me, though perhaps it will not to you; however, I will venture to mention it. I have some points on the top of my house, and the wire where it passes within-side the house is furnished with bells, according to your method, to give notice of the passage of the electric fluid. In summer these bells generally ring at the approach of a thunder-cloud, but cease soon after it begins to rain. In winter, they sometimes, though not very often, ring while it is snowing; but never, that I remember, when it rains. But what was unexpected to me was, that, though the bells had not rung while it was snowing, yet the next day, after it had done snowing, and the weather was cleared up, while the snow was driven

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* Professor of Mathematics and Natural Philosophy in Harvard University, and Fellow of the Royal Society. — EDITOR.

about by a high wind at west or northwest, the bells rung for several hours (though with little intermissions) as briskly as ever I knew them, and I drew considerable sparks from the wire. This phenomenon I never observed but twice; viz. on the 31st of January, 1760, and the 3d of March, 1762.

I am, Sir, &c.

J. WINTHROP.

FROM ALEXANDER SMALL TO BENJAMIN FRANKLIN.

Flash of Lightning that struck St. Bride's Steeple.

I HAVE just recollected, that, in one of our great storms of lightning, I saw an appearance, which I never observed before, nor ever heard described. I am persuaded that I saw *the* flash which struck St. Bride's steeple. Sitting at my window, and looking to the north, I saw what appeared to me a solid straight rod of fire, moving at a very sharp angle with the horizon. It appeared to my eye as about two inches diameter, and had nothing of the zigzag lightning motion. I instantly told a person sitting with me, that some place must be struck at that instant. I was so much surprised at the vivid, distinct appearance of the fire, that I did not hear the clap of thunder, which stunned every one besides. Considering how low it moved, I could not have thought it had gone so far, having St. Martin's, the New Church, and St. Clement's steeples in its way. It struck the steeple a good way from the top, and the first impression it made in the side is in the same direction I saw it move in. It was succeeded by two flashes, almost united, moving in a pointed direction. There were two distinct houses struck in Essex Street. I should have thought the rod would have fallen in Covent Garden, it was so low. Perhaps the appearance is frequent, though never before seen by

Yours,

ALEXANDER SMALL.

TO MR. PETER FRANKLIN, AT NEWPORT.

Best Method of securing a Powder Magazine from Lightning.

. . . . . YOU may acquaint the gentleman that desired you to inquire my opinion of the best method of securing a powder magazine from lightning, that I think they cannot do better than to erect a mast not far from it, which may reach fifteen or twenty feet above the top of it, with a thick iron rod in one piece fastened to it, pointed at the highest end, and reaching down through the earth till it comes to water. Iron is a cheap metal; but, if it were dearer, as this is a public thing, the expense is insignificant; therefore I would have the rod at least an inch thick, to allow for its gradually wasting by rust; it will last as long as the mast, and may be renewed with it. The sharp point for five or six inches should be gilt.

But there is another circumstance of importance to the strength, goodness, and usefulness of the powder, which does not seem to have been enough attended to; I mean the keeping it perfectly dry. For want of a method of doing this, much is spoiled in damp magazines, and much so damaged as to become of little value. If, instead of barrels, it were kept in cases of bottles well corked; or in large tin canisters, with small covers shutting close by means of oiled paper between, cı covering the joining on the canister; or, if in barrels, then the barrels lined with thin sheet-lead; no moisture in either of these methods could possibly enter the powder, since glass and metals are both impervious to water.

By the latter of these means you see tea is brought dry and crisp from China to Europe, and thence to America, though it comes all the way by sea in the damp hold of a ship. And by this method, grain, meal, &c., if well dried before it is put up, may be kept for ages sound and good.

There is another thing very proper to line small barrels with; it is what they call tinfoil, or leaf-tin, being tin milled between rollers till it becomes as thin as paper, and more pliant, at the same time that its texture is extremely close. It may be applied to the wood with common paste, made with boiling water thickened with flour; and, so laid on, will lie very close and stick well; but I should prefer a hard, sticky varnish for that purpose, made of linseed oil much boiled. The heads might be lined separately, the tin wrapping a little round their edges. The barrel, while the lining is laid on, should have the end hoops slack, so that the staves standing at a little distance from each other, may admit the head into its groove. The tinfoil should be plied into the groove. Then, one head being put in, and that end hooped tight, the barrel would be fit to receive the powder, and when the other head is put in and the hoops drove up, the powder would be safe from moisture, even if the barrel were kept under water This tinfoil is but about eighteen pence sterling a pound, and is so extremely thin, that, I imagine, a pound of it would line three or four powder barrels.

I am, &c.

B. Franklin.

TO THOMAS RONAYNE, AT CORK.*

On the Electricity of the Fogs in Ireland.

London, 20 April, 1766.

Sir,

I have received your very obliging and very ingenious letter by Captain Kearney. Your observations upon the electricity of fogs and the air in Ireland, and upon different circumstances of storms, appear to me very curious, and I thank you for them. There is not, in my opinion, any part of the earth whatever which is, or can be, naturally in a state of negative electricity; and, though different circumstances may occasion an inequality in the distribution of the fluid, the equilibrium is immediately restored by means of its extreme subtilty, and of the excellent conductors with which the humid earth is amply provided. I am of opinion, however, that when a cloud, well charged positively, passes near the earth, it repels and forces down into the earth that natural portion of electricity, which exists near its surface, and in buildings, trees, &c., so as actually to reduce them to a negative state before it strikes them. I am of opinion, too, that the negative state in which you have frequently found the balls, which are suspended from your apparatus, is not always occasioned by clouds in a negative state; but more commonly by clouds positively electrified, which have passed over them, and which in their passage have repelled and driven off a part of the electrical matter, which naturally existed in the apparatus; so that, what remained after the passing of the clouds diffusing itself uniformly

* Translated from M. Dubourg's French edition of the author's works; Tome I. p. 265.) — Editor.

through the apparatus, the whole became reduced to a negative state.

If you have read my experiments made in continuation of those of Mr. Canton, you will readily understand this; but you may easily make a few experiments, which will clearly demonstrate it. Let a common glass be warmed before the fire, that it may continue very dry for some time; set it upon a table, and place upon it the small box made use of by Mr. Canton, so that the balls may hang a little beyond the edge of the table. Rub another glass, which has previously been warmed in a similar manner, with a piece of black silk, or a silk handkerchief, in order to electrify it. Hold then the glass above the little box, at about the distance of three or four inches from that part, which is most distant from the balls; and you will see the balls separate from each other; being positively electrified by the natural portion of electricity, which was in the box, and which is driven to the further part of it by the repulsive power of the atmosphere in the excited glass. Touch the box near the little balls (the excited glass continuing in the same state) and the balls will again unite; the quantity of electricity which had been driven to this part being drawn off by your finger. Withdraw then both your finger and the glass, at the same instant, and the quantity of electricity which remained in the box, uniformly diffusing itself, the balls will again be separated, being now in a negative state. While things are in this situation, begin once more to excite your glass, and hold it above the box, but not too near, and you will find, that, when it is brought within a certain distance, the balls will at first approach each other, being then in a natural state In proportion as the glass is brought nearer, they will again separate, being positive. When the glass is moved beyond them, and at some little farther distance, they will unite again, being in a natural state. When it is entirely removed, they will separate again, being then made negative. The excited glass in this experiment may represent a cloud positively charged, which you see is capable of producing in this manner all the different changes in the apparatus, without the least necessity for supposing any negative cloud.

I am nevertheless fully convinced, that there are negative clouds; because they sometimes absorb, through the medium of the apparatus, the positive electricity of a large jar, the hundredth part of which the apparatus itself would have not been able to receive or contain at once. In fact, it is not difficult to conceive that a large cloud, highly charged positively, may reduce smaller clouds to a negative state, when it passes above or near them, by forcing a part of their natural portion of the fluid either to their inferior surfaces, whence it may strike into the earth, or to the opposite side, whence it may strike into the adjacent clouds; so that, when the large cloud has passed off to a distance, the small clouds shall remain in a negative state, exactly like the apparatus; the former (like the latter) being frequently insulated bodies, having communication neither with the earth nor with other clouds. Upon the same principle it may easily be conceived in what manner a large negative cloud may render others positive.

The experiment, which you mention, of filing your glass is analogous to one which I made in 1751, or 1752. I had supposed in my preceding letters, that the pores of glass were smaller in the interior parts than near the surface, and that on this account they prevented the passage of the electrical fluid. To prove whether this was actually the case or not, I ground one of my phials in a part where it was extremely thin, grinding it considerably beyond the middle, and very near to the opposite superficies, as I found, upon breaking it after the experiment. It was charged nevertheless after being ground, equally well as before, which convinced me, that my hypothesis on this subject was erroneous. It is difficult to conceive where the immense superfluous quantity of electricity on the charged side of a glass is deposited.

I send you my paper concerning Meteors, which was lately published here in the Philosophical Transactions, immediately after a paper by Mr. Hamilton on the same subject. I am, Sir, &c.

B. FRANKLIN.

Mode of ascertaining whether the Power, giving a Shock to those who touch either the Surinam Eel or the Torpedo, be Electrical.

1. TOUCH the fish with a stick of dry sealing-wax, or a glass rod, and observe if the shock be communicated by means of those bodies.

Touch the same fish with an iron, or other metalline rod.

If the shock be communicated by the latter body, and not by the others, it is probably not the mechanical effect, as has been supposed, of some muscular action in the fish, but of a subtile fluid, in this respect analogous at least to the electric fluid.

2. Observe farther, whether the shock can be conveyed without the metal being actually in contact with the fish, and, if it can, whether, in the space between, any light appear, and a slight noise or crackling be heard.

If so, these also are properties common to the electric fluid.

3. Lastly, touch the fish with the wire of a small Leyden bottle, and, if the shock can be received across, observe whether the wire will attract and repel light bodies, and you feel a shock, while holding the bottle in one hand, and touching the wire with the other.

If so, the fluid, capable of producing such effects, seems to have all the known properties of the electric fluid.

ADDITION, 12 AUGUST, 1772,

In Consequence of the Experiments and Discoveries made in France by Mr. Walsh, and communicated by him to Dr. Franklin.

LET several persons, standing on the floor, hold hands, and let one of them touch the fish, so as to receive a shock. If the shock be felt by all, place the fish flat on a plate of metal, and let one of the persons holding hands touch this plate, while the person farthest from the plate touches the upper part of the fish with a metal rod; then observe, if the force of the shock be the same as to all the persons forming the circle, or is stronger than before.

Repeat this experiment with this difference; let two or three of the persons forming the circle, instead of holding by the hand, hold each an uncharged electrical bottle, so that the little balls at the end of the wires may touch, and observe, after the shock, if these wires will attract and repel light bodies, and if a ball of cork, suspended by a long silk string between the wires, a little distance from the bottles, will be alternately attracted and repelled by them.

Of Lightning, and the Methods (now used in America) of securing Buildings and Persons from its mischievous Effects.

Paris, September, 1767.

Experiments made in electricity first gave philosophers a suspicion, that the matter of lightning was the same with the electric matter. Experiments afterwards made on lightning obtained from the clouds by pointed rods, received into bottles, and subjected to every trial, have since proved this suspicion to be perfectly well founded; and that whatever properties we find in electricity, are also the properties of lightning.

This matter of lightning, or of electricity, is an extreme subtile fluid, penetrating other bodies, and subsisting in them, equally diffused.

When, by any operation of art or nature, there happens to be a greater proportion of this fluid in one body than in another, the body which has most will communicate to that which has least, till the proportion becomes equal; provided the distance between them be not too great; or, if it is too great, till there be proper conductors to convey it from one to the other.

If the communication be through the air without any conductor, a bright light is seen between the bodies, and a sound is heard. In our small experiments, we call this light and sound the electric spark and snap; but, in the great operations of nature, the light is what we call *lightning*, and the sound (produced at the same time, though generally arriving later at our ears than the light does to our eyes,) is, with its echoes, called *thunder*.

If the communication of this fluid is by a conductor, it may be without either light or sound, the subtile fluid passing in the substance of the conductor.

If the conductor be good and of sufficient bigness, the fluid passes through it without hurting it. If otherwise, it is damaged or destroyed.

All metals and water are good conductors. Other bodies may become conductors by having some quantity of water in them, as wood, and other materials used in building; but, not having much water in them, they are not good conductors, and therefore are often damaged in the operation.

Glass, wax, silk, wool, hair, feathers, and even wood, perfectly dry, are non-conductors; that is, they resist instead of facilitating the passage of this subtile fluid.

When this fluid has an opportunity of passing through two conductors, one good and sufficient, as of metal, the other not so good, it passes in the best, and will follow it in any direction.

The distance at which a body charged with this fluid will discharge itself suddenly, striking through the air into another body that is not charged, or not so highly charged, is different according to the quantity of the fluid, the dimensions and form of the bodies themselves, and the state of the air between them. This distance, whatever it happens to be between any two bodies, is called their *striking distance*, as, till they come within that distance of each other, no stroke will be made.

The clouds have often more of this fluid in proportion than the earth; in which case, as soon as they come near enough (that is, within the striking distance) or meet with a conductor, the fluid quits them and strikes into the earth. A cloud fully charged with this fluid, if so high as to be beyond the striking distance from the earth, passes quietly without making noise or giving light; unless it meets with other clouds that have less.

Tall trees, and lofty buildings, as the towers and spires of churches, become sometimes conductors between the clouds and the earth; but, not being good ones, that is, not conveying the fluid freely, they are often damaged.

Buildings that have their roofs covered with lead, or other metal, and spouts of metal continued from the roof into the ground to carry off the water, are never hurt by lightning, as, whenever it falls on such a building, it passes in the metals and not in the walls.

When other buildings happen to be within the striking distance from such clouds, the fluid passes in the walls, whether of wood, brick, or stone, quitting the walls only when it can find better conductors near them, as metal rods, bolts, and hinges of windows or doors, gilding on wainscot, or frames of pictures, the silvering on the backs of looking-glasses, the wires for bells, and the bodies of animals, as containing watery fluids. And in passing through the house it follows the direction of these conductors, taking as many in its way as can assist it in its passage, whether in a straight or crooked line, leaping from one to the other, if not far distant from each other, only rending the wall in the spaces where these partial good conductors are too distant from each other.

An iron rod being placed on the outside of a building, from the highest part continued down into the moist earth, in any direction, straight or crooked, following the form of the roof or other parts of the building, will receive the lightning at its upper end, attracting it so as to prevent its striking any other part; and, affording it a good conveyance into the earth, will prevent its damaging any part of the building.

A small quantity of metal is found able to conduct a great quantity of this fluid. A wire no bigger than a goose quill has been known to conduct (with safety to the building as far as the wire was continued) a quantity of lightning that did prodigious damage both above and below it; and probably larger rods are not necessary, though it is common in America to make them of half an inch, some of three quarters, or an inch diameter.

The rod may be fastened to the wall, chimney, &c., with staples of iron. The lightning will not leave the rod (a good conductor) to pass into the wall (a bad conductor) through those staples. It would rather, if any were in the wall, pass out of it into the rod, to get more readily by that conductor into the earth.

If the building be very large and extensive, two or more rods may be placed at different parts, for greater security.

Small ragged parts of clouds, suspended in the air between the great body of clouds and the earth (like leaf gold in electrical experiments), often serve as partial conductors for the lightning, which proceeds from one of them to another, and by their help comes within the striking distance to the earth or a building. It therefore strikes, through those conductors, a building that would otherwise be out of the striking distance.

Long, sharp points communicating with the earth, and presented to such parts of clouds, drawing silently from them the fluid they are charged with, they are then attracted to the cloud, and may leave the distance so great as to be beyond the reach of striking.

It is therefore that we elevate the upper end of the rod six or eight feet above the highest part of the building, tapering it gradually to a fine sharp point, which is gilt to prevent its rusting.

Thus the pointed rod either prevents a stroke from the cloud, or, if a stroke is made, conducts it to the earth with safety to the building.

The lower end of the rod should enter the earth so deep as to come at the moist part, perhaps two or three feet; and, if bent when under the surface so as to go in a horizontal line six or eight feet from the wall, and then bent again downwards three or four feet, it will prevent damage to any of the stones of the foundation.

A person apprehensive of danger from lightning, happening during the time of thunder to be in a house not so secured, will do well to avoid sitting near the chimney, near a looking-glass, or any gilt pictures or wainscot; the safest place is in the middle of the room (so it be not under a metal lustre suspended by a chain), sitting in one chair and laying the feet up in another. It is still safer to bring two or three mattresses or beds into the middle of the room, and, folding them up double, place the chair upon them; for they not being so good conductors as the walls, the lightning will not choose an interrupted course through the air of the room and the bedding, when it can go through a continued better conductor, the walls. But, where it can be had, a hammock or swinging bed, suspended by silk cords equally distant from the walls on every side, and from the ceiling and floor above and below, affords the safest situation a person can have in any room whatever; and what, indeed, may be deemed quite free from danger of any stroke by lightning.

B. Franklin

FROM JOHN WINTHROP TO BENJAMIN FRANKLIN

St. Bride's Steeple.

Cambridge, 6 January, 1768.

..... I HAVE read in the Philosophical Transactions the account of the effects of lightning on St. Bride's steeple. It is amazing to me, that, after the full demonstration you had given, of the identity of lightning and of electricity, and the power of metalline conductors, they should ever think of repairing that steeple without such conductors. How astonishing is the force of prejudice, even in an age of so much knowledge and free inquiry!

TO JOHN WINTHROP.

On Conductors for protecting Houses from Lightning.— Singular Kind of Glass Tube.

London, 2 July, 1768.

DEAR SIR,

You must needs think the time long that your instruments have been in hand. Sundry circumstances have occasioned the delay. Mr. Short, who undertook to make the telescope, was long in a bad state of health, and much in the country for the benefit of the air. He however at length finished the material parts that required his own hand, and waited only for something about the mounting, that was to have been done by another workman; when he was removed by death. I have put in my claim to the instrument, and shall obtain it from the executors as soon as his affairs can be settled. It is now become much more valuable than it would have been if he had lived, as he excelled all others in that branch. The price agreed for was one hundred pounds.

The equal altitudes and transit instrument was undertaken by Mr. Bird, who doing all his work with his own hands for the sake of greater truth and exactness, one must have patience that expects any thing from him. He is so singularly eminent in his way, that the commissioners of longitude have lately given him five hundred pounds merely to discover and make public his method of dividing instruments. I send it you herewith. But what has made him longer in producing your instrument is, the great and hasty demand on him from France and Russia, and our Society here, for instruments to go to different parts of the world for observing the next transit of Venus; some to be used in Siberia, some for the observers that go to the South Seas, some for those that go to Hudson's Bay. These are now all completed, and mostly gone, it being necessary, on account of the distance, that they should go this year to be ready on the spot in time. And now, he tells me, he can finish yours, and that I shall have it next week. Possibly he may keep his word. But we are not to wonder if he does not.

Mr. Martin, when I called to see his panopticon, had not one ready; but was to let me know when he should have one to show me. I have not since heard from him, but will call again.

Mr. Maskelyne wishes much that some of the governments in North America would send an astronomer to Lake Superior, to observe this transit. I know no one of them likely to have a spirit for such an undertaking, unless it be the Massachusetts, or that have a person and instruments suitable. He presents you one of his pamphlets, which I now send you, together with two letters from him to me, relating to that observation. If your health and strength were sufficient for such an expedition, I should be glad to hear you had undertaken it. Possibly you may have an *élève* that is capable. The fitting you out to observe the former transit, was a public act for the benefit of science, that did your province great honor.

We expect soon a new volume of the Transactions, in which your piece will be printed. I have not yet got the separate ones which I ordered.

It is perhaps not so extraordinary that unlearned men, such as commonly compose our church vestries, should not yet be acquainted with, and sensible of, the benefits of metal conductors in averting the stroke of lightning, and preserving our houses from its violent effects,* or that they should be still prejudiced against the use of such conductors, when we see how long even philosophers, men of extensive science and great ingenuity, can hold out against the evidence of new knowledge, that does not square with their preconceptions; and how long men can retain a practice that is conformable to their prejudices, and expect a benefit from such practice, though constant experience shows its inutility. A late piece of the Abbé Nollet, printed last year in the Memoirs of the French Academy of Sciences, affords strong instances of this; for, though the very relations he gives of the effects of lightning in several churches and other buildings show clearly, that it was conducted from one part to another by wires, gildings, and other pieces of metal, that were *within* or connected with the building, yet in the same paper he

* Alluding to the preceding letter from Professor Winthrop, respecting St. Bride's steeple. — Editor.

objects to the providing metalline conductors *without* the building, as useless or dangerous.* He cautions people not to ring the church bells during a thunder-storm, lest the lightning, in its way to the earth, should be conducted down to them by the bell-ropes,† which are but bad conductors; and yet is against fixing metal rods on the outside of the steeple, which are known to be much better conductors, and which it would certainly choose to pass in, rather than in dry hemp. And, though for a thousand years past, bells have been solemnly consecrated by the Romish Church,‡ in expec-

* "Notre curiosité pourroit peut-être s'applaudir des recherches qu'elle nous a fait faire sur la nature du tonnerre, et sur la mécanisme de ses principaux effets, mais ce n'est point ce qu'il y a de plus important; il vaudroit bien mieux que nous puissions trouver quelque moyen de nous en garantir; on y a pensé; on s'est même flatté d'avoir fait cette grande découverte; mais malheureusement douze années d'épreuves et un peu de réflexion nous apprennent qu'il ne faut pas compter sur les promesses qu'on nous a faites. Je l'ai dit, il y a long temps, et avec regret, toutes ces pointes de fer qu'on dresse en l'air, soit comme *électroscopes*, soit comme préservatifs, sont plus propre à nous attirer le feu du tonnerre qu'à nous en préserver; et je persiste à dire que le projet d'épuiser une nuée orageuse du feu dont elle est chargée, n'est pas celui d'un physicien." — *Mémoire sur les Effets du Tonnerre.*

† "Les cloches, en vertu de leur bénédiction, doivent écarter les orages et nous préserver des coups de foudre; mais l'église permet à la prudence humaine le choix des momens où il convient d'user de ce préservatif. Je ne sais si le son, considéré physiquement, est capable ou non de faire crever une nuée, et de causer l'épanchement de son feu vers les objets terrestres; mais il est certain et prouvé per l'expérience, que le tonnerre peut tomber sur un clocher, soit que l'on y sonne ou que l'on n'y sonne point; et si cela arrive dans le premier cas, les sonneurs sont en grand danger, parcequ'ils tiennent des cordes par lesquelles la commotion de la foudre peut se communiquer jusqu'à eux; il est donc plus sage de laisser les cloches en repos quand l'orage est arrivé au-dessus de l'église." — *Ibid.*

‡ Suivant le rituel de Paris, lorsqu'on bénit des cloches, on récite les oraisons suivantes.

"Benedic, Domine, ... quotiescumque sonuerit, procul recedat virtus insidiantium, umbra phantasmatis, incursio turbinum, percussio fulminum, læsio tonitruum, calamitas tempestatum, omnisque spiritus procel larum," &c.

"Deus, qui per beatum Moïsen, &c., ... procul pellentur insidiæ ration that the sound of such blessed bells would drive away those storms, and secure our buildings from the stroke of lightning; and during so long a period, it has not been found by experience, that places within the reach of such blessed sound are safer than others where it is never heard; but that, on the contrary, the lightning seems to strike steeples of choice, and that at the very time the bells are ringing;* yet still they continue to bless the new bells, and jangle the old ones whenever it thunders. One would think it was now time to try some other trick; and ours is recommended (whatever this able philosopher may have been told to the contrary) by more than twelve years' experience, wherein, among the great number of houses furnished with iron rods in North America, not one so guarded has been materially hurt with lightning, and several have been evidently preserved by their means; while a number of houses, churches, barns, ships, &c. in different places, unprovided with rods, have been struck and greatly damaged, demolished, or burnt. Probably the vestries of our English churches are not generally well acquainted with these facts; otherwise, since as good Protestants they have no faith in the blessing of bells, they would be less excusable in not providing this other

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inimici, fragor grandinum, procella turbinum, impetus tempestatum, temperentur infesta tonitrua," &c.

"Omnipotens, sempiterne Deus, &c., ... ut ante sonitum ejus effugentur ignita jacula inimici, percussio fulminum, impetus lapidum, læsio tempestatum," &c.

* "En 1718, M. Deslandes fit savoir à l'Académie Royale des Sciences, que la nuit du 14 ou 15 d'Avril de la même année, le tonnerre étoit tombé sur vingt-quatre églises, depuis Landernau jusqu'à Saint-Pol-de-Léon en Brétagne; que ces églises étoient précisément celles où l'on sonnoit, et que la foudre avoit épargné celles où l'on ne sonnoit pas; que dans celle de Gouisnon, qui fut entièrement ruinée, le tonnerre tua deux personnes de quatre qui sonnoient," &c.—*Histoire de l'Académie Royale des Sciences*, 1719.

security for their respective churches, and for the good people that may happen to be assembled in them during a tempest, especially as those buildings, from their greater height, are more exposed to the stroke of lightning than our common dwellings.

I have nothing new in the philosophical way to communicate to you, except what follows. When I was last year in Germany, I met with a singular kind of glass, being a tube about eight inches long, half an inch in diameter, with a hollow ball of near an inch diameter at one end, and one of an inch and half at the other, hermetically sealed, and half filled with water. If one end is held in the hand, and the other a little elevated above the level, a constant succession of large bubbles proceeds from the end in the hand to the other end, making an appearance that puzzled me much, till I found that the space not filled with water was also free from air, and either filled with a subtile, invisible vapor continually rising from the water, and extremely rarefiable by the least heat at one end, and condensable again by the least coolness at the other; or it is the very fluid of fire itself, which parting from the hand pervades the glass, and by its expansive force depresses the water till it can pass between it and the glass, and escape to the other end, where it gets through the glass again into the air. I am rather inclined to the first opinion, but doubtful between the two.

An ingenious artist here, Mr. Nairne, mathematical instrument-maker, has made a number of them from mine, and improved them; for his are much more sensible than those I brought from Germany. I bored a very small hole through the wainscot in the seat of my window, through which a little cold air constantly entered, while the air in the room was kept warmer by fires daily made in it, being winter time. I placed one of his glasses, with the elevated end against this hole; and the bubbles from the other end, which was in a warmer situation, were continually passing day and night, to the no small surprise of even philosophical spectators. Each bubble discharged is larger than that from which it proceeds, and yet that is not diminished; and by adding itself to the bubble at the other end, that bubble is not increased, which seems very paradoxical.

When the balls at each end are made large, and the connecting tube very small, and bent at right angles, so that the balls, instead of being at the ends, are brought on the side of the tube, and the tube is held so as that the balls are above it, the water will be depressed in that which is held in the hand, and rise in the other as a jet or fountain; when it is all in the other, it begins to boil, as it were, by the vapor passing up through it; and the instant it begins to boil, a sudden coldness is felt in the ball held; a curious experiment this, first observed and shown me by Mr. Nairne. There is something in it similar to the old observation, I think mentioned by Aristotle, that the bottom of a boiling pot is not warm; and perhaps it may help to explain that fact; if indeed it be a fact.

When the water stands at an equal height in both these balls, and all at rest, if you wet one of the balls by means of a feather dipped in spirit, though that spirit is of the same temperament as to heat and cold with the water in the glasses, yet the cold occasioned by the evaporation of the spirit from the wetted ball will so condense the vapor over the water contained in that ball, as that the water of the other ball will be pressed up into it, followed by a succession of bubbles, till the spirit is all dried away. Perhaps the observations on these little instruments may suggest and be applied to some beneficial uses. It has been thought, that water reduced to vapor by heat was rarefied only fourteen thousand times, and on this principle our engines for raising water by fire are said to be constructed; but, if the vapor so much rarefied from water is capable of being itself still farther rarefied to a boundless degree, by the application of heat to the vessels or parts of vessels containing the vapor (as at first it is applied to those containing the water), perhaps a much greater power may be obtained, with little additional expense. Possibly too, the power of easily moving water from one end to the other of a movable beam (suspended in the middle like a scale-beam) by a small degree of heat, may be applied advantageously to some other mechanical purposes.

The magic square and circle, I am told, have occasioned a good deal of puzzling among the mathematicians here; but no one has desired me to show him my method of disposing the numbers. It seems they wish rather to investigate it themselves. When I have the pleasure of seeing you, I will communicate it.

With singular esteem and respect, I am, dear Sir,

Your most obedient humble servant,

B. Franklin.

FROM E. KINNERSLEY TO B. FRANKLIN.

On some Electrical Experiments made with Charcoal.

Philadelphia, 13 October, 1770.

The conducting quality of some sorts of charcoal is indeed very remarkable. I have found oak, beech, and maple to conduct very well; but tried several pieces of pine coal without finding one that would conduct at all; perhaps they were made in a fire not hot enough, or not continued in it long enough. A strong line, drawn on paper with a black lead pencil, will conduct an electrical shock pretty readily; but this, perhaps, may not be new to you.

On the 12th of last July, three houses in this city, and a sloop at one of the wharfs, were, in less than an hour's time, all struck with lightning. The sloop, with two of the houses, was considerably damaged; the other was the dwellinghouse of Mr. Joseph Moulde, in Lombard Street, which was provided with a round iron conductor, half an inch thick, its several lengths screwed together, so as to make very good joints, and the lower end five or six feet under ground; the lightning, leaving every thing else, pursued its way through that, melted off six inches and a half of the slenderest part of a brass wire fixed on the top, and did no further damage, within doors or without. Captain Falconer, who brings you this, was in the house at the time of the stroke, and says it was an astonishing loud one.

E. KINNERSLEY.

TO MAJOR DAWSON, ENGINEER.*

On the Security of the Powder Magazines at Purfleet.

Craven Street, 29 May, 1772.

SIR,

Having visited yesterday, as you desired, the powder magazines at Purfleet, in order to see how they may be protected against danger from lightning, I think,

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* This letter is here printed in a translation from the French, as contained in M. Dubourg's edition of the author's writings, (Tom. I. p. 280.) — EDITOR.

1. That all the iron bars, which pass down along the arches, from the top to the place where the powder is deposited, should be removed; as they now constitute, with the brass hoops with which the casks are bound, an imperfect conductor; imperfect in proportion to the greater or less height to which the casks are piled; but, in any case, such that they can only serve to attract towards the powder the first stroke that falls upon the arch; and that they are consequently very dangerous.

2. That the building, which has a leaden coping along the ridge from one end to the other, may be secured by means of a pointed iron rod, carried up near each end, communicating with this coping, and extending through the rock of chalk, which serves as the foundation of the building, till it meets with water. This rod should be at least an inch in diameter, that it may be more durable, and afford the lightning a more free course through its substance; and it should be painted, to preserve it from rust. Its upper extremity should be carried ten feet above the summit of the roof, and taper off gradually till it ends in a sharp point; and, the better to preserve this point, the last six inches should be of brass, because it is less liable to become blunted by rust. If the rod cannot well be made entirely of a single piece, the different pieces composing it should be strongly screwed together, or into one another very closely, with a thin plate of lead between the joints, in order to render the junction or continuation of the metal more perfect.

After all the electrical experiments that I have made in reference to this subject, and all the examples that have come to my knowledge of the effects of lightning on these conductors, it seems to me, that (provided they are good and perfect, carried down till water or very moist ground is reached) they are equally safe, whether placed directly against the wall, and secured by staples driven into it, or whether supported by a pole or staff planted in the ground, at some distance from the wall. The former is the better mode, as the rod can be bent to avoid the windows or doors, which are situated directly below the summit of the roof. Yet, as certain apprehensions may be more effectually set at rest by supporting the rods in the other manner, I should make no objection to this, provided that they can be suitably placed, without interfering with any passage, and that they are so firmly fixed that the wind cannot, by causing them to vibrate, interrupt the communication of iron or lead, between the side of the rod and the lead that covers the ridge.

3 As I am informed that the roofs of the other four buildings are to be reconstructed after the model of that of which I have just been speaking, the same method may be followed with regard to them, when they are finished in this manner. But, if it be asked how they may be rendered secure in the mean time, I would advise, that, (as their roofs are now of a different form, being hip-roofs with four corners, and the joining at their corners, as well as their ridge-pieces, having a coping of lead, which extends to the gutters,) the passages, which it is proposed to carry down till water is reached, be bored or dug immediately, and that that part of each conductor, which is to be carried up from the water as high as the gutters, be fixed in them. From the top of this conductor I would carry out two arms of iron to the corners of the gutters, where the leaden coping of the corners of the roof should be united to the ends of these bars; and at the junction of these corners with the ridge-piece, I would carry up rods to the height of ten feet, pointed as directed above;

which, when a new roof is made, could be used for the upper part of a straight conductor. I am, Sir,

Your most obedient humble servant,

B. FRANKLIN.

P. S. For that part of the conductor which is to be carried under ground, leaden pipes should be used, as less liable to rust.*

REPORT ON LIGHTNING CONDUCTORS FOR THE POWDER MAGAZINES AT PURFLEET.

Drawn up by Benjamin Franklin, August 21st, 1772.

TO THE PRESIDENT AND COUNCIL OF THE ROYAL SOCIETY.

GENTLEMEN,

The Society being consulted by the Board of Ordnance, on the propriety of fixing conductors for securing the powder magazines at Purfleet from lightning, and having thereupon done us the honor of appointing us a committee to consider the same and report our opinion, we have accordingly visited those buildings, and examined with care and attention their situation, construction, and circumstances, which we find as follows;

They are five in number, each about one hundred and fifty feet long, about fifty-two feet wide, built of

* In consequence of this letter the Ordnance Department directed, that the advice of the writer should be followed in some respects; but, that they might be still better authorized to proceed with regard to other points, these gentlemen were desirous to obtain the sanction of the Royal Society, and therefore requested their opinion. The Royal Society appointed Messrs. Cavendish, Watson, Franklin, Wilson, and Robertson, a committee to examine the subject, and report thereon. — DUBOURG.

brick, arched under the roof, which in one of them is slated, with a coping of lead twenty-two inches wide on the ridge, from end to end; and the others, we were informed, are soon to be covered in the same manner. They stand parallel to each other, at about fifty-seven feet distance, and are founded on a chalk rock about one hundred feet from the river, which rises at high tides within a few inches of the level of the ground, its brackish water also soaking through to the wells that are dug near the buildings.

The barrels of powder, when the magazines are full, lie piled on each other up to the spring of the arches; and there are four copper hoops on each barrel, which, with a number of perpendicular iron bars (that come down through the arches to support a long, grooved piece of timber, wherein the crane was usually moved and guided to any part where it was wanted), formed broken conductors, within the building, the more dangerous from their being incomplete; as the explosion from hoop to hoop, in the passage of lightning drawn down through the bars among the barrels, might easily happen to fire the powder contained in them; but the workmen were removing all those iron bars (by the advice of some members of the Society who had been previously consulted), a measure we very much approve of.

On an elevated ground, nearly equal in height with the tops of the magazines, and one hundred and fifty yards from them, is the house wherein the Board usually meet; it is a lofty building, with a pointed hip-roof, the copings of lead down to the gutters; whence leaden pipes descend at each end of the building, into the water of two wells forty feet deep, for the purpose of conveying water, forced up by engines, to a cistern in the roof.

There is also a proof-house adjoining to the end of one of the magazines; and a clock-house at the distance of feet from them, which has a weathercock on an iron spindle, and probably some incomplete conductors within, such as the wire usually extending up from a clock to its hammer, the clock, pendulum, rod, &c.

The blowing up of a magazine of gunpowder by lightning within a few years past, at Brescia in Italy, which demolished a considerable part of the town, with the loss of many lives, does, in our opinion, strongly urge the propriety of guarding such magazines from that kind of danger. And since it is now well known from many observations, that metals have the property of conducting, and a method has been discovered of using that property for the security of buildings, by so disposing and fixing iron rods, as to receive and convey safely away such lightning as might otherwise have damaged them, which method has been practised near twenty years in many places, and attended with success in all the instances that have come to our knowledge, we cannot therefore but think it advisable to provide conductors of that kind for the magazines in question.

In common cases it has been judged sufficient, if the lower part of the conductor were sunk three or four feet into the ground till it came to moist earth; but, this being a case of the greatest importance, we are of opinion, that greater precaution should be taken. Therefore we would advise, that at each end of each magazine a well should be dug in or through the chalk, so deep as to have in it at least four feet of standing water. From the bottom of this water should rise a piece of leaden pipe to or near the surface of the ground, where it should be strongly joined to the end of an upright bar, an inch and a half in diameter, fastened to the wall by leaden straps, and extending ten feet above the ridge of the building, tapering from the ridge upwards to a sharp point; the upper twelve inches to be copper; the iron to be painted.

We mention lead for the underground part of the conductor, as less liable to rust in water and moist places, in the form of a pipe, as giving greater stiffness for the substance; and iron for the part above ground, as stronger and less likely to be cut away. The pieces of which the bar may be composed should be screwed strongly into each other by a close joint, with a thin plate of lead between the shoulders, to make the joining or continuation of metal more perfect. Each rod, in passing above the ridge, should be strongly and closely connected by iron or lead, or both, with the leaden coping of the roof, whereby a communication of metal will be made between the two bars of each building, for a more free and easy conducting of the lightning into the earth.

We also advise, in consideration of the great length of the buildings, that two wells, of the same depth with the others, should be dug within twelve feet of the doors of the two outside magazines; that is to say, one of them on the north side of the north building, the other on the south side of the south building; from the bottoms of which wells, similar conductors should be carried up to the eaves, there joining well with a plate of lead extending on the roof up to the leaden coping of the ridge, the said plate of lead being of equal substance with that of the coping.

We are further of opinion, that it will be right to form a communication of lead from the top of the chimney of the proof-house to the lead on its ridge, and thence to the lead on the ridge of the corridor, and thence to the iron conductor of the adjacent end of the magazine; and also to fix a conductor from the bottom of the weathercock spindle of the clock-house, down on the outside of that building into the moist earth.

As to the board-house, we think it already well furnished with conductors by the several leaden communications above mentioned, from the point of the roof down into the water; and that, by its height and proximity, it may be some security to the buildings below it; we therefore propose no other conductor for that building, and only advise erecting a pointed rod on the summit, similar to those before described, and communicating with those conductors.

To these directions we would add a caution, that, in all future alterations or repairs of the buildings, special care be taken that the metalline communications are not cut off or removed.

It remains that we express our acknowledgments to Sir Charles Frederick, Surveyor-general of the Ordnance, for the obliging attention with which he entertained and accommodated us on the day of our inquiry.

With very great respect we are, Gentlemen,

Your most obedient humble servants,

H. Cavendish,
William Watson,
B. Franklin,
J. Robertson.*

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* Mr. Benjamin Wilson, one of the committee appointed by the Royal Society, dissented from the part of the above report, which relates to pointed conductors. — Editor.

"I dissent from the report," said he, "in that part only which recommends, that each conductor should terminate in a *point*.

"My reason for dissenting is, that such conductors are, in my opinion, less safe than those which are not *pointed*.

"Every *point*, as such, I consider as *soliciting* the lightning, and, by

Experiments, Observations, and Facts, tending to support the Opinion of the Utility of long, pointed Rods, for securing Buildings from Damage by Strokes of Lightning.

READ AT THE COMMITTEE APPOINTED TO CONSIDER THE ERECTING OF CONDUCTORS TO SECURE THE MAGAZINES AT PURFLEET, AUGUST 27TH, 1772.

EXPERIMENT I.

THE prime conductor of an electric machine, *A, B*, (see Plate IV.) being supported about ten inches and a half above the table by a wax stand, and under it erected a *pointed wire*, seven inches and a half high, and one fifth of an inch thick, and tapering to a sharp point, and communicating with the table; when the *point* (being uppermost) is *covered* by the end of a finger, the conductor may be full charged, and the electrometer * will rise to the height indicating a full charge; but the moment the point is *uncovered*, the ball

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that means, not only contributing to *increase* the quantity of every actual discharge, but also frequently occasioning a discharge, where it might not otherwise have happened.

"If, therefore, we invite the lightning, while we are ignorant what the quantity or the effects of it may be, we may be *promoting* the very mischief we mean to prevent.

"Whereas if, instead of pointed, we make use of blunted conductors, those will as effectually answer the purpose of conveying away the lightning *safely*, without that tendency to *increase* or *invite* it.

"My further reasons for disapproving of *points*, in all cases where conductors are judged necessary, are contained in a letter addressed to the Marquis of Rockingham, and published in the *Philosophical Transactions*, Vol. LIV. p. 247.

"There are other reasons also, which I have to offer, for rejecting points on this *particular occasion*, and which were *mentioned at the committee*. Those I shall lay before the Royal Society at another opportunity, for the benefit of the public."

* Mr. Henley's.

of the electrometer drops, showing the prime conductor to be instantly discharged and nearly emptied of its electricity. Turn the wire its *blunt* end upwards (which represents an unpointed bar), and no such effect follows, the electrometer remaining at its usual height when the prime conductor is charged.

OBSERVATION.

What quantity of lightning a high, pointed rod, well communicating with the earth, may be expected to discharge from the clouds silently in a short time, is yet unknown; but I reason from a particular fact to think it may at some times be very great. In Philadelphia I had such a rod fixed to the top of my chimney, and extending about nine feet above it. From the foot of this rod, a wire (the thickness of a goose-quill) came through a covered glass tube in the roof, and down through the well of the staircase; the lower end connected with the iron spear of a pump. On the staircase opposite to my chamber door, the wire was divided; the ends separated about six inches, a little bell on each end; and between the bells a little brass ball, suspended by a silk thread, to play between and strike the bells when clouds passed with electricity in them. After having frequently drawn sparks and charged bottles from the bell of the upper wire, I was one night awaked by loud cracks on the staircase. Starting up and opening the door, I perceived that the brass ball, instead of vibrating as usual between the bells, was repelled and kept at a distance from both; while the fire passed, sometimes in very large, quick cracks from bell to bell, and sometimes in a continued, dense, white stream, seemingly as large as my finger, whereby the whole staircase was enlightened as with sunshine, so that one might see to pick up a pin.* And from the apparent quantity thus discharged, I cannot but conceive that a *number* † of such conductors must considerably lessen that of any approaching cloud, before it comes so near as to deliver its contents in a general stroke; an effect not to be expected from bars *unpointed*, if the above experiment with the blunt end of the wire is deemed pertinent to the case.

EXPERIMENT II.

The pointed wire under the prime conductor continuing of the same height, *pinch* it between the thumb and finger near the top, so as *just to conceal* the point; then turning the globe, the electrometer will rise and mark the full charge. Slip the fingers down, so as to discover about half an inch of the wire, then another half inch, and then another; at every one of these motions *discovering more and more* of the pointed wire; you will see the electrometer fall quick and proportionably, stopping when you stop. If you slip down the *whole distance* at once, the ball falls instantly down to the stem.

OBSERVATION.

From this experiment it seems, that a greater effect in drawing off the lightning from the clouds may be

* M. de Romas saw still greater quantities of lightning brought down by the wire of his kite. He had "explosions from it, the noise of which greatly resembled that of thunder, and were heard (from without) into the heart of the city, notwithstanding the various noises there. The fire seen at the instant of the explosion had the shape of a spindle, eight inches long and five lines in diameter. Yet, from the time of the explosion to the end of the experiment, no lightning was seen above, nor any thunder heard. At another time the streams of fire issuing from it were observed to be an inch thick and ten feet long." See Dr. Priestley's *History of Electricity*, pp. 134–136, first edition.

† Twelve were proposed on and near the magazines at Purfleet.

expected from *long*, pointed rods, than from *short* ones; I mean from such as show the greatest length *above the building* they are fixed on.

EXPERIMENT III.

Instead of pinching the point between the thumb and finger, as in the last experiment, keep the thumb and finger each at *near an inch distance* from it, but at the *same height*, the point between them. In this situation, though the point is fairly exposed to the prime conductor, it has little or no effect; the electrometer rises to the height of a full charge. But the moment the fingers are *taken away*, the ball falls quick to the stem.

OBSERVATION.

To explain this, it is supposed, that one reason of the sudden effect produced by a long, naked, pointed wire is, that (by the repulsive power of the positive charge in the prime conductor) the natural quantity of electricity contained in the pointed wire is driven down into the earth, and the point of the wire made strongly *negative;* whence it attracts the electricity of the prime conductor more strongly than bodies in their natural state would do; the *small quantity of common matter* in the point not being able by its attractive force to retain its *natural quantity of the electric fluid*, against the force of that repulsion. But the finger and thumb, being substantial and blunt bodies, though as near the prime conductor, hold up better their *own* natural quantity against the force of that repulsion; and so, continuing nearly in the natural state, they jointly operate on the electric fluid in the point, opposing its descent, and *aiding the point* to retain it; contrary to the repelling power of the prime conductor, which would drive it down. And this may also serve to explain the different powers of the point in the preceding experiment, on the slipping down the finger and thumb to different distances.

Hence is collected, that a pointed rod, erected *between two tall chimneys*, and very little higher, (an instance of which I have seen,) cannot have so good an effect, as if it had been erected on one of the chimneys, its whole length above it.

EXPERIMENT IV.

If, *instead* of a long, pointed wire, a *large*, *solid body* (to represent a building without a point) be brought under and as near the prime conductor, when charged; the ball of the electrometer will *fall* a little; and, on taking away the large body, will *rise again.*

OBSERVATION.

Its *rising again* shows that the prime conductor lost little or none of its electric charge, as it had done through the point; the *falling* of the ball while the large body was under the conductor therefore shows, that a quantity of its atmosphere was drawn from the end where the electrometer is placed, to the part immediately over the large body, and there accumulated *ready* to strike into it with its whole undiminished force, as soon as within the striking distance; and, were the prime conductor movable like a *cloud*, it would approach the body by attraction till within that distance. The swift motion of clouds, as driven by the winds, probably prevents this happening so often as otherwise it might do; for, though parts of the cloud may stoop towards a building as they pass, in consequence of such attraction, yet they are carried forward beyond the striking distance before they could by their descending come within it

EXPERIMENT V.

Attach a small, light *lock of cotton* to the under side of the prime conductor, so that it may hang down towards the pointed wire mentioned in the first experiment. *Cover* the point with your finger, and, the globe being turned, the cotton will extend itself, stretching down towards the finger, as at *a;* but, on *uncovering* the point, it instantly flies up to the prime conductor, as at *b*, and continues there as long as the point is uncovered. The moment you cover it again, the cotton flies down again, extending itself towards the finger; and the same happens in degree, if (instead of the finger) you use, uncovered, the *blunt* end of the wire uppermost.

OBSERVATION.

To explain this, it is supposed that the cotton, by its connexion with the prime conductor, receives from it a quantity of its electricity; which occasions its being attracted by the *finger* that remains still in nearly its natural state. But, when a *point* is opposed to the cotton, its electricity is thereby taken from it, faster than it can at a distance be supplied with a fresh quantity from the conductor. Therefore being reduced *nearer* to the natural state, it is attracted *up* to the electrified prime conductor; *rather than down*, as before, to the finger.

Supposing farther, that the prime conductor represents a cloud charged with the electric fluid; the cotton, a ragged fragment of cloud (of which the underside of great thunder-clouds are seen to have many), the finger, a chimney or highest part of a building. We then may conceive, that, when such a cloud passes over a *building*, some one of its ragged, under-hanging fragments may be drawn down by the chimney, or other high part of the edifice; creating thereby a *more easy communication* between it and the great cloud. But a *long, pointed rod,* being presented to this fragment, may occasion its receding, like the cotton, up to the great cloud; and thereby *increase,* instead of *lessening* the distance, so as often to make it *greater* than the striking distance. Turning the *blunt end of a wire* uppermost (which represents the unpointed bar), it appears that the same good effect is not from that to be expected. A long, pointed rod, it is therefore imagined, may *prevent* some strokes; as well as *conduct* others that fall upon it, when a great body of cloud comes on so heavily that the above repelling operation on fragments cannot take place.

EXPERIMENT VI.

Opposite the side of the prime conductor place *separately,* isolated by wax stems, Mr. Canton's two boxes with pith balls suspended by fine linen threads. On each box lay a wire, six inches long and one fifth of an inch thick, tapering to a sharp point; but so laid, as that four inches of the *pointed* end of *one* wire, and an equal length of the *blunt* end of the *other,* may project beyond the ends of the boxes; and both at eighteen inches distance from the prime conductor. Then charging the prime conductor by a turn or two of the globe, the balls of each pair will separate; those of the box, whence the point projects most, *considerably;* the others *less.* Touch the prime conductor, and those of the box with the *blunt* point will *collapse,* and join; those connected with the *point* will at the same time approach each other, *till* within about an inch, and there *remain.*

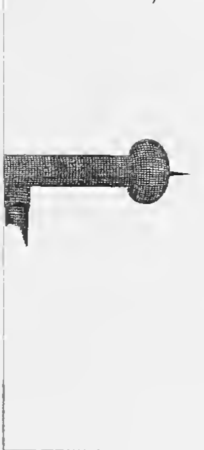
OBSERVATION.

This seems a proof, that, though the small, sharpened part of the wire must have had a *less natural* quantity in it before the operation, than the thick, blunt part, yet a greater quantity was *driven down from it* to the balls. Thence it is again inferred, that the pointed rod is rendered *more negative;* and, farther, that if a *stroke must fall* from the cloud over a building, furnished with such a rod, it is more likely to be drawn to that pointed rod than to a blunt one; as being more strongly negative, and of course its attraction stronger. And it seems more eligible, that the lightning should fall on the point of the conductor (provided to convey it into the earth) than on any other part of the building, *thence* to proceed to such conductor. Which end is also more likely to be obtained by the length and loftiness of the rod; as protecting more extensively the building under it.

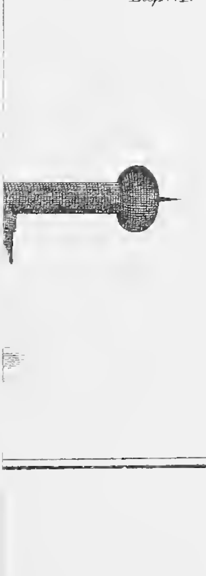
It has been *objected*, that erecting pointed rods upon *edifices* is to *invite* and draw the lightning into *them;* and therefore dangerous. Were such rods to be erected on buildings, *without continuing the communication* quite down into the moist earth, this objection might then have weight; but, when such complete conductors are made, the lightning is invited, not into the building, but into the *earth*, the situation it aims at, and which it always seizes every help to obtain, even from broken, partial metalline conductors.

It has also been suggested, that, from such electric experiments, *nothing certain can be concluded as to the great operations of nature;* since it is often seen, that experiments, which have succeeded in small, in large have failed. It is true, that in mechanics this has sometimes happened. But when it is considered, that we

Exp.III



Exp.VI.



owe our first knowledge of the nature and operations of lightning to observations on such small experiments; and that, on carefully comparing the most accurate accounts of former facts, and the exactest relations of those that have occurred since, the effects have surprisingly agreed with the theory; it is humbly conceived, that in natural philosophy, in this branch of it at least, the suggestion has not so much weight; and that the farther new experiments, now adduced in recommendation of *long*, sharp-pointed rods, may have some claim to credit and consideration.

It has been urged, too, that, though points may have considerable effects on a *small* prime conductor at *small distances*; yet, on *great* clouds and at *great distances*, nothing is to be expected from them. To this it is answered, that in those *small* experiments it is evident the points act at a greater than the *striking* distance; and, in the large way, their service is *only expected* where there is *such* nearness of the cloud as to *endanger a stroke;* and there, it cannot be doubted, the points must have some effect. And, if the quantity discharged by a single pointed rod may be so considerable as I have shown it, the quantity discharged by a number will be proportionably greater.

But this part of the theory does not depend alone on *small* experiments. Since the practice of erecting pointed rods in America (now near twenty years), five of them have been struck by lightning, namely, Mr. Raven's and Mr. Maine's in South Carolina, Mr. Tucker's in Virginia, Mr. West's and Mr. Moulder's in Philadelphia. Possibly there may have been more, that have not come to my knowledge. But, in every one of these, the lightning did *not* fall upon the *body of the house*, but precisely on the several *points* of the rods; and, though the conductors were sometimes *not sufficiently* *large and complete*, was conveyed into the earth, without any material damage to the buildings. Facts then *in great*, as far as we have them authenticated, justify the opinion that is drawn from the experiments *in small*, as above related.

It has also been objected, that, unless we knew the quantity that might *possibly* be discharged at one stroke from the clouds, we cannot be sure we have provided *sufficient* conductors; and therefore cannot depend on their conveying away *all* that may fall on their points. Indeed we have nothing to form a judgment by in this, but past facts; and we know of no instance, where a *complete* conductor to the moist earth *has* been insufficient, if half an inch in diameter. It is probable, that many strokes of lightning have been conveyed through the common leaden pipes affixed to houses to carry down the water from the roof to the ground; and there is no account of such pipes being melted and destroyed, as must sometimes have happened, if they had been insufficient. We can, then, only judge of the dimensions proper for a conductor of lightning, as we do of those proper for a *conductor of rain*, by past observation. And, as we think a pipe of three inches bore sufficient to carry off the rain that falls on a square of twenty feet, because we never saw such a pipe glutted by any shower; so we may judge a conductor of an inch diameter more than sufficient for any stroke of lightning that will fall on its point. It is true, that, if another deluge should happen wherein the windows of heaven are to be opened, such pipes may be unequal to the falling quantity; and, if God for our sins should think fit to rain fire upon us, as upon some cities of old, it is not expected that our conductors, of whatever size, should secure our houses against a miracle. Probably, as water drawn up into the air and there forming clouds, is disposed to fall again in *rain* by its natural gravity, as soon as a number of particles sufficient to make a drop can get together; so, when the clouds are (by whatever means) over or under charged with the *electric fluid* to a degree sufficient to attract them towards the earth, the equilibrium is restored, before the difference becomes great beyond that degree. Mr. Lane's *electrometer*, for limiting precisely the quantity of a shock that is to be administered in a medical view, may serve to make this more easily intelligible. The discharging knob does by a screw approach the conductor to the distance intended, but there remains fixed. Whatever power there may be in the glass globe to collect the fulminating fluid, and whatever capacity of receiving and accumulating it there may be in the bottle or glass jar, yet neither the accumulation nor the discharge ever exceeds the destined quantity. Thus, were the *clouds* always at a certain fixed distance from the earth, all discharges would be made when the quantity accumulated was equal to the distance. But there is a circumstance, which, by occasionally lessening the distance, lessens the discharge; to wit, the movableness of the clouds, and their being drawn nearer to the earth by attraction when electrified; so that discharges are thereby rendered more frequent and of course less violent. Hence, whatever the quantity may be in nature, and whatever the power in the clouds of collecting it, yet an accumulation and force beyond what mankind has hitherto been acquanted with is scarce to be expected.*

B. F.

August 27th, 1772.

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* It may be fit to mention here, that the immediate occasion of the dispute concerning the preference between pointed and blunt conductors of lightning arose as follows. A powder-mill having blown up at Brescia,

*Description of a Portable Apparatus, invented by Mr. John Canton, for the Purpose of easily demonstrating Dr. Franklin's fundamental Principles of Electricity.**

This apparatus is very simple, and takes up but little room in the pocket.

ITS CONSTRUCTION.

Take a rod of common wood, two feet long, an inch wide and three lines in thickness, planed by a joiner.

Divide it in four pieces, or four rods of equal length, each being six inches long.

Place two of these rods end to end on a table, and unite the contiguous ends, by pasting over them a small strip of fine linen, which, when it has become dry, will answer the purpose of a hinge, to double or fold the two pieces together at pleasure.

Unite the other two pieces in the same manner. Have two pairs of little balls, made of cork or the pith of the elder, and of nearly the size of a pea.

Attach one pair of these to the two ends of a very fine

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in consequence of its being struck with lightning, the English Board of Ordnance applied to their painter, Mr. Wilson, then of some note as an electrician, for a method to prevent the like accident to their magazines at Purfleet. Mr. Wilson having advised a blunt conductor, and it being understood that Dr. Franklin's opinion, formed upon the spot, was for a pointed one, the matter was referred in 1772, to the Royal Society, and by them as usual to a committee, who, after consultation, prescribed a method conformable to Dr. Franklin's theory. But a harmless stroke of lightning having, under particular circumstances, fallen upon one of the buildings and its apparatus in May, 1777, the subject came again into violent agitation, and was again referred to the Society, and by the Society again referred to a new committee, which committee confirmed the decision of the first committee. — B. V.

* Translated from M. Dubourg's edition of Franklin's works. — Editor.

linen thread, about twelve inches long; then, doubling the thread in the middle, these two balls, suspended at the ends of the thread, will be in contact.

Then fasten the middle of the thread to one end of one of these pairs of rods. The threads should be very smooth, and free from any little fibres; and must be dipped once in salt water.* Proceed in the same manner with regard to the other two balls, and the other two rods.

Make little hemispherical holes in each pair of rods, to place the balls in, when you wish to shut up the apparatus.

MODE OF USING IT.

To make use of this apparatus, take three large drinking-glasses, and warm and dry them well before the fire.

On one of the glasses, place one pair of the rods open, the hinge being on the upper side, and the little balls suspended at the end. Place the other pair in like manner on the second glass.

Place these two glasses near a corner of the table, in such a position that the ends of the rods from which the balls are suspended may extend beyond the table, and thus the balls may hang entirely free of the table, on either side of the same corner, while the two ends without balls are an inch apart, and the rods in a line with each other.

Rub the third glass with a silk handkerchief, of any color; a piece of black silk, however, is better than any thing else.

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* The reason why the threads should be dipped once in salt water is, that they may always continue to be good conductors; for, unless this is done, in dry weather they would sometimes become too dry to conduct freely. For this ingenious method, we are indebted to Mr. Cavendish.

1. Bring the rubbed glass near one pair of balls; they will be attracted by it, and receive electricity from it; and, when you withdraw the glass, the balls will hang apart, because they will repel each other.

2. To show that this *electricity is a subtile fluid, which penetrates wood, and passes readily through it from end to end, being at the same time susceptible of division and of communication;*

Without touching the wood, bring the glasses nearer each other, so that the ends of both pairs of rods will meet; and you will immediately perceive that the two separated balls will approach each other by half the distance that divides them, and that the two balls which were hanging in contact will recede from each other, to an equal distance.

3. To show that *electricity does not pass into wax, although it passes into wood;*

Touch the wood with a stick of sealing-wax; and you will perceive no change in the respective positions of the balls.

4. A proof that *it does not enter glass* is, that it is retained as long as the rods are supported on the glass.

5. But, to prove that *it enters metals and animal bodies*, touch the rods either with a key, or with the finger, and the electricity will instantly pass off into the ground, whence it was attracted by rubbing the glass, and each pair of balls will come together again.

6. To show that *the particles of the fluid mutually repel each other, and that the natural quantity of it contained in any substance whatever can be put in motion by repulsion;*

Rub the glass well, and, having separated the two pairs of rods, hold the glass over that end of one pair from which the balls are not suspended; on the approach of the glass, you will see the balls separate and recede from each other. Remove the glass, and they will come together again; which shows that the divergence of the balls was not occasioned by any electricity communicated, for none remains; but solely by the motion of the quantity naturally contained in the wood, which the repellent power of that of the rubbed glass has driven from one end of the wood to the other, so that it is accumulated at the end where the balls are suspended, the end next the glass being deprived of it in proportion. By withdrawing the glass it is made to resume its place, because the equilibrium is restored, and the balls reunite.

7. Again hold the glass over the end of one pair of rods; and, when the natural quantity of electricity is driven to the end from which the balls are suspended, and has separated them, touch this end with the finger, which will carry off the accumulated electricity, leaving in this end and the balls only their natural quantity, and the balls will consequently come together again; then withdraw at the same moment the glass and the finger, and you will see the balls again recede from each other; but they are now, as well as the wood, in a negative state; for, on removing the glass, the natural quantity of electricity, which the finger had left at the other end, returns and is diffused equally throughout the wood; and, as this wood has lost a portion of its natural quantity, which was carried off by the finger, what remains is, in reference to the whole substance, less than the natural quantity.

8. To prove that these balls are now in a negative state, present the rubbed glass to them, and it will attract them, whereas it would repel them if they were in a positive state. On the other hand, they would be repelled by a stick of sealing-wax that had been rubbed, whose electricity is negative; instead of which

this same rubbed wax would attract them, if they were in a positive state.

9. But you may obtain the most convincing proof, that they are in a negative state, in the following manner. Electrify the other pair of rods positively, as was directed above; and, when the balls of each pair have receded to the same distance from each other, which shows that there is as much positive electricity in one pair as there is negative in the other, bring the ends of the rods in contact, and you will see the balls on each pair of rods come together instantly, one pair of rods restoring to the other the quantity which it had parted with, so that both are restored to their natural state. When both pairs are electrified *plus*, or both *minus*, separately and equally, in vain would you bring them in contact; no effect whatever would be produced.

To perform these experiments well, care must be taken to keep the glasses always dry; and the best way to do this is to warm them from time to time, if the air is damp.

TO M. DUBOURG.*

On the Analogy between Magnetism and Electricity.

London, 10 March, 1773.

SIR,

As to the magnetism, which seems produced by electricity, my real opinion is, that these two powers of nature have no affinity with each other, and that the

* This letter and the three following it are translated from M. Dubourg's French edition, (Tom. I. pp. 277, 312, 332.) – EDITOR.

apparent production of magnetism is purely accidental. The matter may be explained thus.

1st. The earth is a great magnet.

2dly. There is a subtile fluid, called the magnetic fluid, which exists in all ferruginous bodies, equally attracted by all their parts, and equally diffused through their whole substance; at least where the equilibrium is not disturbed by a power superior to the attraction of the iron.

3dly. This natural quantity of the magnetic fluid, which is contained in a given piece of iron, may be put in motion so as to be more rarefied in one part and more condensed in another; but it cannot be withdrawn by any force that we are yet made acquainted with, so as to leave the whole in a negative state, at least relatively to its natural quantity; neither can it be introduced so as to put the iron into a positive state, or render it *plus*. In this respect, therefore, magnetism differs from electricity.

4thly. A piece of soft iron allows the magnetic fluid which it contains to be put in motion by a moderate force; so that, being placed in a line with the magnetic pole of the earth, it immediately acquires the properties of a magnet, its magnetic fluid being drawn or forced from one extremity to the other; and this effect continues as long as it remains in the same position, one of its extremities becoming positively magnetized, and the other negatively. This temporary magnetism ceases as soon as the iron is turned east and west, the fluid immediately diffusing itself equally through the whole iron, as in its natural state.

5thly. The magnetic fluid in hard iron, or steel, is put in motion with more difficulty, requiring a force greater than the earth to excite it; and, when once it has been forced from one extremity of the steel to the other, it is not easy for it to return; and thus a bar of steel is converted into a permanent magnet.

6thly. A great heat, by expanding the substance of this steel, and increasing the distance between its particles, affords a passage to the magnetic fluid, which is thus again restored to its proper equilibrium; the bar appearing no longer to possess magnetic virtue.

7thly. A bar of steel, which is not magnetic, being placed in the same position, relatively to the pole of the earth, which the magnetic needle assumes, and in this position being heated and suddenly cooled, becomes a permanent magnet. The reason is, that while the bar was hot, the magnetic fluid which it naturally contained was easily forced from one extremity to the other by the magnetic virtue of the earth; and that the hardness and condensation, produced by the sudden cooling of the bar, retained it in this state without permitting it to resume its original situation.

8thly. The violent vibrations of the particles of a steel bar, when forcibly struck in the same position, separate the particles in such a manner during their vibration, that they permit a portion of the magnetic fluid to pass, influenced by the natural magnetism of the earth; and it is afterwards so forcibly retained by the re-approach of the particles, when the vibration ceases, that the bar becomes a permanent magnet.

9thly. An electric shock passing through a needle in a like position, and dilating it for an instant, renders it, for the same reason, a permanent magnet; that is, not by imparting magnetism to it, but by allowing its proper magnetic fluid to put itself in motion.

10thly. Thus there is not in reality more magnetism in a given piece of steel after it is become magnetic, than existed in it before. The natural quantity is only displaced or repelled. Hence it follows, that a strong apparatus of magnets may charge millions of bars of steel, without communicating to them any part of its proper magnetism; only putting in motion the magnetism which already existed in these bars.

I am chiefly indebted to that excellent philosopher of Petersburg, Mr. Æpinus, for this hypothesis, which appears to me equally ingenious and solid. I say *chiefly*, because, as it is many years since I read his book, which I have left in America, it may happen, that I may have added to or altered it in some respect; and, if I have misrepresented any thing, the error ought to be charged to my account.

If this hypothesis appears admissible, it will serve as an answer to the greater part of your questions. I have only one remark to add, which is, that, however great the force is of magnetism employed, you can only convert a given portion of steel into a magnet of a force proportioned to its capacity of retaining its magnetic fluid in the new position in which it is placed, without letting it return. Now this power is different in different kinds of steel, but limited in all kinds whatever.

B. Franklin

FROM M. DUBOURG TO B. FRANKLIN.

On the Choice of Glass for the Leyden Experiment.

Paris, 25 March, 1773.

Sir,

If I have rightly understood your principles, the glass to be used in the Leyden experiment ought to combine these two qualities; first, it should be impermeable to the electric fluid; secondly, it should not be impermeable to the action of this fluid; or, to express the same thing in other words, the electric fluid must not be able to pass from one surface to the other, but its afflux on one of the surfaces of the glass must have the power to excite an efflux on the opposite surface.

Glass generally unites these two qualities, but not every kind of glass. There is even glass that the electric fluid passes through, almost as readily as it enters metals. This is a property natural to some kinds of glass, and accidental to others. It would seem astonishing, that no philosopher had yet thought of seeking out the causes of all these differences, if natural philosophy alone were equal to the task; but there is need of the aid of chemistry, which certainly may throw some light on so interesting a subject.

I would not propose to the chemists to analyze the different kinds of glass, permeable or impermeable to electricity; but to endeavour to imitate them, which would be much easier for them to do.

Pure vitrifiable earth is without doubt the only ingredient in rock crystal, which may be considered as a true natural glass; but art has not yet succeeded in obtaining for us a glass so pure, and there is even very little reason to hope that such perfection can ever be attained.

There is no earth known so vitrifiable as not to require some auxiliary solvent to facilitate its vitrification. Now solvents are distinguished into three principal kinds, which are, saline solvents, metallic solvents, and earthy solvents; for there are different kinds of earths, which, although each singly is refractory, yet serve as mutual solvents, as there are also many kinds of salts, and many kinds of metals, which may be used as solvents for the vitrifiable earths, and which may be combined in different proportions with the same earths. We ought not to be more surprised to find glass more or less permeable to electricity, than to find it pervious and impervious to light. Since there is transparent glass and opaque glass, or glass of various colors, why should there not be glass which is a conductor, and that which is a non-conductor, of electricity?

It would not be a problem of difficult solution for a chemist, but yet it would be a labor requiring considerable time, to furnish us with a comparative table of the different kinds of glass possessing either of these qualities in all their various degrees. The places merely, occupied by your greenish American glass, as well as by the white London glass, would indicate, at the first glance, the mixture of ingredients of which they are respectively composed.

On the other hand, as the intensity of heat to which the substance of the glass is exposed, whether in melting or annealing, may cause the evaporation of some of these ingredients, and as this heat is not equally powerful in every part of the furnace, it is not very surprising, that you should have found considerable difference between several glass globes from the same manufactory, as you inform us.

Independently of the natural properties of one kind of glass or another, arising from their particular composition, great differences may also result from the different thickness of their masses, were it from this consideration alone, that the heat could not be precisely the same, nor the rapidity of cooling very nearly equal, in the different layers of very thick glass; without taking into the account, that it seems almost impossible, that the action of the electric fluid in motion should be effectually conveyed from one surface to another of a very massive body.

Lastly; it is equally easy to conceive, that a considerable degree of heat, by rarefying the substance of thin glass, should open its pores to the electric fluid; but that the degree of heat must be in proportion to the thickness of the glass; and that Mr. Kinnersley found a heat of only two hundred and ten degrees (the point at which water boils, according to Fahrenheit's thermometer,) necessary to render the very thin glass of a Florence flask permeable to the electric shock, while Mr. Cavendish required a heat of four hundred degrees to make glass a little thicker permeable to the common stream.

My reason for wishing that some chemist would have the goodness to enlighten us upon all these points is, that too much pains cannot be taken to spare the lovers of natural philosophy any unnecessary expense; because this may turn some entirely aside from its pursuit, and somewhat damp the zeal of many others.

I am, &c.

TO MESSRS. DUBOURG AND DALIBARD.*

Concerning the Mode of rendering Meat tender by Electricity.

My dear Friends,

My answer to your questions, concerning the mode of rendering meat tender by electricity, can only be founded upon conjecture; for I have not experiments enough to warrant the facts. All that I can say at present is, that I think electricity might be employed for this purpose, and I shall state what follows as the observations or reasons which make me presume so

* This letter has no date, but the one to which it is an answer is dated May 1st, 1773.

It has been observed, that lightning, by rarefying and reducing into vapor the moisture contained in solid wood, in an oak, for instance, has forcibly separated its fibres, and broken it into small splinters; that, by penetrating intimately the hardest metals, as iron, it has separated the parts in an instant, so as to convert a perfect solid into a state of fluidity; it is not then improbable, that the same subtile matter, passing through the bodies of animals with rapidity, should possess sufficient force to produce an effect nearly similar.

The flesh of animals, fresh killed in the usual manner, is firm, hard, and not in a very eatable state, because the particles adhere too forcibly to each other. At a certain period, the cohesion is weakened, and, in its progress towards putrefaction, which tends to produce a total separation, the flesh becomes what we call tender, or is in that state most proper to be used as our food.

It has frequently been remarked, that animals killed by lightning putrefy immediately. This cannot be invariably the case, since a quantity of lightning, sufficient to kill, may not be sufficient to tear and divide the fibres and particles of flesh, and reduce them to that tender state, which is the prelude to putrefaction. Hence it is, that some animals killed in this manner will keep longer than others. But the putrefaction sometimes proceeds with surprising celerity. A respectable person assured me, that he once knew a remarkable instance of this. A whole flock of sheep in Scotland, being closely assembled under a tree, were killed by a flash of lightning; and, it being rather late in the evening, the proprietor, desirous of saving something, sent persons early the next morning to flay them; but the putrefaction was such, and the stench so abominable, that they had not the courage to execute their orders, and the bodies were accordingly buried in their skins. It is not unreasonable to presume, that, between the period of their death and that of their putrefaction, a time intervened in which the flesh might be only tender, and only sufficiently so to be served at table. Add to this, that persons, who have eaten of fowls killed by our feeble imitation of lightning (electricity), and dressed immediately, have asserted, that the flesh was remarkably tender.

The little utility of this practice has perhaps prevented its being much adopted. For, though it sometimes happens, that a company unexpectedly arriving at a country-house, or an unusual conflux of travellers to an inn, may render it necessary to kill a number of animals for immediate use; yet, as travellers have commonly a good appetite, little attention has been paid to the trifling inconvenience of having their meat a little tough. As this kind of death is nevertheless more sudden, and consequently less severe, than any other, if this should operate as a motive with compassionate persons to employ it for animals sacrificed for their use, they may conduct the process thus.

Having prepared a battery of six large glass jars (each from twenty to twenty-four pints) as for the Leyden experiment, and having established a communication, as usual, from the interior surface of each with the prime conductor, and having given them a full charge (which, with a good machine, may be executed in a few minutes, and may be estimated by an electrometer), a chain which communicates with the exterior of the jars must be wrapped round the thighs of the fowl; after which the operator, holding it by the wings, turned back and made to touch behind, must raise it so high that the head may receive the first shock from the prime conductor. The animal dies instantly. Let the head be immediately cut off to make it bleed, when it may be plucked and dressed immediately. This quantity of electricity is supposed sufficient for a turkey of ten pounds weight, and perhaps for a lamb. Experience alone will inform us of the requisite proportions for animals of different forms and ages. Probably not less will be required to render a small bird, which is very old, tender, than for a larger one, which is young. It is easy to furnish the requisite quantity of electricity, by employing a greater or less number of jars. As six jars, however, discharged at once, are capable of giving a very violent shock, the operator must be very circumspect, lest he should happen to make the experiment on his own flesh, instead of that of the fowl.

B. FRANKLIN.

TO M. DUBOURG.

In Answer to some Queries concerning the Choice of Glass for the Leyden Experiment.

London, 1 June, 1773.

SIR,

I wish, with you, that some chemist (who should, if possible, be at the same time an electrician) would, in pursuance of the excellent hints contained in your letter, undertake to work upon glass with the view you have recommended. By means of a perfect knowledge of this substance, with respect to its electrical qualities, we might proceed with more certainty, as well in making our own experiments, as in repeating those which have been made by others in different countries, which, I believe, have frequently been attended with different success on account of differences in the glass employed, thence occasioning frequent misunderstandings and contrariety of opinions.

There is another circumstance much to be desired with respect to glass, and that is, that it should not be subject to break when highly charged in the Leyden experiment. I have known eight jars broken out of twenty, and, at another time, twelve out of thirty-five. A similar loss would greatly discourage electricians desirous of accumulating a great power for certain experiments. We have never been able hitherto to account for the cause of such misfortunes. The first idea which occurs is, that the positive electricity, being accumulated on one side of the glass, rushes violently through it, in order to supply the deficiency on the other side and to restore the equilibrium. This, however, I cannot conceive to be the true reason, when I consider, that, a great number of jars being united, so as to be charged and discharged at the same time, the breaking of a single jar will discharge the whole; for, if the accident proceeded from the weakness of the glass, it is not probable, that eight of them should be precisely of the same degree of weakness, as to break every one at the same instant, it being more likely, that the weakest should break first, and, by breaking, secure the rest; and again, when it is necessary to produce a certain effect, by means of the whole charge passing through a determined circle, (as, for instance, to melt a small wire,) if the charge, instead of passing in this circle, rushed through the sides of the jars, the intended effect would not be produced; which, however is contrary to fact. For these reasons, I suspect, that there is, in the substance of the glass, either some little globules of air, or some portions of unvitrified sand or salt, into which a quantity of the electric fluid may be forced during the charge, and there retained till the general discharge; and that the force being suddenly withdrawn, the elasticity of the fluid acts upon the glass in which it is enclosed, not being able to escape hastily without breaking the glass. I offer this only as a conjecture, which I leave to others to examine.

The globe which I had that could not be excited, though it was from the same glass-house which furnished the other excellent globes in my possession, was not of the same frit. The glass which was usually manufactured there, was rather of the green kind, and chiefly intended for drinking-glasses and bottles; but, the proprietors being desirous of attempting a trial of white glass, the globe in question was of this frit. The glass not being of a perfect white, the proprietors were dissatisfied with it, and abandoned their project. I suspected, that too great a quantity of salt was admitted into the composition; but I am no judge of these matters.

B. Franklin.

TO JOHN WINTHROP.

On Conductors of Lightning.

London, 25 July, 1773.

Your remark on the passage of Castillioneus will be read at the Society at their next meeting. I thank you much for the papers and accounts of damage done by lightning, which you have favored me with. The conductors begin to be used here. Many country-seats are provided with them, some churches, the powder magazines at Purfleet, the Queen's house in the Park,

&c.; and M. Le Roy, of the Academy of Sciences at Paris, has lately given a Memoir recommending the use of them in that kingdom, which has been long opposed and obstructed by Abbé Nollet. Of the Duke of Tuscany he says, "Ce prince, qui ne connoît pas de délassement plus agréable des soins pénibles du gouvernement, que l'étude de la physique, a ordonné, l'année dernière, qu'on établît de ces barres au-dessus de tous les magasins à poudre de ses Etats; on dit que la république de Venise a donné les mêmes ordres."

B. Franklin.

QUERIES ON ELECTRICITY, FROM DR. INGENHOUSZ;* WITH ANSWERS BY DR. FRANKLIN.

QUESTION I.

If the electrical fluid is truly accumulated on the inside of a Leyden phial, and expelled in the same proportion from the other side, why are the particles of glass not all thrown outwards, when the phial being overcharged breaks, or is perforated by a spontaneous explosion?

ANSWER.

By the circumstances that have appeared to me, in all the jars that I have seen perforated at the time of their explosion, I have imagined that the charge did not pass by those perforations. Several single jars, that

* An eminent physician and chemist, born at Breda in 1730. He passed a large part of his life in England, where he died, September 7th, 1799. — Editor.

have broke while I was charging them, have shown, besides the perforation in the body, a trace on both sides of the neck, where the polish of the glass was taken off the breadth of a straw; which proved that great part at least of the charge, probably all, had passed over that trace. I was once present at the discharge of a battery containing thirty jars, of which eight were perforated and spoilt at the time of the discharge; yet the effect of the charge on the bodies upon which it was intended to operate, did not appear to be diminished. Another time I was present when twelve out of twenty jars were broken at the time of the discharge; yet the effect of the charge, which passed in the regular circuit, was the same as it would have been if they had remained whole. Were those perforations an effect of the charge within the jar forcing itself through the glass to get at the outside, other difficulties would arise and demand explanation. 1. How it happens, that in eight bottles, and in twelve, the strength to bear a strong charge should be so equal, that no one of them would break before the rest, and thereby save his fellows; but all should burst at the same instant. 2. How it happens, that they bear the force of the great charge till the instant that an easier means of discharge is offered them, which they make use of, and yet the fluid breaks through at the same time.

My conjecture is, that there has been, in the place where the rupture happens, some defect in the glass, some grain of sand perhaps, or some little bubble in the substance nearly void, where, during the charging of the jar, the electric fluid is forced in and confined till the pressure is suddenly taken off by the discharge, when, not being able to escape so quickly, it bursts its way out by its elastic force. Hence all the ruptures happen nearly at the same instant with the regular discharge, though really a little posterior, not being themselves discharges, but the effects of a discharge which passed in another channel.

QUESTION II.

When a strong explosion is directed through a pack of cards or a book, having a piece of tinfoil between several of its leaves, the electrical flash makes an impression in some of those metallic leaves, by which it seems as if the direction of the electric explosion had gone from the outside towards the inside, when, on the other metallic leaves, the impression is in such a direction, that it indicates the current of electrical fire to have made its way from the inside of the phial towards the outside; so that it appears to some electricians, that, in the time of the explosion of an electrical phial, two streams of electrical fire rush at the same time from both surfaces, and meet or cross one another.

ANSWER.

These impressions are not effects of a moving body, striking with force in the direction of its motion; they are made by the burs rising in the neighbouring perforated cards, which rise accidentally, sometimes on one side of a card, and sometimes on the other, in consequence of certain circumstances in the form of their substances or situations. In a single card, supported without touching others, while perforated by the passing fluid, the bur generally rises on both sides, as I once showed to Mr. Symmer at his house. I imagine that the hole is made by a fine thread of electric fluid first passing, and augmented to a bigger thread at the time of the explosion, which, obliging the parts of a card to recede every way, condenses a part within the substance, and forces a part out on each side, because there is least resistance.

QUESTION III.

When a flash of lightning happens to hit a flat piece of metal, the metal has sometimes been pierced with several holes, whose edges were turned some the one way and some the other; so that it has appeared to some philosophers, that several streams of electrical fire had rushed in one way, and some the opposite way. Such an effect of lightning has been published lately by Father Barletti.

ANSWER.

This will be answered in my remarks on Mr. Barletti's book; which remarks, when finished, I will send you.

QUESTION IV.

Though, from the very charging of the Leyden phial, it seems clear, that the electrical fluid does in reality not pervade the substance of glass, yet it is still difficult to conceive how such a subtile fluid may be forced out from one side of a very thick pane of glass, by a similar quantity of electrical fire thrown upon the other surface, and yet that it does not pass through any substance of glass, however thin, without breaking it. Is there some other fact or illustration besides those to be found in your public writings, by which it may be made more obvious to our understanding, that electrical fire does not enter at all the very substance of glass, and yet may force from the opposite surface an equal quantity; or that it really enters the pores of the glass without breaking it? Is there any comparative illustration or example in nature, by which it may be made clear, that a fluid thrown upon one surface of any body, may force out the same fluid from the other surface without passing through the substance?

ANSWER.

That the electric fluid, by its repulsive nature, is capable of forcing portions of the same fluid out of bodies without entering them itself, appears from this experiment. Approach an isolated body with a rubbed tube of glass; the side next the tube will then be electrized negatively, the opposite positively. If a pair of cork balls hang from that opposite side, the electrical fluid forced out of the body will appear in those balls, causing them to diverge. Touch that opposite side, and you thereby take away the positive electricity. Then remove the tube, and you leave the body all in a negative state. Hence it appears, that the electric fluid appertaining to the glass tube did not enter the body, but retired with the tube, otherwise it would have supplied the body with the electricity it had lost.

With regard to *powder magazines*, my idea is, that to prevent the mischief which might be occasioned by the stones of their walls flying about in case of accidental explosion, they should be constructed in the ground; that the walls should be lined with lead, the floor lead, all a quarter of an inch thick, and the joints well soldered; the cover copper, with a little scuttle to enter the whole, in the form of a canister for tea. If the edges of the cover-scuttle fall into a copper channel containing mercury, not the smallest particle of air or moisture can enter to the powder, even though the walls stood in water, or the whole was under water.

TO JOHN INGENHOUSZ.

An Attempt to explain the Effects of Lightning on the Vane of the Steeple of a Church in Cremona, August, 1777.

1. When the subtile fluid, which we call fire or heat, enters a solid body, it separates the particles of which that body consists farther from each other, and thus dilates the body, increasing its dimensions.

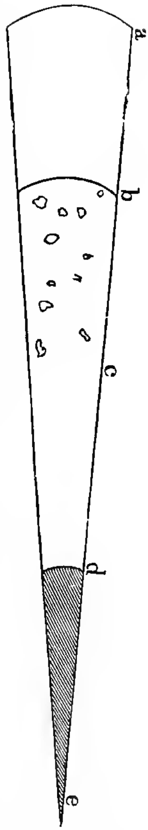
2. A greater proportion of fire introduced separates the parts so far from each other, that the solid body becomes a fluid, being melted.

3. A still greater quantity of heat separates the parts so far, that they lose their mutual attraction, and acquire a mutual repulsion, whence they fly from each other, either gradually or suddenly, with great force, as the separating power is introduced gradually or suddenly.

4. Thus ice becomes water, and water vapor, which vapor is said to expand fourteen thousand times the space it occupied in the form of water, and with an explosive force in certain cases capable of producing great and violent effects.

5. Thus metals expand, melt, and explode; the two first effected by the gradual application of the separating power, and all three, in its sudden application, by artificial electricity or lightning.

6. That fluid in passing through a metal rod or wire is generally supposed to occupy the whole dimension of the rod. If the rod is smaller in some places than in others, the quantity of fluid, which is not sufficient to make any change in the larger or thicker part, may be sufficient to expand, melt, or explode the smaller, the quantity of fluid passing being the same, and the quantity of matter less that is acted upon.



7. Thus the links of a brass chain, with a certain quantity of electricity passing through them, have been melted in the small parts that form their contact, while the rest have not been affected.

8. Thus a piece of tinfoil cut in this form, enclosed in a pack of cards, and having the charge of a large bottle sent through it, has been found unchanged in the broadest part, between *a* and *b*, melted only in spots between *c* and *d*, and the part between *d* and *e* reduced to smoke by explosion.

9. The tinfoil melted in spots between *b* and *c*, and that whole space not being melted, seems to indicate that the foil in the melted parts had been thinner than the rest, on which thin parts the passing fluid had therefore a greater effect.

10. Some metals melt more easily than others; tin more easily than copper, copper than iron. It is supposed (perhaps not yet proved), that those which melt with the least of the separating power, whether that be common fire or the electric fluid, do also explode with less of that power.

11. The explosions of metal, like those of gunpowder, act in all directions. Thus the explosion of gold leaf between plates of glass, breaking the glass to pieces, will throw those pieces into all parts of the room; and the explosion of iron, or even of water, between the joints of stone in a steeple, will scatter the stones in all directions round the neighbourhood. But the direction, given to those stones by the explosion, is to be considered as different from the direction of the light-

ning, which happened to occasion those explosions of the matter it met with in its passage between the clouds and the earth.

12. When bodies positively electrized approach sharp pointed rods or thin plates of metal, these are more easily rendered negative by the repulsive force of the electric fluid in those positively electrized bodies, which chases away the natural quantity contained in those *mince* rods or plates, though it would not have force enough to chase the same out of larger masses. Hence such points, rods, and plates, being in a negative state, draw to themselves more strongly and in greater quantities the electric fluid offered them, than such masses can do which remain nearly in their natural state. And thus a pointed rod receives not only at its point, though more visibly there, but at all parts of its length that are exposed. Hence a needle held between the finger and thumb, and presented to a charged prime conductor, will draw off the charge more expeditiously if held near the eye, and the rest of its length is exposed to the electrical atmosphere, than if all but half an inch of the point is concealed and covered.

13. Lightning so differs from solid projectiles, and from common fluids projected with violence, that, though its course is rapid, it is most easily turned to follow the direction of good conductors. And it is doubted whether any experiments in electricity have yet decisively proved, that the electric fluid in its violent passage through the air where a battery is discharged has what we call a momentum, which would make it continue its course in a right line, though a conductor offered near that course to give it a different or even contrary direction; or that it has a force capable of pushing forward or overthrowing the objects it strikes against, even though it sometimes pierces them. Does not this

seem to indicate, that the perforation is not made by the force of a projectile passing through, but rather by the explosion or the dilatation, in passing, of a subtile line of fluid?

14. Such an explosion or dilatation of a line of fluid, passing through a card, would raise burs round the hole, sometimes on one side, sometimes on the other, and sometimes on both, according to the disposition of the part of the paper near the surface, without any regard to the direction of the fluid.

15. Great thanks are due to the ingenious philosopher, who examined the vane at Cremona, and who took the pains to describe so exactly the effects of the lightning upon it, and to communicate that description. The fact is extremely curious. It is well worth considering. He invites to that consideration. He has fairly given his own opinion. He will with candor receive that of others, though it may happen to differ from his own. By calmly discussing rather than by warmly disputing, the truth is most easily obtained. I shall give my opinion freely, as it is asked, hoping it may prove the true one; and promising myself, if otherwise, the honor at least of acknowledging frankly my error, and of being thankful to him who kindly shows it to me.

16. By the account given of this stroke of lightning upon the steeple of Cremona, it appears that the rod of iron or spindle, on which the vane turned, was of about two inches circumference, terminating in a cross above the vane, and its lower end fixed in a marble pedestal.

17. That the plate of the vane was copper, eight or nine inches wide, and near twice as long. That it was about one line thick near the spindle, and growing thinner insensibly towards the other end, where its thickness did not exceed three quarters of a line, the weight twenty ounces and a half.

18. That the copper had been tinned over.

19. That the marble pedestal was split by the stroke into many pieces, and scattered over the roof, garden, and court of a neighbouring building. One piece was thrown to the distance of forty feet. The spindle was broken and displaced, and the vane thrown on the roof of the parsonage house, twenty feet from the steeple.

20. That the vane was perforated in eighteen places, the holes of irregular forms, and the metal which had filled them pushed outwards, in some of them on one side of the vane, in others on the other. The copper showed marks of having been partly melted, and in some places tin and copper melted and mixed together. There were marks of smoke in several places.

21. The ragged parts bent outwards round each hole, being brought back to their original flat position, were not, though evidently a little thinned and dilated, sufficient to fill the place.

22. From the effects described (19), it is clear that the quantity of lightning which fell on this steeple at Cremona was very great.

23. The vane being a thin plate of copper, its edges and corners may be considered as a series of points and, being therefore sooner rendered negative by the repulsive force of an approaching positive cloud than the blunt and thick iron cross (12), was probably first struck, and thence became the conductor of that great quantity.

24. The plate of which the vane was formed, being thicker near the spindle, and diminishing in thickness gradually to the other end (17), was probably not of copper plated by passing between rollers, for they would have left it of equal thickness; but of metal plated by the hammer. The surface too of rolled copper is even and plain; that of hammered is generally

uneven, with hollows occasioned by the impressions of the hammer.

25. In those concave impressions the metal is thinner than it is around them, and probably thinnest near the centre of each impression.

26. The lightning, which in passing through the vane was not sufficient to melt its thicker parts, might be sufficient to melt the thinner (6, 7, 8, 9), and to soften those that were in the middle state.

27. The part of the tin (18), which covered the thinner parts, being more easily melted and exploded than copper (10), might possibly be exploded when the copper was but melted. The smoke appearing in several places (20) is a proof of explosion.

28. There might probably be more tin in the concave impressions of the hammer on one side of the plate, than on the convex part of those impressions on the other. Hence stronger explosions on the concave side.

29. The nature of those explosions is to act violently in all directions; and in this case, being near the plate, they would act against it on one side, while they acted against the air on the other.

30. These thin parts of the plate being at the same instant partly in fusion, and partly so softened as to be near it, the softened parts were pushed outwards, a hole made, and some of the melted parts blown away; hence there was not left metal enough to re-fill the vacancy by bending back the ragged parts to their places.

31. The concave impressions of the hammer, being indifferently made on both sides of the plate, it is natural, from 28, 29, 30, that the pushing outwards of the softened metal by explosions, should be on both sides of the plate nearly equal.

32. That the force of a simple electrical explosion

is very great, appears from the Geneva experiment, wherein a spark between two wires, under oil in a drinking-glass, breaks the glass, body, stem, and foot, all to shivers.

33. The electric explosion of metal acts with still more force. A strip of leaf-gold no broader than a straw, exploded between two pieces of thick looking-glass, will break the glass to pieces, though confined by the screws of a strong press; and, between two pieces of marble pressed together by a weight of twenty pounds, will lift that weight. Much less force is necessary to move the melted and softened parts of a thin plate of copper.

34. This explication of the appearances on the vane is drawn from what we already know of electricity and the effects of lightning. The learned author of the account gives a different but very ingenious one, which he draws from the appearances themselves. The matter pushed out of the holes is found, that of some on one side of the plate, and of others on the other. Hence he supposes them to be occasioned (if I understand him right) by streams or threads of electric matter of different and contrary kinds, rushing violently towards each other, and meeting with the vane, so accidentally placed, as to be found precisely in the place of their meeting, where it was pierced by all of them, they all striking on both its sides at the same instant. This however is so extraordinary an accident, as to be in the author's own opinion almost miraculous; "Passeranno" (says he) "forse più secoli prima che ritorni traile infinite combinazioni un caso simile a quello della banderuola che ora abbiamo per mano. Forza è che si esaurisca una non più udita miniera di fulmini sopra una grande città, pressoche seminata di campanili e di banderuole, il che è rarissimo; e può ancora [cento?]

volte ciò succedere, senza che s' incontri giammai un altera banderuola tanto opportunamente situata tra i limiti della fulminea explosione."

35. But, though the author's explication of these appearances of the vane does not satisfy me, I am not so confident of my own as to propose its being accepted without confirmation by experiment. Those who have strong electric batteries may try it thus; form a little vane of paper, and spot it on both sides by attaching small pieces of leaf-gold or tinfoil, not exactly opposite to each other; then send the whole force of the battery through the vane, entering at one end of it and going out at the other. If the metal explodes, I imagine it will be found to make holes in the paper, forcing the torn parts out on the sides opposite to the metal. A more expensive but perhaps a more satisfactory experiment would be, to make a new vane as exactly as possible like that in question, in all the particulars of its description, and place it on a tall mast fixed on some hill subject to strokes of lightning, with a better conductor to the earth than the wood of the mast; if this should be struck in the course of a few years, and the same effects appear upon it, it would be still more miraculous to suppose it happened by accident to be exactly situated where those crossing threads of different electricities were afterwards to meet.

36. The perforation of glass bottles when overcharged is, I imagine, a different case, and not explicable by either of these hypotheses. I cannot well suppose the breach to be occasioned by the passage of electricity through it; since a single bottle, though so broken in the discharge, always is found to send round in its usual course the quantity with which it was charged. Then the breach never happens but at the instant of the circuitous discharge, either by the dis-

charging rod, or in overleaping the borders of the glass. Thus, I have been present when a battery of twenty glasses was discharged by the discharging rod, and produced the same effect in its circuit as if none of the bottles had been pierced; and yet, on examining them, we found no less than twelve of them in that situation. Now, all the bottles of the battery being united by a communication of all the outsides together, and of all the insides together, if one of them had been pierced by a forced passage of the different kinds of electricity to meet each other, before the discharge by the discharging rod, it would not only have prevented the passage of the electricity by the common circuit, but it would have saved all the rest of its fellows, by conducting the whole through its own breach. And it is not easy to conceive that twelve bottles in twenty should be so equally strong as to support the whole strength of their charge, till the circuit of their discharge was opened, and then be so equally weak as to break all together when the weight of that charge was taken off from them by opening the circuits. At some other time I will give you my opinion of this effect, if you desire it.

I have taken the account of this stroke of lightning from an Italian piece, entitled *Analisi d' un nuovo Fenomeno del Fulmine*, the dedication of which is subscribed *Carlo Barletti, delle Scuole Pie*, who I suppose is the author. As I do not perfectly understand that language, I may possibly in some things have mistaken that philosopher's meaning. I therefore desire, my dear friend, that you would not permit this to be published, till you have compared and considered it with that original piece, and communicated to me your remarks and corrections. Nor would I in any case have it appear with my name, as perhaps it may occasion disputes, and I have no time to attend to them.

*The Leyden Phial, and M. Volta's Experiment.**

Paris, 1778.

I THANK you for the account you give me of M. Volta's experiment. You judge rightly in supposing, that I have not much time at present to consider philosophical matters; but, as far as I understand it from your description, it is only another form of the Leyden phial, and explicable by the same principles. I must, however, own myself puzzled by one part of your account, viz. "and thus the electric force once excited may be kept alive years together," which is perhaps only a mistake. I have known it indeed to be continued many months in a phial hermetically sealed, and suppose it may be so preserved for ages; but, though one may, by repeatedly touching the knob of a charged bottle with a small insulated plate, like the upper one of the electrophore, draw an incredible number of sparks successively, that is, one after every touch, and those for a while not apparently different in magnitude, yet at length they will become small, and the charge be finally exhausted. But I am in the wrong to give my opinion till I have seen the experiment.

I like much your pasteboard machine, and think it may, in some respects, be preferable to the very large glass ones constructed here. The Duc de Chaulnes has one, said, if I remember right, to be five feet in diameter. I saw it tried, but it happened not to be in order.

B. F.

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* It is not known to whom this letter was addressed. — EDITOR.

TO JOHN INGENHOUSZ.

On an Electrical Experiment.

Passy, 16 May, 1783.

I am glad you have made the experiments you mention, and with success. You will find that the holes are not made by the impulse of the fluid moving in certain directions, but by circumstances of explosion of parts of the matter; and I still think my explanation of the holes in the vane probable, viz. that it was the explosion of tin against parts of the copper plate that were almost in a state of fusion, and therefore easily burst through either on one side or the other, as it happened.* The bursting of the twelve bottles all at once, I take to be owing to small bubbles in the substance of the glass, or grains of sand, into which a quantity of the electric fluid had been forced and compressed while the bottles were charging; and when the pressure was suddenly taken off by discharging the bottles, that confined portion by its elastic force expanding caused the breach. My reasons for thinking, that the charge did not pass by those holes you will find in a former letter;† and I think you will always find, that the coating within and without is forced both ways by the explosion of these bubbles.

B. Franklin.

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* See page 472.

† See page 463.

*On the Shock by the Electric Bottle, and the Density of Glass.**

Passy, 14 June, 1783.

SIR,

I received some time since the letter you honored me with, containing your hypothesis for explaining the shock given by the electric bottle, on which you seem to desire my opinion. It is many years since I was engaged in those pleasing studies, and my mind is at present too much occupied with other and more important affairs to permit my returning to them. I cannot therefore examine your ingenious hypothesis with the attention it appears to merit. You will find in a letter of mine to Dr. Lining, dated March 18th, 1755, that I abandoned my hypothesis of the greater density of glass in the middle than near its surfaces, as contributing to produce the effect, because I found the effect to be the same after I had ground that part away.

And I think you might likewise try yours by an easy experiment. Take a plate of lead twelve inches square; cover one of its sides with a coat of bees' wax, about one line thick; upon that apply closely a thin plate of lead eight inches square, so as to leave a margin of two inches all round. Electrify this composition of lead and wax, and try if you can receive a shock from it; if not, you may draw thence a further argument to support your hypothesis, because the wax, though a non-conductor, is not elastic, any more than pure lead. I see you are endowed with a genius for the study of nature; and I would recommend it to you to employ your time rather in making experiments, than

* It is not known to whom this letter was written. — EDITOR.

in making hypotheses and forming imaginary systems, which we are all too apt to please ourselves with, till some experiment comes and unluckily destroys them. Wishing you success in your inquiries, I have the honor to be, Sir, &c.

B. Franklin.

TO EDWARD NAIRNE.

On his patent Electrical Machine, and the Effects of Lightning on the Eyes of Animals killed by it.

Passy, 18 October, 1783.

Dear Sir,

I received your favor of August 14th, by Mr. Sykes, with the book of directions for using your patent electric machine. The machine itself is also come to hand in good order, after some delay on the road; and I think it very ingeniously contrived indeed; I wish your success in the sale may be equal to its merits. The experiments in your pamphlet gave me pleasure, and I shall be glad to see the account you mention of the shortening of wires by lightning.

What you have heard of the eyes of sheep forced out by a stroke of lightning which killed them, puts me in mind of having formerly seen at Philadelphia six horses all killed by lightning in a stable, every one of whom appeared to have bled at the eyes, nose, and mouth; though I do not recollect that any of their eyes were out.

You are so good as to consider how much my time has been taken up, and to excuse on that account my being a bad correspondent. Near three years ago I began a letter to you on the subject of hygrometers.

I had written three folio pages of it, when I was interrupted by some business; and, before I had time to finish it, I had mislaid it. I have now found it, and, having added what I suppose I had intended to add, I enclose it. You can judge better than myself, whether my idea of such an instrument is practicable and may be useful.*

If you favor me with another line, let me know how Mrs. Nairne does, and your amiable children. With great esteem, &c.

B. Franklin.

TO JOHN INGENHOUSZ.

Effect of an Electrical Shock.

Passy, 29 April, 1785.

My dear Friend,

I believe my last letter to you was of May 16th, 1783. I am therefore much in your debt as a correspondent. I have now before me all your letters since received, and shall endeavour as well as I can to answer them. I confess that a man, who can leave so many letters so long unanswered, does not deserve so valuable a correspondence as yours. But I am grown very old, being now in my eightieth year; I am engaged in much business that must not be neglected. Writing becomes more and more irksome to me; I grow more indolent; philosophic discussions, not being urgent like business, are postponed from time to time till they are forgotten. Besides, I have been these twenty months

* The letter here mentioned is dated November 13th, 1780. It will be found among the Philosophical Papers, under that date. — Editor.

past afflicted with the stone, which is always giving me more or less uneasiness, unless when I am laid in bed; and, when I would write, it interrupts my train of thinking, so that I lay down my pen, and seek some light amusement.

I consent to your request concerning my paper on the weathercock struck by lightning. Dispose of it as you please.

You will find an account of the first great stroke I received, in pages 160, 161, of my book, fifth edition, 1774.* The second I will now give you. I had a paralytic patient in my chamber, whose friends brought him to receive some electric shocks. I made them join hands so as to receive the shock at the same time, and I charged two large jars to give it. By the number of those people, I was obliged to quit my usual standing, and placed myself inadvertently under an iron hook which hung from the ceiling down to within two inches of my head, and communicated by a wire with the outside of the jars. I attempted to discharge them, and in fact did so; but I did not perceive it, though the charge went through me, and not through the persons I intended it for. I neither saw the flash, heard the report, nor felt the stroke. When my senses returned, I found myself on the floor. I got up, not knowing how that had happened. I then again attempted to discharge the jars; but one of the company told me they were already discharged, which I could not at first believe, but on trial found it true. They told me they

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* The passage here alluded to is a part of Mr. Watson's "Account" of Franklin's "Experiments and Observations on Electricity." See Appendix, No. I., pp. 491, 492.

The incident mentioned is the same as that described in a letter to a gentleman in Boston, dated December 25th, 1750, and printed for the first time in the present edition. See above, p. 255. — EDITOR.

had not felt it, but they saw I was knocked down by it, which had greatly surprised them. On recollecting myself, and examining my situation, I found the case clear. A small swelling rose on the top of my head, which continued sore for some days; but I do not remember any other effect, good or bad.

The stroke you received, and its consequences, are much more curious. I communicated that part of your letter to an operator, encouraged by government here to electrify epileptic and other poor patients, and advised his trying the practice on mad people according to your opinion. I have not heard whether he has done it.

B. FRANKLIN.

TO PROFESSOR LANDRIANI, OF ITALY.

On the Utility of Electrical Conductors.

Philadelphia, 14 October, 1787.

I have received the excellent work, *Upon the Utility of Electrical Conductors*, which you had the goodness to send me. I read it with great pleasure, and beg you to accept my sincere thanks for it.

Upon my return to this country, I found the number of conductors much increased, many proofs of their efficacy in preserving buildings from lightning having demonstrated their utility. Among other instances, my own house was one day attacked by lightning, which occasioned the neighbours to run in to give assistance, in case of its being on fire. But no damage was done, and my family was only found a good deal frightened with the violence of the explosion.

Last year, my house being enlarged, the conductor was obliged to be taken down. I found, upon examination, that the pointed termination of copper, which was originally nine inches long, and about one third of an inch in diameter in its thickest part, had been almost entirely melted; and that its connexion with the rod of iron below was very slight. Thus, in the course of time, this invention has proved of use to the author of it, and has added this personal advantage to the pleasure he before received from having been useful to others.

Mr. Rittenhouse, our astronomer, has informed me, that, having observed with his excellent telescope many conductors that are within the field of his view, he has remarked in various instances, that the points were melted in like manner. There is no example of a house, provided with a perfect conductor, which has suffered any considerable damage; and even those which are without them have suffered little, since conductors have become common in this city.

B. FRANKLIN.

APPENDIX

TO THE

LETTERS AND PAPERS ON ELECTRICITY

APPENDIX

TO THE PAPERS ON ELECTRICITY.

No. I.

WATSON'S ABSTRACT OF FRANKLIN'S ELECTRICAL EXPERIMENTS AND OBSERVATIONS.

An Account of Mr. Benjamin Franklin's Treatise, lately published, entitled "Experiments and Observations on Electricity, made at Philadelphia in America;" by William Watson, F. R. S.

READ AT THE ROYAL SOCIETY, JUNE 6TH, 1751.

Mr. Franklin's Treatise, lately presented to the Royal Society, consists of four letters to his correspondent in England, and of another part, entitled "Opinions and Conjectures concerning the Properties and Effects of the Electrical Matter, arising from Experiments and Observations."

The four letters, the last of which contains a new hypothesis for explaining the several phenomena of thunder-gusts, have, either in the whole or in part, been before communicated to the Royal Society. It remains, therefore, that I now only lay before the Society an account of the latter part of this treatise, as well as that of a letter intended to be added thereto by the author, but which arrived too late for publication with it, and was therefore communicated to the Society by our worthy brother, Mr. Peter Collinson.

This ingenious author, from a great variety of curious and well-adapted experiments, is of opinion, that the electrical matter consists of particles extremely subtile; since it can permeate common matter, even the densest metals, with such ease and freedom, as not to receive any perceptible resistance; and that, if any one should doubt, whether the electrical matter passes through the substance of bodies, or only over and along their surfaces, a shock from an electrified large glass jar, taken through his own body, will probably convince him.

Electrical matter, according to our author, differs from common matter in this, that the parts of the latter mutually attract, and those of the former mutually repel, each other; hence the divergency in a stream of electrified effluvia.* But that, though the particles of electrical matter do repel each other, they are strongly attracted by all other matter.

From these three things, viz. the extreme subtilty of the electrical matter, the mutual repulsion of its parts, and the strong attraction between them and other matter, arises this effect, that when a quantity of electrical matter is applied to a mass of common matter of any bigness or length within our observation (which has not already got its quantity), it is immediately and equally diffused through the whole.

Thus common matter is a kind of sponge to the electrical fluid; and, as a sponge would receive no water, if the parts of water were not smaller than the pores of the sponge; and even then but slowly, if there was not a mutual attraction between those parts and the parts of the sponge; and would still imbibe it faster, if the mutual attraction among the parts of the water did not impede, some force being required to separate them; and fastest, if, instead of attraction, there were a mutual repulsion among those parts, which would act in conjunction with the attraction of the sponge; so is the case between the electrical and common matter. In common matter, indeed, there is generally as much of the electrical as it will contain within its substance; if more is added, it lies without upon the surface,† and forms what we call an electrical atmosphere, and then the body is said to be electrified.

It is supposed, that all kinds of common matter do not attract and retain the electrical with equal force, for reasons to be given hereafter; and that those called electrics *per se*, as glass, &c., attract and retain it the strongest, and contain the greatest quantity

We know that the electrical fluid is in common matter, because we can pump it out by the globe or tube; and that common matter has near as much as it can contain, because, when we add a little more to any portion of it, the additional quantity does not enter, but forms an electrical atmosphere; and we know, that

* As the electric stream is observed to diverge very little, when the experiment is made *in vacuo*, this appearance is more owing to the resistance of the atmosphere, than to any natural tendency in the electricity itself. — W. W.

† The author of this account is of opinion, that what is here added, lies not only without upon the surface, but penetrates with the same degree of density the whole mass of common matter upon which it is directed.

common matter has not (generally) more than it can contain; otherwise all loose portions of it would repel each other, as they constantly do when they have electric atmospheres.

The form of the electrical atmosphere is that of the body which it surrounds. This shape may be rendered visible in a still air, by raising a smoke from dry resin dropped into a hot teaspoon under the electrified body, which will be attracted and spread itself equally on all sides, covering and concealing the body. And this form it takes, because it is attracted by all parts of the surface of the body, though it cannot enter the substance already replete. Without this attraction it would not remain round the body, but be dissipated in the air.

The atmosphere of electrical particles surrounding an electrified sphere is not more disposed to leave it, or more easily drawn off from any one part of the sphere than from another, because it is equally attracted by every part. But that is not the case with bodies of any other figure. From a cube it is more easily drawn at the corners than at the plane sides, and so from the angles of a body of any other form, and still most easily from the angle that is most acute; and, for this reason, points have a property of drawing on, as well as throwing off, the electrical fluid, at greater distances than blunt bodies can.

From various experiments recited in our author's treatise, to which the curious may have recourse, the preceding observations are deduced. You will observe how much they coincide with and support those which I some time since communicated to the Society upon the same subject.

To give even the shortest account of all the experiments contained in Mr. Franklin's book, would exceed greatly the time allowed for these purposes by the Royal Society; I shall content myself, therefore, with laying a few of the most singular ones before you.

The effects of lightning, and those of electricity, appear very similar. Lightning has often been known to strike people blind. A pigeon, struck dead to appearance by the electrical shock, recovering life, drooped several days, ate nothing, though crumbs were thrown to it, but declined and died. Mr. Franklin did not think of its being deprived of sight; but afterwards a pullet, struck dead in like manner, being recovered by repeatedly blowing into its lungs, when set down on the floor, ran headlong against the wall, and on examination appeared perfectly blind; hence he concluded, that the pigeon also had been absolutely blinded by the shock. From this observation we should be extremely cautious, how in electrizing we draw the strokes, especially in making the experiment of Leyden, from the eyes, or even from the parts near them.

Some time since it was imagined, that deafness had been relieved by electrizing the patient, by drawing the snaps from the ears, and by making him undergo the electrical commotion in the same manner. If hereafter this remedy should be fantastically applied to the eyes in this manner, to restore dimness of sight, I should not wonder, if perfect blindness were the consequence of the experiment.

By a very ingenious experiment our author endeavours to evince the impossibility of success, in the experiments proposed by others of drawing forth the effluvia of non-electrics, cinnamon, for instance, and by mixing them with the electrical fluid, to convey them with that into a person electrified; and our author thinks, that, though the effluvia of cinnamon and the electrical fluid should mix within the globe, they would never come out together through the pores of the glass, and thus be conveyed to the prime conductor; for he thinks, that the electrical fluid itself cannot come through, and that the prime conductor is always supplied from the cushion, and this last from the floor. Besides, when the globe is filled with cinnamon, or other non-electrics, no electricity can be obtained from its outer surface, for the reasons before laid down. He has tried another way, which he thought more likely to obtain a mixture of the electrical and other effluvia together, if such a mixture had been possible. He placed a glass plate under his cushion, to cut off the communication between the cushion and the floor; he then brought a small chain from the cushion into a glass of oil of turpentine, and carried another chain from the oil of turpentine to the floor, taking care, that the chain from the cushion to the glass touched no part of the frame of the machine. Another chain was fixed to the prime conductor, and held in the hand of a person to be electrified. The ends of the two chains in the glass were near an inch from each other, the oil of turpentine between. Now the globe, being turned, could draw no fire from the floor through the machine, the communication that way being cut off by the thick glass plate under the cushion; it must then draw it through the chains, whose ends were dipped in the oil of turpentine. And, as the oil of turpentine, being in some degree an electric *per se*, would not conduct what came up from the floor, the electricity was obliged to jump from the end of one chain to the end of the other, which he could see in large sparks; and thus it had a fair opportunity of seizing of the finest particles of the oil in its passage, and carrying them off with it; but no such effect followed, nor could he perceive the least difference in the smell of the electrical effluvia thus collected, from what it had when collected otherwise; nor does it otherwise affect the body of the person electrified. He likewise put into a phial, instead of water, a strong purging liquid, and then charged the phial, and took repeated shocks from it; in which case every particle of the electrical fluid must, before it went through his body, have first gone through the liquid, when the phial is charging, and returned through it when discharging; yet no other effect followed than if the phial had been charged with water. He has also smelt the electrical fire, when drawn through gold, silver, copper, lead, iron, wood, and the human body, and could perceive no difference; the odor being always the same, where the spark does not burn what it strikes; and therefore he imagines, that it does not take that smell from any quality of the bodies it passes through. There was no abridging this experiment, which I think very well conceived, and as well conducted, in a manner to make it intelligible; and therefore I have laid the author's words nearly before you.

As Mr. Franklin, in a letter to Mr. Collinson some time since, mentioned his intending to try the power of a very strong electrical shock upon a turkey, I desired Mr. Collinson to let Mr. Franklin know, that I should be glad to be acquainted with the result of that experiment. He accordingly has been so very obliging as to send an account of it, which is to the following purpose. He made first several experiments on fowls, and found, that two large thin glass jars gilt, holding each about six gallons, and such as I mentioned I had employed in the last paper I laid before you upon this subject, were sufficient, when fully charged, to kill common hens outright; but the turkeys, though thrown into violent convulsions, and then, lying as dead for some minutes, would recover in less than a quarter of an hour. However, having added three other such to the former two, though not fully charged, he killed a turkey of about ten pounds' weight, and believes that they would have killed a much larger. He conceited, as himself says, that the birds killed in this manner eat uncommonly tender.

In making these experiments, he found, that a man could, without great detriment, bear a much greater shock than he imagined; for he inadvertently received the stroke of two of these jars through his arms and body, when they were very near fully charged. It seemed to him a universal blow throughout the body from head to foot, and was followed by a violent, quick trembling in the trunk, which went gradually off in a few seconds. It was some minutes before he could recollect his thoughts, so as to know what was the matter; for he did not see the flash, though his eye was on the spot of the prime conductor, from whence it struck the back of his hand; nor did he hear the crack, though the by-standers said it was a loud one; nor did he particularly feel the stroke on his hand, though he afterwards found it had raised a swelling there of the bigness of half a swan-shot or pistol-bullet. His arms and the back of his neck felt somewhat numbed the remainder of the evening, and his breast was sore for a week after, as if it had been bruised. From this experiment may be seen the danger, even under the greatest caution, to the operator, when making these experiments with large jars; for it is not to be doubted, but that several of these fully charged would as certainly, by increasing them in proportion to the size, kill a man, as they before did the turkey.

Upon the whole, Mr. Franklin appears in the work before us, to be a very able and ingenious man; that he has a head to conceive, and a hand to carry into execution, whatever he thinks may conduce to enlighten the subject-matter, of which he is treating; and, although there are in this work some few opinions, in which I cannot perfectly agree with him, I think scarce anybody is better acquainted with the subject of electricity than himself.

No. II.

LETTER FROM THE ABBÉ NOLLET TO BENJAMIN FRANKLIN.*

A Monsieur Benjamin Franklin, Auteur du Livre intitulé "Expériences et Observations sur l'Electricité, faites à Philadelphie en Amérique."

Monsieur,

Lorsqu'on fit paroître en Français vos Lettres sur l'Electricité, je m'empressai de les lire, et j'y trouvai, comme l'annoncent vos Editeurs, des faits nouveaux et intéressants, des expériences bien imaginées et conduites avec intelligence, des vues fort ingénieuses et des conjectures plausibles. Si ce témoignage, qui est très-sincère de ma part, étoit capable de vous flatter, je vous le rends avec d'autant plus d'empressement et de plaisir, que des gens peu instruits de mes vrais sentiments, m'ont accusé très-mal-à-propos de penser d'une autre façon. Cela vient apparemment de ce que j'ai mis quelques restrictions à mes applaudissements, et de ce qu'en parlant de vos opinions, j'en ai cité quelques-unes comme me paroissant incompatibles avec certaines vérités bien établies, et d'autres comme des nouveautés dont j'aurois voulu trouver les preuves plus solides. Mais cette liberté que j'ai osé prendre, et que je crois bien permise en pareille matière, doit-elle m'attirer des reproches que je n'ai pas mérités? Voudroit-on, en dissimulant les bornes que je mets à ma critique, laisser à penser que je désapprouve tout ce qui est dans votre ouvrage, afin qu'on me croie un homme peu au fait de la matière, ou mal intentionné? Ou bien s'offenseroit-on de ce que je ne souscris pas pleinement aux éloges illimités qu'on lui donne, comme si quelques restrictions de ma part portoient préjudice au discernement de ceux qui n'ont point usé de la même réserve? C'est à vous-même, Monsieur, qui êtes à mille cinq cent lieues de ces tracasseries, et aux personnes judicieuses qui se tiennent à l'écart pour juger sans prévention et sans partialité, que je m'adresse pour dire tout naturellement ce que je pense sur des questions auxquelles j'ai droit de m'interesser plus

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* This letter is the first of a series written by the Abbé Nollet to Dr. Franklin, and serves to explain the grounds of the controversy, which the Abbé set on foot in regard to the Franklinian theory of electricity —Editor.

particulièrement que bien d'autres, par le goût que j'y ai pris, et par l'application que j'y donne depuis nombre d'années; persuadé que vous prendrez la peine de peser mes raisons, et que vous ne chercherez pas à m'imputer d'autre motif que celui d'éclaircir la vérité.

Vous serez peut-être surpris d'entendre ainsi parler un homme qu'on ne vous a point nommé parmi les physiciens électrisants de l'Europe; si vous cherchez à pénétrer la cause de cette omission qui n'est pas fort importante, vous pouvez croire, si vous le voulez, que l'Auteur qui a pris soin de vous en envoyer la liste, n'ayant entrepris qu'une *Historie abrégée de l'Electricité*, s'est contenté de citer les premiers Maîtres de l'Art, et qu'il m'a réservé pour le supplement, s'il en donne un quelque jour. Quoi qu'il en soit, puisque je vous suis tout-à-fait inconnu, je suis comme forcé de m'annoncer moi-même, et de vous dire, que ma place, si j'en dois avoir une, est entre M. Dufay, avec qui j'ai eu l'honneur de travailler pendant plusieurs années, et les physiciens d'Allemagne, qui n'ont commencé à faire parler d'eux que vers l'année 1742, et même encore plus tard en France, à cause du peu de correspondance qu'ils y avoient.

Après avoir médité pendant dix ans sur les expériences dont j'avois été témoin, et sur celles que j'avois continué de faire depuis la mort de M. Dufay, qui arriva en 1739, éclairé de nouveau par le grand nombre et par la grandeur des faits que nous procura l'usage des globes de verre substitués aux tubes, je commençai en 1745 à donner des mémoires sur l'électricité, et à soumettre au jugement des savants les pensées que je n'avois encore confiées que de vive voix aux amateurs qui avoient fréquenté mon école; dans l'espace de quatre ans, j'en lus six, qui se trouvent dans les volumes de l'Académie des Sciences, et dont j'ai donné les extraits dans deux ouvrages imprimés l'un en 1746, avec le titre d'*Essai sur l'Electricité des Corps*, et l'autre en 1748, sous celui de *Recherches sur les Causes particulières des Phénomènes électriques.* Je prends la liberté de vous envoyer l'un et l'autre, premièrement comme un hommage que je rends á votre mérite, et en second lieu pour abréger les citations que j'aurai à vous faire de mes expériences, ou des conséquences que j'en ai déduites, n'ayant plus qu'à vous indiquer les endroits où vous pourrez les trouver.

Si vous vous donnez la peine de lire ces deux petits volumes avec un peu d'attention, vous vous appercevrez bientôt, qu'en travaillant sur l'électricité, je me suis bien moins appliqué à produire des effets surprenants et capables de faire spectacle, qu'à étudier les circonstances de ceux qui étoient déjà connus, ou qui se présentoient à moi dans le cours de mes recherches ; et que mon but principal a toujours été de remonter aux causes par la voie de l'expérience, sans m'abandonner à une admiration oisive, quand j'ai appréhendé de n'en tirer aucun fruit pour le progrès de mes connoissances. Ceci est une affaire de goût ; je suis bien éloigné de blâmer ceux qui, ne pensant pas comme moi, ou qui ayant plus de loisir, s'occupent à rendre les expériences brillantes, ou même effrayantes, et à soutenir l'admiration des curieux qui prennent part à ces découvertes ; je crois même qu'on doit leur en savoir très-bon gré ; l'électricité devient par-là plus intéressante ; le nombre des amateurs augmente, le public en est plus ardent à demander les raisons de ce qu'il voit avec étonnement, et les savants s'empressent davantage à les rechercher, et à les lui offrir.

Vous trouverez que toutes mes explications roulent sur un principe, dont il faut que je vous entretienne un moment ; c'est celui des *effluences et affluences simultanées ;* je pense, comme vous le verrez, que la matière électrique s'élance du corps électrisé en forme de rayons qui sont divergents entr'eux, et c'est-là ce que j'appelle *matière effluente ;* une pareille matière vient, selon moi, de toutes parts au corps électrisé, soit de l'air de l'atmosphère, soit des autres corps environnants, et voilà ce que je nomme *matière affluente ;* ces deux courants qui ont des mouvements opposés, ont lieu tous deux ensemble, c'est ce que j'explique par le mot *simultanés.*

Lorsque je mis ce principe au jour pour la première fois,* je n'avois encore vu que les expériences que nous avions faites avec des tubes, et un petit nombre de celles qu'on commençoit à faire à l'aide des globes ; c'est-à-dire, que je n'en avois ni autant, ni d'aussi fortes preuves que j'en ai à présent ; je ne le donnai que comme une conjecture plausible ; aujourd'hui j'ose dire que c'est un fait évident pour quiconque ne sera point prévenu d'un autre sentiment ; un fait adopté par des savants du premier ordre dans la matière dont il s'agit ; † un fait auquel d'autres physiciens du même rang ont été naturellement conduits par leurs propres lumières ; ‡

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* Le 28 Avril, 1745. Voyez les Mémoires de l'Académie des Sciences pour la même année, p. 124.

† Voyez l'ouvrage de M. Boze, qui a pour titre, *Recherches sur la Cause et la véritable Théorie de l'Electricité,* imprimé en 1745, dans l'Appendice, p. 44, et suiv.

‡ Voyez l'ouvrage de M. Watson, imprimé en Anglois en 1746, et

un fait en un mot qui se montre tellement à quiconque répète ou tente les expériences avec un peu de réflexion, que je le trouve exprimé en propres termes ou en termes équivalents, dans des ouvrages où l'on se proposoit toute autre chose que d'acquiescer à mes opinions ;* et pour vous citer vous-même, c'est un fait que vous aviez *découvert* et *démontré* par le moyen des roues d'un petit moulin à vent,† &c., mais que vous avez attribué depuis à *diverses circonstances d'attraction et de répulsion*, dont vous n'avez pas rendu compte dans votre ouvrage, et que je serois bien curieux d'apprendre.

En établissant dans mon *Essai* ce principe des effluences et affluences simultanées, je n'ai cité en preuves que sept ou huit faits, que j'ai cru suffisants ; mais si vous n'en êtes pas satisfait, donnez-vouz la peine de suivre mes explications dans le volume des *Recherches*, et si vous les trouvez heureusement déduites de cette source, vous serez obligé de convenir que chaque phénomène ainsi expliqué fournit un nouveau dégré de certitude. J'ose espérer que par cette lecture vous reconnoîtrez encore que ce premier trait de lumière m'a guidé non-seulement pour rendre raison des effets déjà connus, mais encore pour en découvrir d'autres à la connoissance desquels je ne serois peut-être jamais parvenu sans lui ; c'est en réfléchissant, par exemple, sur l'effluence de la matière électrique, qu'il m'est venu en pensée d'essayer si les parties propres

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traduit en Français dans un *Recueil de Pièces sur l'Electricité*, à Paris, 1748.

Voyez dans le premier volume des Mémoires étrangers, imprimé sous les auspices de l'Académie des Sciences, les Mémoires sur l'Electricité par M. du Tour de Riom, Correspondant de l'Académie.

Musschenbroek, *Elém. Phys.* in 8vo. Edition 1748, en l'endroit où il traite de l'Electricité.

* Voyez la *nouvelle Dissertation* sur l'Electricité, par M. Morin, Professeur de Philosophie à Chartres, imprimée en 1747 ; un ouvrage anonyme qui a pour titre *Cause et Méchanique de l'Electricité*, 1749 ; l'ouvrage en deux parties de M. Boulanger en 1750, &c. En parcourant ces ouvrages on reconnoît par-tout que les auteurs ne peuvent se passer d'admettre deux courants de matière électrique.

On peut ajouter à tout cela que M. Waitz, dont la Dissertation a été couronnée par l'Académie de Berlin, a tellement compté sur la *matière affluente*, qu'il n'en a point voulu admettre d'autre ; cette matière est pourtant la seule qu on ose contester ; car pour *la matière effluente*, tout le monde en convient.

† *Expériences et Observations sur l'Electricité*, par M. Benjamin Franklin, p. 32.

de certains corps ne seroient point entraînées au dehors pendant le cours d'une électrisation de longue durée; si l'évaporation des liquides, si le dessèchement des fruits, si la transpiration des animaux n'en seroient point accélérés; c'est en comptant aussi sur la matière affluente, que j'ai osé prévoir de pareils effets à l'égard des mêmes corps placés dans le voisinage d'une masse quelconque électrisée; or tout ce que j'avois prévu à cet égard étant arrivé, ne suis-je pas fondé à croire que ces effets viennent véritablement de la cause que j'avois en vue, quand j'ai conçu l'espérance de les faire paroître?

Je vous avoue donc, Monsieur, avec franchise que je suis un peu attaché au principe dont je viens de vous parler, et qu'avant d'essayer d'un autre, je suis résolu d'examiner s'il ne peut pas quadrer avec les faits dont vous faites mention dans votre ouvrage; car s'il en peut fournir des explications plausibles et bien naturelles, je me croirai en droit de le préférer aux vôtres; premièrement parce qu'ils ne me paroissent pas assez prouves, et en second lieu, parce qu'il me semble qu'ils font violence à des vérités bien établies, et presque généralement reconnues. Je vous parle avec la liberté qu'inspire l'amour de la vérité; si vous me faites l'honneur de me répondre, je vous prie d'en user de même; l'attachement que j'ai pour mon opinion ne va pas jusqu'à l'opiniâtreté: si en m'expliquant vos pensées, qui pourroient bien avoir perdu quelque chose de leur valeur, soit par la manière précipitée avec laquelle elles ont été données au public, soit par quelque inexactitude de traduction ou d'impression; si, dis-je, en me les expliquant, vous me les rendez plus intelligibles, plus probables, et que je les trouve enfin préférables aux miennes, je vous promets d'en faire un aveu solemnel; et si je voyois que vous eussiez le même avantage sur les autres physiciens de l'Europe, je ne manquerois pas de joindre ma voix à celle de vos éditeurs, pour dire combien vous l'emportez sur tous ceux qui vous ont precédé dans cette carrière, comme je me fais un plaisir de reconnoître et de publier dès-à-present que vous y avez fait de très-grands progrès.

Je serai obligé de vous dire en plus d'un endroit que vous avez été prévenu sur certaines découvertes, et sur quelques pensées ingénieuses qui paroissent comme neuves dans vos lettres, et que vos éditeurs, tant Anglois que Français, semblent avoir regardé comme telles; ne prenez pas cela, je vous prie, pour un reproche; si c'en étoit un, il ne pourroit pas tomber sur vous; je vous crois trop judicieux et trop modeste pour vouloir briller aux dépens de personne, et trop riche de votre propre fond pour vouloir vous approprier le bien d'autrui; éloigné comme vous l'êtes, on croira sans peine que vous aurez ignoré bien des découvertes qui s'étoient déjà faites ailleurs, ainsi que les conséquences qu'on en avoit déduites; si je fais donc ces sortes de remarques, c'est pour conserver aux auteurs leur priorité de date, ce que je ne pourrois me dispenser de faire sans paroître injuste, ou ignorer les progrès de ceux qui ont travaillé avant vous sur l'électricité. C'est encore pour inspirer un nouveau dégré de confiance aux lecteurs qui auroient vu ces faits, ou ce qui en résulte, dans d'autres ouvrages que le vôtre; je crois que cela ne peut manquer d'arriver, quand on verra qu'un habile homme, sans être prévenu ni pour ni contre, a rencontré et enseigné formellement une partie de ces vérités surprenantes qu'on ne veut, et qu'on ne doit croire qu'à bon titre.

Si j'ai à vous parler de vos systèmes et de vos conjectures, ce ne sera pas pour trouver à redire que vous en ayez faits; je pense que cela est très-permis et même utile en physique, pourvu qu'on en use sobrement, et qu'on les donne, comme vous faites, pour ce qu'ils sont; je ne les désapprouve que quand on y met un ton décisif et impérieux, qui ne peut convenir tout au plus que pour les réalités les mieux prouvées et les plus évidentes; je trouve qu'il y a bien de l'inconséquence à citer, comme on le fait, l'exemple de Newton et des physiciens qui se piquent le plus de suivre la méthode de ce grand homme, pour nous ôter l'envie que nous pourrions avoir de risquer quelques hypothèses, à moins qu'on ne leur en accorde le privilége exclusif. Si je vous parle donc de celles que vous avez avancées, ce ne sera que pour vous dire combien les unes sont naturelles et plausibles, en vous apprenant qu'il y a déjà plusieurs années qu'elles ont gagné les esprits, comme d'elles-mêmes, dans un monde à qui vous n'aviez pas encore fait part de vos pensées, et pour vous faire quelques représentations sur d'autres qui ne paroissent pas assez d'accord avec l'expérience, et sur lesquelles je vous prierai de vouloir bien me donner quelques éclaircissements. Voilà, Monsieur, à peu près les articles dont je me propose de vous entretenir dans les lettres qui suivront celle-ci; si vous les jugez dignes d'une réponse, j'aurai obligation à la physique de m'avoir procuré l'honneur de votre correspondance; je ferai de mon mieux pour en mériter la continuation, et pour vous prouver la parfaite estime avec laquelle j'ai l'honneur d'être,

Monsieur, votre très-humble et très-obéissant serviteur,

NOLLET.

A Paris, ce 1 *Juillet*, 1752.

No. III.

SPEECH OF THE EARL OF MACCLESFIELD, PRESIDENT OF THE ROYAL SOCIETY, ON THE OCCASION OF AWARDING TO FRANKLIN A MEDAL FOR HIS DISCOVERIES IN ELECTRICITY.*

AT A MEETING OF THE ROYAL SOCIETY, THURSDAY, NOVEMBER 30TH, 1753.

The President made a declaration of the prize-medal to be given this year by the Society in consequence of the legacy left by the late Sir Godfrey Copley, namely, that the Council of the Society, on whom the right of bestowing this prize was undoubtedly devolved by the death of Sir Hans Sloane, the surviving trustee named in Sir Godfrey's will, had nominated, for the same, Benjamin Franklin, Esquire, of Philadelphia, in Pennsylvania, on account of his curious experiments and observations on electricity.

In the declaring and bestowing which prize the President addressed himself to the Society in the following manner, here inserted at the express desire of the gentlemen present.

"Gentlemen,

"Sir Hans Sloane being now dead, who was the surviving trustee of the late Sir Godfrey Copley, Baronet, the right of disposing of that gentleman's annual benefaction is incontestably devolved upon your President and Council, who have accordingly taken that matter into consideration.

"And, deliberating thereupon, they thought it their duty to keep these two points steadily in view, namely, the advancement of science and useful knowledge, and the honor of this Society. To the attaining both which ends they were convinced, that a strictly just and impartial disposal of this benefaction in favor of those only, who truly deserved it, would not a little conduce.

"Since such a disposition of it, if constantly practised, would greatly contribute to the credit of this Society, and at the same time would encourage laudable emulation among learned and ingenious men, who would thereby be induced to exert their functions, and endeavour to excel each other, not only in making useful and curious discoveries and improvements, but also in a

* For this paper I am indebted to Mr. B. B. Thatcher, by whom it was transcribed from the manuscript *Journal* of the Royal Society. — Editor

readiness to communicate them to this respectable body, who are extremely able to judge of their merit, and have it in their power to reward it, by bestowing upon them this desirable prize; desirable not so much in regard to the intrinsic value of the medal itself, as for the manner in which, and the persons by whom, it shall be adjudged to them; a prize which they will be proud to show during their own lives, and will with pleasure transmit to their posterity, as a lasting and honorable mark of the esteem wherein themselves were held by the Royal Society of London.

"And on this occasion I cannot but greatly applaud the happy instance, which our late most worthy President, Martin Falker, Esquire, gave of his sagacity and judgment, when he proposed, that this benefaction should not be paid in the current coin of this or any other country, which, being of common use and of a transitory nature, could retain in itself no inherent mark of honor, with respect either to its present or future possessor; but that a gold medal of the like or greater value, and adapted to this particular purpose, should be substituted in lieu thereof; which might be converted into specie, if the proprietor or his descendants should at any time be so pleased, or might remain under the same form in the possession of himself and his family after him, a convincing testimony of his own real merit.

"Nor did your Council think it was at all fit and proper to confine their benefaction within the narrow limits of any particular country, much less of this Society itself.

"For they were of opinion, that learned men and philosophers of all nations ought to entertain more enlarged notions; that they should consider themselves and each other as constituent parts and fellow-members of one and the same illustrious republic, and look upon it to be beneath persons of their character to betray a fond partiality for this or that particular district, where it had happened to be their own lot, either to be born or reside; and that their benevolence should be universally diffused, and as extensive as the knowledge they profess to pursue, and should be sensibly felt by all, who, in their respective stations, contributed their proportion to the common stock of the whole, by their endeavours to promote and advance science and useful knowledge, wherein alone the true interest and welfare of such a republic consist.

"For which reason your Council judged it to be highly expedient that, *Tros Rutulusve ferat*, whoever should deserve well of that learned republic in general, and of this Society in particular, should indifferently partake of your favors and honors.

"Upon these principles your Council proceeded in fixing their choice of a person on whom this honorable mark of distinction should be this day conferred, and on such an occasion they could not overlook the merit of Benjamin Franklin, Esquire, of Pennsylvania; for, though he is not a Fellow of this Society, nor an inhabitant of this Island, he is a subject of the crown of Great Britain, and must be acknowledged to have deserved well of the philosophical world, and of this learned body in particular, to whom he has at various times caused to be communicated many of the experiments he has made, and of which you have lately received a large collection, together with the conclusions which he imagines may be deduced from them; all which are contained in his printed treatise upon the subject of electricity. A subject known in part, indeed, long ago, but which not many years since was thought to be of little importance, and was at that time only applied to illustrate in some degree the being and nature of attraction and repulsion; nor was any thing worth much notice expected to ensue from it.

"But, to the honor of this Society, and of the British nation in general, let it be remembered, that the person, who first attempted to explain the secrets of this then neglected subject, which now appears to have a most surprising share of power in nature, and who gave occasion to the diligent researches, that have since been made into the principles and essence of it, was a member of this Society, and a native and inhabitant of England, who, I am sorry to say, is now no more, since it must have given him inexpressible pleasure to see, that what he had done with respect to electricity had occasioned those great and important discoveries, which have now been made in relation thereto.

"For not only his countrymen, but foreigners also, were incited by what he had discovered to make further experiments, and to push on with a becoming spirit their inquiries into the nature of this extraordinary phenomenon; and the indefatigable pains of a learned brother,* now present, were crowned with success even beyond expectation, and enabled him to make so considerable a progress in explaining and forming a kind of system of electricity, which now does and will continue to do him the greatest honor in all parts of the learned world.

"I am persuaded, that it would offend this gentleman's modesty to hear, especially in this public manner, those commendations

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* Mr. William Watson, who drew up and read to the Royal Society an account of Franklin's discoveries in electricity, which makes the first article in this Appendix. — Editor.

which he justly deserves, and the high opinion which not only myself, but the whole Society, entertain of his uncommon skill and abilities, as well in other branches of knowledge, as in this whereof I have been speaking; for which reason I shall put a constraint upon myself, and forbear entering into that encomium, which I really think to be due to him.

"The advances, however, which this gentleman and others had made towards laying open the nature of electricity, though very considerable in themselves, left room for carrying on these inquiries still further. To this work Mr. Franklin earnestly applied himself; and, as his diligence and ingenuity deserved, so they met with, uncommon success. For, though some others might have begun to entertain suspicions of an analogy between the effects of lightning and electricity, yet I take Mr. Franklin to be the first, who, among other curious discoveries, undertook to show from experiments, that the former owed its origin entirely to the latter; and who pointed out an easy method whereby any one might satisfy himself of the truth of the fact, which he had so advanced.

"This method, which he had pointed out, was so much approved, and has been so successfully put into execution in many different places, that it remains no longer a matter of suspicion and doubt, but is clear and plain to a demonstration, that electricity alone is the cause of that tremendous appearance, whose effects prove frequently so fatal in many parts of this terraqueous globe. And it were greatly to be wished, that some effectual and practicable way could be found by Mr. Franklin, or others, to prevent, or at least to lessen, the mischiefs, which too often attend that terrible meteor.

"Mr. Franklin's book has for some time been in the hands of most who hear me, and large accounts, drawn up by foreigners (as well as by the learned gentleman before mentioned), of Mr. Franklin's numerous and curious experiments, have been laid before this Society, besides those which himself has more immediately caused to be communicated to us at various times. It would therefore be impertinent in me to trespass upon your patience by entering into a detail of particulars, which, I am satisfied, you are all well acquainted with.

"True it is, that several learned men, both at home and abroad, do not entirely agree with him in all the conclusions, which he thinks may be deduced from the experiments he has made. But far be it from me to pretend to decide these points, more especially in this place and at this time. That matter is yet in dispute; and, if I am rightly informed, Mr. Franklin is now preparing to produce in support of his sentiments still farther experiments, some of which, he flatters himself, will appear more surprising than any that have already been communicated to the world.

"Let it therefore suffice for the present to say, that even those persons, who happen to differ from him in opinion as to some points, universally acknowledge his great merit, and particularly the learned gentleman, whom I have more than once mentioned, is pleased to declare Mr. Franklin to be '*a very able and ingenious man*,' and says, 'that he has a head to conceive, and a hand to carry into execution, whatever he thinks may conduce to enlighten the subject-matter of which he is treating;' and, although that gentleman 'cannot agree with him in some of his opinions, yet he thinks scarce anybody better acquainted with the subject of electricity than Mr. Franklin.' These testimonials, therefore, given by so capable as well as unprejudiced judges, in his favor, and more especially that character of him, which I have just quoted, joined with that opinion, which every one who has read his books must entertain of him, will sufficiently justify your Council in having adjudged to Mr. Franklin the Copley medal for this year, as a mark of distinction due to his unquestionable merit.

"Many and very considerable advantages and improvements have, within the space of some years past, been made in several branches of natural knowledge; but there is ample room still remaining for the inquisitive and able philosopher to employ his skill and labor. The Book of Nature is a very huge and comprehensive volume; and, notwithstanding no small part of it has been unfolded and exposed to our view by learned and ingenious men of this and many other countries, yet it still contains abundantly sufficient matter to exercise our talents upon, and which justly ought to excite our curiosity, and encourage us to proceed with vigor in our endeavours to bring to light what is at present concealed from our eyes. We know that few things are of so occult and obstinate a nature, as not to yield to sagacity, and to be forced to lay open their most hidden properties to the diligent and inquisitive inquirer.

"In confidence whereof let us pursue, with unwearied application and assiduity, our researches into every branch of natural philosophy. Nor let us be discouraged from such pursuits by a mistaken notion, that any part of it is too inconsiderable to deserve our regard and attention; since who could have entertained any hopes, some years ago, that electricity was capable of furnishing matter for so great and important discoveries, as have lately been made in relation thereto, and which a this time afford us a promising prospect of much more and greater, if due pains are not wanting, on our part, to search after them?

"It is, therefore, to be hoped, that those gentlemen, who have applied their thoughts and studies to lay open the amazing properties of electricity, will not sit down contented with the progress that has already been made therein, but will rather be encouraged thereby to proceed diligently in the same work. And I flatter myself, that Mr. Franklin will consider this honorable present not only as a reward, in some measure, of the discoveries with which he has already favored the world in relation to this very powerful agent in nature, but also as a proper incitement to carry on still farther his inquiries into this truly deserving and important subject. Nor do I in the least doubt, that our worthy brother, Mr. Peter Collinson, to whom (as Mr. Franklin resides in a remote country) I shall recommend the care of conveying this medal to him, will make use of all proper means to induce him to persevere in so laudable an undertaking." *

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* In the *Minutes of the Council*, December 19th, 1754, it is recorded. "A letter from Benjamin Franklin, Esquire, to the President and Council of the Royal Society, dated Philadelphia, 29 May, 1754, returning his thanks for the honor they have done him in bestowing on him the gold medal for the year 1753, was read."

Franklin was elected a Fellow of the Royal Society on the 29th of April, 1756. — EDITOR.

No. IV.

LETTER FROM JOHN BAPTIST BECCARIA TO BENJAMIN FRANKLIN.

Experiments in Electricity.

READ AT THE ROYAL SOCIETY, FEBRUARY 14TH, 1760.

Benjamino Franklin, viro de re electrica meritissimo, Joannes Baptista Beccaria ex Scholis Piis S. P. D.

1. SOSPITEM ex America Londinum te appulisse gaudeo, vir præclarissime. Offero tibi de motibus electricis, qualem experimentis excudi, hypothesin; partior hanc in duas partes, quemadmodum ipsa postulare videtur motuum hujusmodi differentia; ago parte prima de accessionibus, de discessionibus dico parte altera.

2. Et continuo universam de accessionibus pertractationem meam ita paucis comprehendo; "Quum ignis electricus copiosior in corpore altero vi expandendi se ad æqualitatem trajicit in alterum, partem interjecti aeris dimovet e loco pro majore sua copia majorem; fit inde, ut aer a tergo corporibus adjacens deficiente fulcro aeris intermedii ruat versus ipsum medium locum; ruit vero non circumeundo corpora, quæ via est longior, atque impedita abs igne profluente, sed ipsa trudendo a tergo; hac aeris trusione accedunt corpora inæqualiter electrica; dum accedunt, accelerantur, quia pro accessione majore copiosior ignis interfluit, copiosior intermedius aer disjicitur, augeturque adeo momentum aeris a tergo trudentis.'

EXPERIMENTUM I.

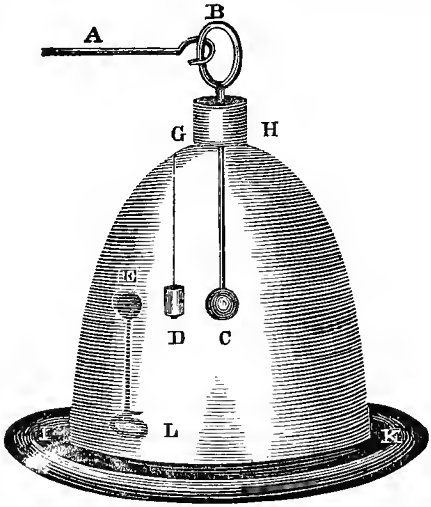
3. Aerem disjici ab interfluente electrico igne, scintillæ experimento demonstratur, quæ excitatur in medio tubulo, hinc clauso hermetice, inde impedito abs liquore aliquo, ipsa enim, disjiciens liquorem, disjectum aerem testatur.

4. Neque vero interfluens ignis aeris intermedii disjecti fulcrum potest supplere, quo aer corporibus a tergo adjacens sustineatur; is enim liberrime effluit, et effunditur per alterum corpus; quare, cum non fulciatur ipse, nec fulcri vices potest agere.

EXPERIMENTUM II.

5. Experimento res confirmatur plane luculentissimo; vittam ex charta inaurata longam pollices octo, latam lineas quatuor, convolvo

circa sese, ut cylindrum solidum *D* efformet; hunc suspendo serico filo *D*, *G*, sub fornice vitri pneumatici *I*, *H*, *K*, per cujus verticem



H init virga metallica *B*, *C*, desinens in metallicam sphæram *C*; figo in lance *I*, *K*, virgam metallicam *L*, *E*, simili sphæra ornatam; nempe sphæræ *C* et *E* sunt in eodem plano cum pendulo *D*, atque ab ipso distant ambæ æqualiter; tum nexa catena *A*, *B*, quæ pertinet ad machinam electricam, virgæ *B*, *C*, et consequenter immisso electrico igne in virgam *B*, *C*, observo; 1. ante subductum aerem chartaceum cylindrum *D* agitari vehementissimis vibrationibus inter duas sphæras *E*, *C*; 2. dum aer subducitur, minui eam agitationem plane pro copia subducti aeris; 3. omni, quantus potest, aere subducto, cylindrum *D* vix nutare. His observatis aerem restituo particulatim; atque pro aere admisso video vibrationes iterum augescere, et fieri, quemadmodum antea, vehementissimas; quæ dum contemplor singula, atque omnia simul comprehendo animo, intelligo magnitudinem motuum electricorum aeri, vel toti, vel residuo proportione respondere.

EXPERIMENTUM III.

6 Quod leviora corpuscula, bracteolæ, et pulvisculi, motu adhuc satis sensili agitentur in rarefacto aere, id in causa fuit, cur censuerim a principio cum physicis aliis electricos motus actioni ignis electrici in aerem acceptos referri non debere; quod, re nunc accuratius collata, residuos videam in residuo aere motus non majorem habere ad primos motus, qui fiunt in toto aere atmospherico,

proportionem, quam ea sit, quæ inter residuum et primum aerem intercedit, id nunc facit, ut illum meum, et alienum errorem agnoscam, atque in contrariam veniam, quam verissima testatur experientia, sententiam.

7. Neque omittam partem observationis opportunissimam rei confirmandæ; soleo enim allatum ultimo loco experimentum persæpe capere in cubiculo obtenebrato, atque tum observo ignem vibrantem pendulum ante aerem subductum micare hinc inde crepitanibus quidem, ac lucidissimis, sed arctis, atque brevibus prope sphæram utramque scintillis; deinceps ignem hunc pro subducto aere, adeoque pro minutis penduli vibrationibus effluere magis amplo radio, magis tranquillo, magis continuo, quanquam non ita micante.

8. Atque hæc ipsa res certe reactionem aeris demonstrat ignem electricum cohibentis in densitate quadam, quæ densitati suæ proportioni respondeat; hæc autem aeris reactio non potest actioni non respondere ignis electrici aerem nitentis disjicere, ac plane disjicientis, ubi necessaria is igni vi polleat.

9. Atque his plura non adferam tibi pro accessionibus explicandis corporum electricorum inæqualiter, attuli in datis ad Beccarium litteris, in quibus tamen non nisi dubitanter plura admodum disserebam de mechanica accessionum causa; accuratior consideratio experimentorum facit nunc, ut de accessionum causa dicam fidentius.

10. Corpora æqualiter electrica discedunt; qua causa id efficiatur, nunc persequar.

11. "Ignis electricus, qui quoquomodo insidet in corporibus, nititur, ut libretur cum igne electrico, qui insidet in aere. Si uterque" (sinito me illum deinceps proprium dicere hunc aereum) "æqualem habet proportionem ad nativam corporum atque aeris capacitatem, corpora accedunt, aut in nativa quiescunt directione; alter si superat proprius, vel aereus, corpora explicat similiter, compellitque ad discessionem." Hæc rei narratio.

EXPERIMENTUM IV.

12. Quoties in cubiculo quodam meo amplo ipso quidem at clauso pergo diutius urgere alium atque alium in catenam electricum ignem, experior partem ejus ignis effundi in aerem ambientem, ipsumque etiam, quantuscumque in cubiculo est (dum a tempestate siccus sit, vel abs igne) facere excessu electricum. Duo enim tenuia ex lino fila, quæ vel summis digitis prehensa, vel arundine suspensa defero quolibet, in quodlibet cubiculi spatium, mutuo

discedunt. Atque, sive in eodem ipsa contineam loco, sive in loco transferam alia atque alia, pergunt divergere ad semihoram, ad horam quandoque, et ultra.

EXPERIMENTUM V.

13. Si ea fila ope vitri separentur ab arundine, adeoque a solo, principio divergunt, tum ad nativam veniunt directionem; obtingunt autem hæc omnia post omnes elicitas, quantæ possunt, a catena scintillas, post omnem ab ipsa subductum redundantem ignem, post catenam nexam cum solo.

EXPERIMENTUM VI.

14. Ex diuturna electricitate machinæ phænomena experior omnino eadem. At, si diuturna electricitas machinæ continuo consequitur diuturnam electricitatem catenæ, aut contra, fila, quæ arundine suspensa constanter divergere videbam ex alterius electricitate, video principio accedere mutuo incipiente electricitate alterius, tum iterum divergere quemadmodum antea.

15. His inquam experimentis doceri nos arbitror. "1. Dum alium atque alium ignem congerimus in catenam, aliam atque aliam ipsius partem discedere quam latissime in ambientem aerem, ipsique adhærescere, atque ita omnem contentum in cubiculo aerem evadere excessu electricum; similiter dum alium atque alium ignem subtrahimus a machina, aliam atque aliam ignis partem machinam haurire abs aere ambiente; atque ita omnem contentum in cubiculo aerem fieri defectu electricum. 2. Fila vel manu, vel arundine delata discedere in aere, vel electrico excessu ex catena, vel electrico defectu ex machina, vel vi proprii nativi ignis superantis aereum, si merguntur in aere electrico ex machina, vel vi ignis aerei superantis nativum proprium filorum ignem, si merguntur in aere electrico ex catena. 3. Fila hujusmodi divergentia ex electricitate catenæ, ex consequente electricitate machinæ (vel contra) primo accedere, quia machina primo hauriat abs aere excessum inditum a catena, vel catena ignem restituat aeri sublatum a machina; atque ita ignis in aere ad nativam mensuram reductus librari debeat cum igne nativo permanente in filis. 4. At demceps ex diuturniore electricitate machinæ consequente electricitatem catenæ, vel contra, fila iterum divergere, quia vel machina pergat haurire partem ignis nativi, vel catena pergat addere alium ultra nativum aeri ignem. 5. Denique fila eadem cum vitro separantur, principio divergere, quia ipsa, quæ solum ignem nativum habeant, mergantur in aerem vel excessu, vel defectu electricum. At dein,

cum sunt vitro separata, venire ad nativam directionem, quia vel pars ignis aerei, si aer est excessu electricus a catena, in ipsa se denique effundat ad æqualitatem, quin ultro præterfluat ob cohibens vitrum; vel pars ignis nativi et proprii filorum se effundat in aerem, si aer est electricus defectu, quia suppleri aliunde possit ob interdicens vitrum."

16. Quare hæc videntur universe constare; "I. Aerem suum continere nativum ipsi sibi ignem. 2. Nativo aeris igni ignem alium addi posse, nativi abs aere ignis partem posse subtrahi, sed lente, et quasi per vim. 3. Aerem dimittere redundantem, haurire ignem deficientem, sed quam lentissime. 4. Si aer æque ac contenta corpora habeant nativum ignem suum, consistere hæc in nativo statu; si aer, manente nativo in corporibus igne, ignem habeat nativo aut copiosiorem, aut parciorem, corpora discedere." Verum singula hæc theoremata experimentis aliis illustrari mirum in modum possunt, et demonstrari latius.

EXPERIMENTUM VII.

17. Duo fila nexa catenæ post paucas globi conversiones divergunt maxime; deinceps a diuturniore catenæ electricitate incipiunt minus divergere; atque hæc divergentia ad certum usque gradum minuitur, ut quandoque angulus divergentiæ post continuatam diutius globi fricationem fiat subduplus anguli divergentiæ, qui extiterat ab electricitate eadem primo excitata. Quum hanc filorum divergentiam video minutam satis, tum globum non frico ulterius, sed stilum acutissimum catenæ admoveo pedetentim, quo lente redundantem omnem abs ipsa ignem hauriam. Id dum fit, lente fila accedunt, tum continenter lente iterum divergunt ad angulum primo quidem minorem, sed satis magnum, quæ quandoque vix metiantur gradus quadraginta quinque; tum vero pergunt divergere ad diuturnum tempus.

18. Videlicet maximus abs electricitate primo excitata angulus, quia tum satis ingens immissus in catenam, et in nexa fila, ignis; nullus, vel minimus, in aerem. Fit deinceps minor angulus, prout augescit ignis, qui consequenter immittitur in aerem, constante eodem ignis excessu in catena. Dum admoto stilo lente minuitur ignis in catenam immissus, minuitur adhuc angulus prout accedunt ad æqualitatem ignis in catena residuus, atque ignis in aerem immissus, ipsique affixus; ubi uterque ignis pertingit ad æqualitatem, fila attingunt ad directionem suam nativam; cum deinceps minuitur ulterius ignis redundans adhuc in catena, nec similiter minuitur ignis redundans in aere (aeri enim, uti vidimus, adhærescit, atque

ab ipso lente dimittitur), fila iterum discedunt pro excessu ignis aerei supra ignem in catena; qui denique aereus ignis, quoniam lentissime dimittitur, diutissime pergunt divergere fila.

EXPERIMENTUM VIII.

19. Si fila sint nexa machinæ, eadem omnia in iis contingunt phænomena ex diuturna electricitate machinæ, quæ in iis contingebant catenæ nexis ex diuturna electricitate catenæ.

20. Quare universe, quemadmodum constitui a principio, "Si ignis proprius corporum, quantuscumque is sit, libratur cum igne ambientis aeris, corpora vel consistunt in nativo statu, vel ad ipsum redeunt; si alter ignis superat alterum, corpora discedunt vi ignis superantis."

21. Atque hinc rationem vides, ni fallor, vir præstantissime, cur æque discedant tum quæ a catena, tum quæ a machina sunt electrica corpora. "Ignis proprius in corporibus a catena electricis vincit aereum, aereus vincit æque proprium in electricis a machina."

EXPERIMENTUM IX.

22. Quoties fila mutuo discedunt a se invicem, atque divergunt ex aucto in ipsis, vel minuto igne nativo, ad meum accedunt admotum digitum; quoties discedunt, atque divergunt servantes ignem suum nativum ex aucto, vel minuto igne nativo aeris, a digito refugiunt meo.

23. Hæc vero res primo quidem notissimis legibus accessionum atque discessionum electricarum est consentanea; quum enim nativus in filis ignis auctus est, vel minutus, ipsa sunt inæqualiter ac digitus electrica, qui habet nativum ignem suum; quum vero nativus ignis perstat in filis, et ipsa discedunt mutuo ob ignem auctum, vel minutum in aere, tum, quemadmodum discedunt ambo alterum abs altero, ita discedant oportet a digito meo ipso etiam habente ignem nativum, vi aeris, in quo nativus ignis minutus est, aut auctus. Sed præterea hæc filorum a digito discessio ipsa hanc probat etiam, quam affero, discessionis causam; nam et digitus, et fila, cum solo communicant, adeoque alium in se certe non habent ignem, nisi nativum, quo quoniam non discedunt, restat ipsa discedere ex nativo igne in aere aucto, vel minuto.

24. Cum in hanc primo incidi discessionum electricarum theoriam, ea me ancipitem tenuit suspicio, ne ignis aereus discessiones facere non posset in machina iis æquales in pernicitate, et magnitudine, quas facit in catena ignis proprius; hæc inde subibat

animum suspicio, quod ignis in machina, et catena (universe in corporibus omnibus deferentibus) mensura mutetur quam pernicissime, lentissime autem augeatur, aut minuatur mensura ignis in aere ambiente. Alia præterea suspicionem exaggerabat consideratio; tantum me nunquam abs aere, quantum a machina, subtrahere ignem potuisse, tantum potuisse nunquam aeri addere, quantum catenæ; nunquam enim eo veni, ut omnem aerea sola electricitate sustulerim filorum divergentiam, quanta existebat ex integra machinæ aut catenæ electricitate.

Factum inde est, ut experimenta hæc eadem, imo et alia, in literis attulerim ad præclarissimum instituti Bononiensis præsidem datis, quin hanc in iis satis late theoriam discessionum constituerem.

Verum re maturius perpensa intellexi pernicitatem discessionum, quæ fiant abs igne aereo, non ipsi pernicitati respondere debere, qua vel augeatur ipsius copia, vel minuatur; sed pernicitati, qua agat copia inhærens; et magnitudinem discessionum, quæ fiant ab igne eodem, non absolutæ, sed comparativæ ipsius magnitudini respondere debere; utrumque autem facile vidi pro re obvenire.

EXPERIMENTUM X.

25. Si in Experimento VI. post minutam ex diuturniore electricitate catenæ filorum divergentiam, non lente, sed protinus (manu nempe in catenam immissa) omnem subtraho a catena redundantem ignem, continuo incipiunt quidem accedere fila quam velocissime; verum velocitate æquali resiliunt repente, antequam pertingant ad nativam directionem. Hæc autem altera discessio quoniam fit ex aereo igne superante proprium in filis residuum, video inde ignem aereum (quamquam mutetur lentissime ipsius copia) ipsum tamen discessiones facere iis æque veloces, quæ abs igne proprio efficiuntur.

EXPERIMENTUM XI.

26. Sed et ipsas ex igne aereo obvenire æque magnas ita intelligo. Post ignem inditum in aerem, qui catenam ambit quantus potest, dempto redundante omni ab catena igne, atque adeo discedentibus jam filis ex igne aereo, vitreo globo substituo sulphureum, atque ex hujus functione, video, principio augeri angulum divergentiæ, quem effecerat ignis aereus, tum ipsum continenter minui.

27. Id autem certum; primas globi sulphurei frictiones demere partem nativi ignis a catena, neque pariter demere excessivum ignem ambientis aeris (aer enim lente, ut vidimus, accipit ignem

alienum, lente acceptum exuit); quare augescit magnitudo divergentiæ, quæ fit abs igne aereo, non mutata magnitudine absoluta ignis aerei, sed mutata solum magnitudine ipsius comparativa, minuto nempe igne proprio; adeoque aucta proportione aerei ad proprium. Igitur quoniam quantum ignis ingeritur in catenam, tantundem subtrahitur a machina; proportio ignis aerei circa machinam ad residuum in machina eadem erit ac proportio ignis in catena redundantis ad aereum circa catenam; quamobrem aereus circa machinam discessiones faciet non æque veloces solum, sed et æque magnas, ac eæ sunt, quas facit ignis proprius in catena.

28. Itaque, ut omnia demum paucis complectar, quæ pertinere videntur ad motus electricos universe omnes explicandos (suspensiones enim, adhæsiones, vibrationes, infinitosque alios compositiores quasi ludos electricos, tu ipse probe videre visus es discessionibus omnes, atque accessionibus contineri),hæc denique est summa hypothesis meæ. "Accessiones corporum inæqualiter electricorum efficiuntur ab igne electrico a corpore altero, in quo copiosior est, effluente in alterum per aerem interjectum, ipsumque disjiciente. Discessiones autem vel igne proprio corporum efficiuntur se expandente contra aereum, vel aereo se expandente valentius contra proprium;" quæ tamen expansio ignis alterius alterum superantis sine mixtione mutua alterius cum altero videtur contingere. Aer enim ignem continet suum quantumcunque, ne discedat; arcet proprium deferentium corporum ignem, ne adhærescat sibi.

29. Hanc, inquam, hypothesim offero tibi, vir præclarissime, quo tu eam facias meliorem. Si tanti interea ipsam ducas, ut Regiæ isti scientiarum Societati exhibenda videatur, res ex meo obtinget desiderio, qui quando ornamentum ipsi adferre nullum possum, diligentiam saltem nolim desiderari meam. Tu vero cura, ut valeas. Servari enim te decet quam diutissime utilissime, scientiæ perficiendæ amplificandæque, quam certissimam instituisti.

Dat. Taurini, 24 *Decembris*, 1757.

Remarks on the preceding Paper, by Dr. Franklin.

For the better understanding this paper, it is necessary to know, that Father Beccaria uses a large chain, suspended by silk lines, for the purpose of a prime conductor; and that his machine for turning the glass globe is so contrived, as that he can, on occasion, readily isolate it (that is, place it on glass or wax), together with the person that works it. When the communication is thus cut off between the earth and the chain, and also between the earth and the machine, he observes, that, the globe being turned, both the chain and the machine show signs of electricity; and, as these signs, when examined, appear to be different in the chain and in the machine, and the globe having, as he supposes, drawn from the machine part of its natural or common quantity of electricity, and given it to the chain, he calls the electricity appearing in the chain, electricity *by excess;* and the electricity appearing in the machine, electricity *by defect;* which answer to our terms of *positive* and *negative* electricity, or electricity *plus* and *minus*. And thus his expressions, *electrifying by the chain*, and *electrifying by the machine*, are to be understood, electrifying *positively*, and electrifying *negatively*.

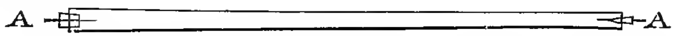
No. V.

LETTER FROM PROFESSOR THORBERN BERGMAN, OF UPSAL, TO BENJAMIN WILSON.*

Remarks on One of Franklin's Experiments in Electricity.

READ AT THE ROYAL SOCIETY, NOVEMBER 20TH, 1760.

DOMINUS *Franklin in* § 28 *tertiæ epistolæ miratur glaciei frustum non transmittere commotionem electricam*, cum *aqua idem perfecte præstet;* † sed feci nonnulla experimenta, quæ monstrant *parvam aquæ quantitatem nec huic fini sufficere.* Scilicet capiatur tubus vitreus trium vel quatuor pedum, qualis barometris inservit; hic aqua impleatur, et claudatur utrumque extremum subere perforato filo metallico aquam paululum intrante, uti figura adposita indicat.



Si jam duo homines in circulo explosorio constituti teneant extrema filorum metallicorum, *A*, *A*, et tentetur evacuatio, non tamen perfecta evenit, nam vix carpus et rarissime flexura cubitus hac methodo

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* This letter is dated at Upsal, October 17th, 1760. An extract only is here given. The remainder of the letter relates to a different subject. See the whole in the *Philosophical Transactions*, Vol. LI. p. 907. — EDITOR.

† See p. 209 of the present volume. — EDITOR.

concutitur, licet deinde idem vas absque ulteriori cumulatione tantum contineat electricitatis, ut more consueto evacuatum pectus valide ferire possit. Aucta tubi capacitate, magis transit, usque dum ita increverit, ut plenarium transitum permittat, nec impedit aquæ quantitas justo major, quod testantur commotiones per lacus et flumina propagatæ. *Conveniunt itaque aqua et glacies in eo, quod parvæ quantitates concussionem ægre tramittant.*

Hinc suspicatus sum *magnam glaciei quantitatem faciliorem concedere transitum, quod etiam experientia comprobavit,* etsi adhuc *non majus* adhibui *frustum* quam quo *commotio flexuram cubitus attigit.* Præterea *ex æqualibus* aquæ et glaciei quantitatibus, *glacies minus transmittit.*

No. VI.

LETTER FROM M. DUBOURG TO M. DE LOR.*

Parallel between the Theories of Franklin and Nollet.

SIR,

I return you the *History of Electricity,* which you had the goodness to lend me, with my thanks for it. Mr. Priestley's zeal for the glory of Mr. Franklin has given umbrage to the editor, who is animated with a zeal no less ardent for the memory of the Abbé Nollet. Which would all be very well, if he did not attempt to make it a party matter between the French and English. Let us leave these national prejudices to the common people; let political ministers espouse their passions, if they think they can make them subservient to their designs; but let not philosophers be influenced by these petty local considerations. The republic of letters is one; let us have a care that we do not dismember it; it allows distinctions, but abhors a division. Nollet, Franklin, Hawksbee, Musschenbroek, Æpinus, Wilson, and Beccaria are all fellow-citizens, and we should regard them all with equal favor.

I will give you candidly, and I would repeat it with the same frankness before all the world, my opinion of Franklin and of

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* Translated from M. Dubourg's edition of Franklin's works. M. de Lor was Professor of Experimental Philosophy in Paris. — EDITOR.

Nollet; and I will thank you to weigh my thoughts on this subject, with the same candor and impartiality.

Electricity is like an extensive and valuable field, which, after having lain fallow for a long succession of ages, has, for the last few years, been cultivated with wonderful ardor and success, but has not yielded its richest fruits. Natural philosophers of all countries have devoted themselves, in emulation of each other, to electrical researches; they have collected observations, have multiplied and varied experiments; they have constructed systems to explain facts, and to discover their causes; they have attempted to make useful applications of them; but all have not been equally skilful, nor equally successful. It is not for me to decide among them, but every one may say what he thinks. I shall use this right, while I endeavour not to abuse it.

And I think we should set out with this principle; of two hypotheses, the best, in my opinion, is that which, embracing all known facts, and showing their agreement and their points of difference, connects them together in such a regular order, that it is not only easy to apprehend all their relations to each other, but that we perceive, almost at the same moment, what is wanting to their completeness, and what remains to be done to fill up some blank spaces, or unite the scattered links in the great chain of philosophical truths.

If one would judge, by this standard, Nollet's hypothesis of simultaneous afflux and efflux, and Franklin's hypothesis of positive and negative electricity, I think he would not hesitate long between them.

Nollet, by referring every thing vaguely and indistinctly to afflux and efflux, does not teach us to discriminate any thing; still less, to foresee any thing. He presents a rallying-point for all facts known, or hereafter to be known, but furnishes no clue to guide us out of the labyrinth where they are to be sought. It is as if a botanist should rest satisfied with telling us, that all trees have a trunk, roots, branches, leaves, flowers, and fruits, without teaching us by what features we may recognise such or such a tree, and in what its distinguishing characteristics consist; facts with which it would be more important, however, to make us acquainted, than tediously to repeat these same generalities respecting each individual.

Franklin, in distinguishing between positive and negative electricity, and assigning to each its right place and proper character, so far as the present state of philosophical science admits, diffuses light far and near, points out the path we must follow in order to make new discoveries, connect them with those already made, extend the limits of science, and make it productive not merely of pleasure but of positive utility. He says; *Do this, and such results will follow; change such a circumstance, and such will be the consequences; thus, you can turn such a thing to account; and thus, you may guard against such an inconvenience.* You follow his instructions, and every thing takes place in the manner and order that he has pointed out, every thing answers to his views in Europe as in America, and every thing, even the celestial phenomena, demonstrate the soundness of principles, which his modesty suffered him to propose only as mere conjectures.

In a word, I think you will find, as I have done, about the same difference between the theories of these two celebrated electricians, as between the barren and fruitful fig-tree.

On the other hand, it must be admitted, to the honor of the Abbé Nollet, that his electrical experiments on organized bodies, and especially with regard to vegetation and transpiration, are very clear and interesting; and that in this department no one has hitherto surpassed or even equalled him. It were much to be wished, that some good natural philosopher, treading in his steps with the same ardor and skill, would devote himself earnestly to the task of making the most brilliant electrical experiments serve to throw light on various other important points in the animal economy, and especially on the nervous system, the glandular system, the circulation of the fluids, muscular motion, respiration, &c., not only as respects man, but, more particularly, animals of different kinds and orders, (quadrupeds, birds, fishes, reptiles, insects, &c.,) directing electricity by turns on the different organic parts, and under every imaginable variety of circumstances. I should especially desire, that some one would make the experiment, and take all possible care to ascertain, whether, while the internal parts are true conductors, the integuments, at least in most animals, (wool, silk, scales, &c.,) are non-conductors, and to what extent; and whether in this respect, there is much difference, or little, between claws and horns, between hair and wool, &c. I am, Sir, &c.

DUBOURG

END OF VOL. V.