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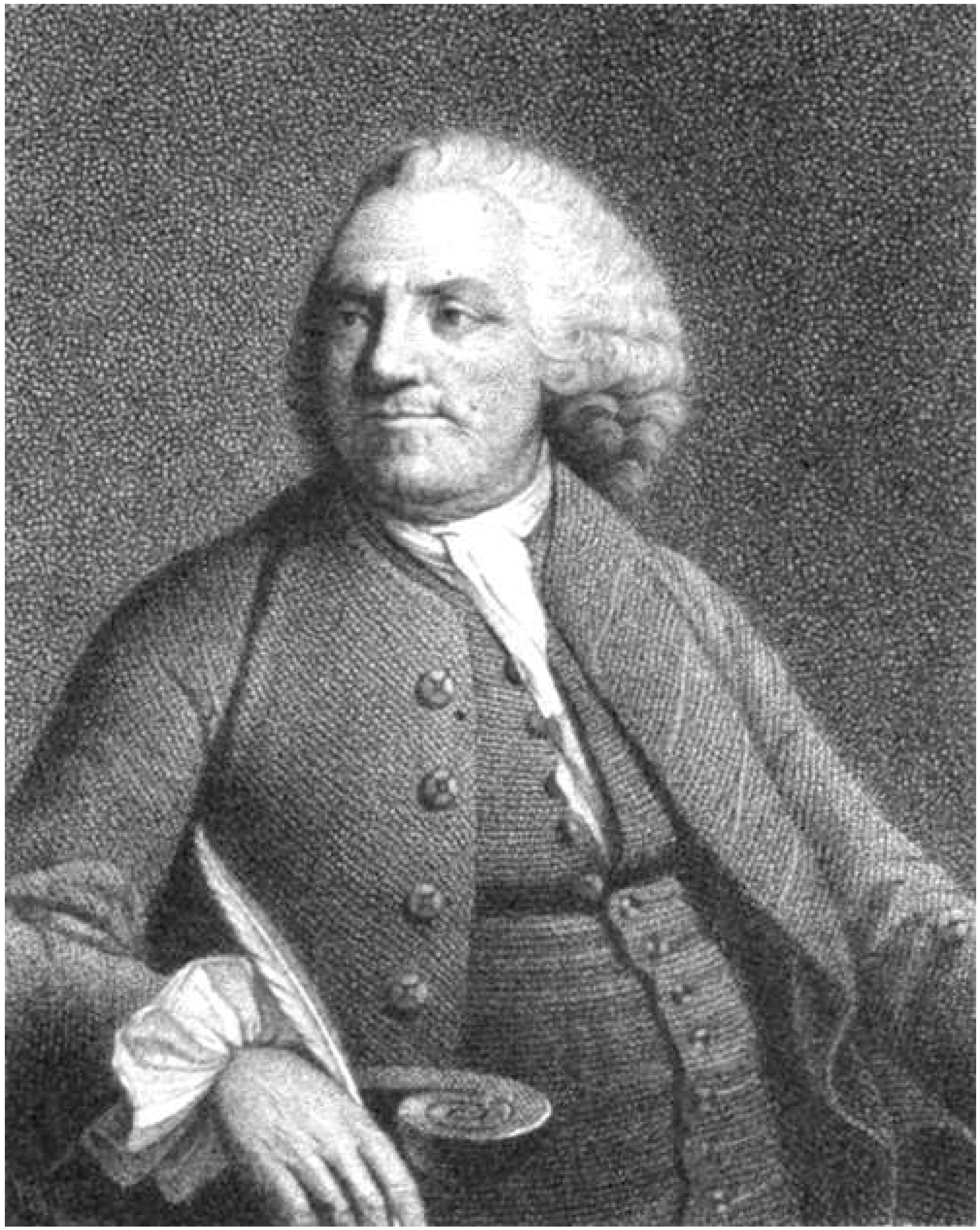

BENJAMIN FRANKLIN, L.L.D.

Publish'd April 1, 1806; by Longman, Rees, Hurst, & Orme, Paternoster Row.

The
WORKS
Of
BENJAMIN FRANKLIN, L.L.D.

VOL. 1.

Engraved by W. & G. Cooke

PRINTED,
for Longman, Hurst, Rees, & Orme, Paternoster Row, London.

THE

COMPLETE
WORKS,

IN

PHILOSOPHY, POLITICS, AND MORALS,

OF THE LATE

DR. BENJAMIN FRANKLIN,

NOW FIRST COLLECTED AND ARRANGED:
WITH

MEMOIRS OF HIS EARLY LIFE,

WRITTEN BY HIMSELF.

IN THREE VOLUMES.

VOL. I.

London:

PRINTED FOR J. JOHNSON, ST. PAUL'S CHURCH-YARD;
AND LONGMAN, HURST, REES AND ORME,
PATERNOSTER-ROW.

1806.

ADVERTISEMENT.

The works of Dr. Franklin have been often partially collected, never before brought together in one uniform publication.

The first collection was made by Mr. Peter Collinson in the year 1751. It consisted of letters, communicated by the author to the editor, on one subject, electricity, and formed a pamphlet only, of which the price was half-a-crown. It was enlarged in 1752, by a second communication on the same subject, and in 1754, by a third, till, in 1766, by the addition of letters and papers on other philosophical subjects, it amounted to a quarto volume of 500 pages.

Ten years after, in 1779, another collection was made, by a different editor, in one volume, printed both in quarto and octavo, of papers not contained in the preceding collection, under the title of Political, Miscellaneous, and Philosophical Pieces.

In 1787, a third collection appeared in a thin octavo volume, entitled Philosophical and Miscellaneous Papers. [vi]

And lastly, in 1793, a fourth was published, in two volumes, crown octavo, consisting of Memoirs of Dr. Franklin's Life, and Essays humourous, moral and literary, chiefly in the Manner of the Spectator.

In the present volumes will be found all the different collections we have enumerated, together with the various papers of the same author, that have been published in separate pamphlets, or inserted in foreign collections of his works, or in the Transactions of our own or of foreign philosophical societies, or in our own or foreign newspapers and magazines, as far as discoverable by the editor, who has been assisted in the research by a gentleman in America. Among these papers some, we conceive, will be new to the English reader on this side of the Atlantic; particularly a series of essays entitled The Busy-Body, written, as Dr. Franklin tells us in his Life, when he was an assiduous imitator of Addison; and a pamphlet, entitled Plain Truth, with which he is said to have commenced his political career as a writer. We hoped to have [vii] *been enabled to add, what would have been equally new, and still more acceptable, a genuine copy of the Life of our author, as written by himself; but in this hope we are disappointed, and we are in consequence obliged to content ourselves with a translation, which has been already before the public, from a copy in the French language, coming no farther down than the year 1731; and a continuation of his history from that period, by the late Dr. Stuber of Philadelphia.*

The character of Dr. Franklin, as a philosopher, a politician, and a moralist, is too well known to require illustration, and his writings, from their interesting nature, and the fascinating simplicity of their style, are too highly esteemed, for any apology to be necessary for so large a collection of them, unless it should be deemed necessary by the individual to whom Dr. Franklin in his will consigned his manuscripts: and to him our apology will consist in a reference to his own extraordinary conduct.

In bequeathing his papers, it was no doubt the intention of the testator, that the world should have the chance of being benefited by their publication. It was so understood by the person in question, his grandson, who, accordingly, shortly [viii] *after the death of his great relative, hastened to London, the best mart for literary property, employed an amanuensis for many months in copying, ransacked our public libraries that nothing might escape, and at length had so far prepared the*

works of Dr. Franklin for the press, that proposals were made by him to several of our principal booksellers for the sale of them. They were to form three quarto volumes, and were to contain all the writings, published and unpublished, of Franklin, with Memoirs of his Life, brought down by himself to the year 1757, and continued to his death by the legatee. They were to be published in three different languages, and the countries corresponding to those languages, France, Germany, and England, on the same day. The terms asked for the copyright of the English edition were high, amounting to several thousand pounds, which occasioned a little demur; but eventually they would no doubt have been obtained. Nothing more however was heard of the proposals or the work, in this its fair market. The proprietor, it seems, had found a bidder of a different description in some emissary of government, whose object was to withhold the manuscripts from [ix]
the world, not to benefit it by their publication; and they thus either passed into other hands, or the person to whom they were bequeathed received a remuneration for suppressing them. This at least has been asserted, by a variety of persons, both in this country and America, of whom some were at the time intimate with the grandson, and not wholly unacquainted with the machinations of the ministry; and the silence, which has been observed for so many years respecting the publication, gives additional credibility to the report.

What the manuscripts contained, that should have excited the jealousy of government, we are unable, as we have never seen them, positively to affirm; but, from the conspicuous part acted by the author in the American revolution and the wars connected with it, it is by no means difficult to guess; and of this we are sure, from his character, that no disposition of his writings could have been more contrary to his intentions or wishes.

We have only to add, that in the present collection, which is probably all that will ever be published of the works of this [x]
extraordinary man, the papers are methodically arranged, the moral and philosophical ones according to their subjects, the political ones, as nearly as may be, according to their dates; that we have given, in notes, the authorities for ascribing the different pieces to Franklin; that where no title existed, to indicate the nature of a letter or paper, we have prefixed a title; and lastly, that we have compiled an index to the whole, which is placed at the beginning, instead of, as is usual, at the end of the work, to render the volumes more equal.

April 7, 1806.

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VOL. I.

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Page.	*Line.*	
2	10:	for true, read me.
5	5:	for was born, read who was born.
20	1:	for Tryon, read Tyron's.
ib.	7	from the bottom: for put to blush, read put to the blush.
ib.	4	from the bottom: for myself, read by myself.
15	4:	for collection, read works.
21	9	from the bottom: for or, read nor.
25	4	from the bottom: for pasquenades, read pasquinades.
28	7:	dele the.
ib.	12:	for printer, read a printer.
28	3	from the bottom: for my old favourite work, Bunyan's Voyages, read my old favourite Bunyan.
40	5:	for money, read in money.
44	3:	for Bernet, read Burnet.
ib.	17:	for unabled, read unable.
50	19:	for ingenuous, read ingenious.
67	5:	dele bridge.
80	3	from the bottom: for into, read into which.
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LIFE

OF

DR. BENJAMIN FRANKLIN.

[Pg 1]

LIFE

OF

DR. BENJAMIN FRANKLIN,

&c. &c.

MY DEAR SON,

I have amused myself with collecting some little anecdotes of my family. You may remember the enquiries I made, when you were with me in England, among such of my relations as were then living; and the journey I undertook for that purpose. To be acquainted with the particulars of my parentage and life, many of which are unknown to you, I flatter myself will afford the same pleasure to you as to me. I shall relate them upon paper: it will be an agreeable employment of a week's uninterrupted leisure, which I promise myself during my present retirement in the country. There are also other motives which induce me to the undertaking. From the bosom of poverty and obscurity, in which I drew my first breath, and spent my earliest years, I have raised myself to a state of opulence and to some degree of celebrity in the world. A constant good fortune has attended me through every period of life to my present advanced age; and my [2] descendants may be desirous of learning what were the means of which I made use, and which, thanks to the assisting hand of providence, have proved so eminently successful. They may also, should they ever be placed in a similar situation, derive some advantage from my narrative.

When I reflect, as I frequently do, upon the felicity I have enjoyed, I sometimes say to myself, that, were the offer made me, I would engage to run again, from beginning to end, the same career of life. All I would ask, should be the privilege of an author, to correct, in a second edition, certain errors of the first. I could wish, likewise if it were in my power, to change some trivial incidents and events for others more favourable. Were this, however, denied me, still would I not

decline the offer. But since a repetition of life cannot take place, there is nothing which, in my opinion, so nearly resembles it, as to call to mind all its circumstances, and, to render their remembrance more durable, commit them to writing. By thus employing myself, I shall yield to the inclination, so natural in old men, to talk of themselves and their exploits, and may freely follow my bent, without being tiresome to those who, from respect to my age, might think themselves obliged to listen to me; as they will be at liberty to read me or not as they please. In fine—and I may as well avow it, since nobody would believe me were I to deny it—I shall perhaps, by this employment, gratify my vanity. Scarcely indeed have I ever read or heard the introductory phrase, "*I may say without vanity*," but some striking and characteristic instance of vanity has immediately followed. The generality of men hate vanity in others, however strongly [3]
they may be tinctured with it themselves: for myself, I pay obeisance to it wherever I meet with it, persuaded that it is advantageous, as well to the individual whom it governs, as to those who are within the sphere of its influence. Of consequence, it would in many cases, not be wholly absurd, that a man should count his vanity among the other sweets of life, and give thanks to providence for the blessing.

And here let me with all humility acknowledge, that to divine providence I am indebted for the felicity I have hitherto enjoyed. It is that power alone which has furnished me with the means I have employed, and that has crowned them with success. My faith in this respect leads me to hope, though I cannot count upon it, that the divine goodness will still be exercised towards me, either by prolonging the duration of my happiness to the close of life, or by giving me fortitude to support any melancholy reverse, which may happen to me, as to so many others. My future fortune is unknown but to Him in whose hand is our destiny, and who can make our very afflictions subservient to our benefit.

One of my uncles, desirous, like myself, of collecting anecdotes of our family, gave me some notes, from which I have derived many particulars respecting our ancestors. From these I learn, that they had lived in the same village (Eaton in Northamptonshire,) upon a freehold of about thirty acres, for the space at least of three hundred years. How long they had resided there prior to that period, my uncle had been unable to discover; probably ever since the institution of surnames, when they took the appellation of Franklin, which had formerly been the name of a particular order of individuals.[1] [4]

This petty estate would not have sufficed for their subsistence, had they not added the trade of blacksmith, which was perpetuated in the family down to my uncle's time, the eldest son having been uniformly brought up to this employment: a custom which both he and my father observed with respect to their eldest sons.

In the researches I made at Eaton, I found no account of their births, marriages, and deaths, earlier than the year 1555; [5]
the parish register not extending farther back than that period. This register informed me, that I was the youngest son of the youngest branch of the family, counting five generations. My grandfather, Thomas, who was born in 1598, lived at Eaton till he was too old to continue his trade, when he retired to Banbury in Oxfordshire, where his son John, who was a dyer, resided, and with whom my father was apprenticed. He died, and was buried there: we saw his monument in 1758. His eldest son lived in the family house at Eaton, which he bequeathed, with the land belonging to it, to his only daughter; who, in concert with her husband, Mr. Fisher of Wellingborough, afterwards sold it to Mr. Estead, the present proprietor.

My grandfather had four surviving sons, Thomas, John, Benjamin, and Josias. I shall give you such particulars of them as my memory will furnish, not having my papers here, in which you will find a more minute account, if they are not lost during my absence.

Thomas had learned the trade of a blacksmith under his father; but possessing a good natural understanding, he improved it by study, at the solicitation of a gentleman of the name of Palmer, who was at that time the principal

inhabitant of the village, and who encouraged, in like manner, all my uncles to cultivate their minds. Thomas thus rendered himself competent to the functions of a country attorney; soon became an essential personage in the affairs of the village; and was one of the chief movers of every public enterprise, as well relative to the county as the town of Northampton. A variety of remarkable incidents were told us of him at Eaton. After enjoying the esteem and patronage of [6]
Lord Halifax, he died, January 6, 1702, precisely four years before I was born. The recital that was made us of his life and character, by some aged persons of the village, struck you, I remember, as extraordinary, from its analogy to what you knew of myself. "Had he died," said you, "just four years later, one might have supposed a transmigration of souls."

John, to the best of my belief, was brought up to the trade of a wool-dyer.

Benjamin served his apprenticeship in London to a silk-dyer. He was an industrious man: I remember him well; for, while I was a child, he joined my father at Boston, and lived for some years in the house with us. A particular affection had always subsisted between my father and him; and I was his godson. He arrived to a great age. He left behind him two quarto volumes of poems in manuscript, consisting of little fugitive pieces addressed to his friends. He had invented a short-hand, which he taught me, but having never made use of it, I have now forgotten it. He was a man of piety, and a constant attendant on the best preachers, whose sermons he took a pleasure in writing down according, to the expeditory method he had devised. Many volumes were thus collected by him. He was also extremely fond of politics, too much so, perhaps, for his situation. I lately found in London a collection which he had made of all the principal pamphlets relative to public affairs, from the year 1641 to 1717. Many volumes are wanting, as appears by the series of numbers; but there still remain eight in folio, and twenty-four in quarto and octavo. The collection had fallen into the hands of a second-hand bookseller, who, knowing me by having sold me some books, brought it to me. My uncle, it seems, had left it behind him [7]
on his departure for America, about fifty years ago. I found various notes of his writing in the margins. His grandson, Samuel, is now living at Boston.

Our humble family had early embraced the Reformation. They remained faithfully attached during the reign of Queen Mary, when they were in danger of being molested on account of their zeal against popery. They had an English bible, and, to conceal it the more securely, they conceived the project of fastening it, open, with pack-threads across the leaves, on the inside of the lid of the close-stool. When my great-grandfather wished to read to his family, he reversed the lid of the close-stool upon his knees, and passed the leaves from one side to the other, which were held down on each by the pack-thread. One of the children was stationed at the door, to give notice if he saw the proctor (an officer of the spiritual court) make his appearance: in that case, the lid was restored to its place, with the Bible concealed under it as before. I had this anecdote from my uncle Benjamin.

The whole family preserved its attachment to the Church of England till towards the close of the reign of Charles II. when certain ministers, who had been ejected as nonconformists, having held conventicles in Northamptonshire, they were joined by Benjamin and Josias, who adhered to them ever after. The rest of the family continued in the episcopal church.

My father, Josias, married early in life. He went, with his wife and three children, to New England, about the year 1682. Conventicles being at that time prohibited by law, and frequently disturbed, some considerable persons of his acquaintance determined to go to America, where they hoped to enjoy the free exercise of their religion, and my father [8]
was prevailed on to accompany them.

My father had also by the same wife, four children born in America, and ten others by a second wife, making in all seventeen. I remember to have seen thirteen seated together at his table, who all arrived to years of maturity, and were married. I was the last of the sons, and the youngest child, excepting two daughters. I was born at Boston in New England. My mother, the second wife, was Abiah Folger, daughter of Peter Folger, one of the first colonists of New England, of whom Cotton Mather makes honourable mention, in his Ecclesiastical History of that province, as "*a pious and learned Englishman*," if I rightly recollect his expressions. I have been told of his having written a variety of little pieces; but there appears to be only one in print, which I met with many years ago. It was published in the year 1675, and is in familiar verse, agreeably to the taste of the times and the country. The author addresses himself to the governors for the time being, speaks for liberty of conscience, and in favour of the anabaptists, quakers, and other sectaries, who had suffered persecution. To this persecution he attributes the war with the natives, and other calamities which afflicted the country, regarding them as the judgments of God in punishment of so odious an offence, and he exhorts the government to the repeal of laws so contrary to charity. The poem appeared to be written with a manly freedom and a pleasing simplicity. I recollect the six concluding lines, though I have forgotten the order of words of the two first; the sense of which was, that his censures were dictated by benevolence, and that, of consequence, he wished to be known as the author; because, [9]
said he, I hate from my very soul dissimulation:

From Sherburn,[2] where I dwell,
I therefore put my name,
Your friend, who means you well,

PETER FOLGER.

My brothers were all put apprentices to different trades. With respect to myself, I was sent, at the age of eight years, to a grammar-school. My father destined me for the church, and already regarded me as the chaplain of the family. The promptitude with which from my infancy I had learned to read, for I do not remember to have been ever without this acquirement, and the encouragement of his friends, who assured him that I should one day certainly become a man of letters, confirmed him in this design. My uncle Benjamin approved also of the scheme, and promised to give me all his volumes of sermons, written, as I have said, in the short-hand of his invention, if I would take the pains to learn it.

I remained, however, scarcely a year at the grammar-school, although, in this short interval, I had risen from the middle to the head of my class, from thence to the class immediately above, and was to pass, at the end of the year, to the one next in order. But my father, burdened with a numerous family, found that he was incapable, without subjecting himself to difficulties, of providing for the expences of a collegiate education; and considering besides, as I heard him say to his [10]
friends, that persons so educated were often poorly provided for, he renounced his first intentions, took me from the grammar-school, and sent me to a school for writing and arithmetic, kept by a Mr. George Brownwell, who was a skilful master, and succeeded very well in his profession by employing gentle means only, and such as were calculated to encourage his scholars. Under him I soon acquired an excellent hand; but I failed in arithmetic, and made therein no sort of progress.

At ten years of age, I was called home to assist my father in his occupation, which was that of a soap-boiler and tallow-chandler; a business to which he had served no apprenticeship, but which he embraced on his arrival in New England, because he found his own, that of dyer, in too little request to enable him to maintain his family, I was accordingly employed in cutting the wicks, filling the moulds, taking care of the shop, carrying messages, &c.

This business displeased me, and I felt a strong inclination for a sea life; but my father set his face against it. The vicinity of the water, however, gave me frequent opportunities, of venturing myself both upon and within it, and I soon acquired the art of swimming, and of managing a boat. When embarked with other children, the helm was commonly deputed to me, particularly on difficult occasions; and, in every other project, I was almost always the leader of the troop, whom I sometimes involved in embarrassments. I shall give an instance of this, which demonstrates an early disposition of mind for public enterprises, though the one in question was not conducted by justice. [11]

The mill-pond was terminated on one side by a marsh, upon the borders of which we were accustomed to take our stand, at high water, to angle for small fish. By dint of walking, we had converted the place into a perfect quagmire. My proposal was to erect a wharf that should afford us firm footing; and I pointed out to my companions a large heap of stones, intended for the building a new house near the marsh, and which were well adapted for our purpose. Accordingly, when the workmen retired in the evening, I assembled a number of my play-fellows, and by labouring diligently, like ants, sometimes four of us uniting our strength to carry a single stone, we removed them all, and constructed our little quay. The workmen were surprised the next morning at not finding their stones; which had been conveyed to our wharf. Enquiries were made respecting the authors of this conveyance; we were discovered; complaints were exhibited against us; and many of us underwent correction on the part of our parents; and though I strenuously defended the utility of the work, my father at length convinced me, that nothing which was not strictly honest could be useful.

It will not, perhaps, be uninteresting to you to know what a sort of man my father was. He had an excellent constitution, was of a middle size, but well made and strong, and extremely active in whatever he undertook. He designed with a degree of neatness, and knew a little of music. His voice was sonorous and agreeable; so that when he sung a psalm or hymn, with the accompaniment of his violin, as was his frequent practice in an evening, when the labours of the day were [12]
finished, it was truly delightful to hear him. He was versed also in mechanics, and could, upon occasion, use the tools of a variety of trades. But his greatest excellence was a sound understanding and solid judgment, in matters of prudence, both in public and private life. In the former, indeed, he never engaged, because his numerous family, and the mediocrity of his fortune, kept him unremittingly employed in the duties of his profession. But I well remember, that the leading men of the place used frequently to come and ask his advice respecting the affairs of the town, or of the church to which he belonged, and that they paid much deference to his opinion. Individuals were also in the habit of consulting him in their private affairs, and he was often chosen arbiter between contending parties.

He was fond of having at his table, as often as possible, some friends or well-informed neighbours, capable of rational conversation, and he was always careful to introduce useful or ingenious topics of discourse, which might tend to form the minds of his children. By this means he early attracted our attention to what was just, prudent, and beneficial in the conduct of life. He never talked of the meats which appeared upon the table, never discussed whether they were well or ill dressed, of a good or bad flavour, high-seasoned or otherwise, preferable or inferior to this or that dish of a similar kind. Thus accustomed, from my infancy, to the utmost inattention as to these objects, I have been perfectly regardless of what kind of food was before me; and I pay so little attention to it even now, that it would be a hard matter for me to recollect, a [13]
few hours after I had dined, of what my dinner had consisted. When travelling, I have particularly experienced the advantage of this habit; for it has often happened to me to be in company with persons, who, having a more delicate, because a more exercised taste, have suffered in many cases considerable inconvenience; while, as to myself, I have had nothing to desire.

My mother was likewise possessed of an excellent constitution. She suckled all her ten children, and I never heard either her or my father complain of any other disorder than that of which they died: my father at the age of eighty-seven, and my mother at eighty-five. They are buried together at Boston, where, a few years ago, I placed a marble over their grave, with this inscription:

> "Here lie
> Josias Franklin and Abiah his wife: They lived together with reciprocal affection for fifty-nine years; and without private fortune, without lucrative employment, by assiduous labour and honest industry, decently supported a numerous family, and educated with success, thirteen children, and seven grand children. Let this example, reader, encourage thee diligently to discharge the duties of thy calling, and to rely on the support of divine providence,
> He was pious and prudent,
> She discreet and virtuous.
> Their youngest son, from a sentiment of filial duty, consecrates
> this stone
> to their memory."

I perceive, by my rambling digressions, that I am growing old. But we do not dress for a private company as for a formal ball. This deserves, perhaps, the name of negligence.

To return. I thus continued employed in my father's trade for the space of two years; that is to say, till I arrived at twelve [14] years of age. About this time my brother John, who had served his apprenticeship in London, having quitted my father, and being married and settled in business on his own account at Rhode Island, I was destined, to all appearance to supply his place, and be a candle-maker all my life: but my dislike of this occupation continuing, my father was apprehensive, that, if a more, agreeable one were not offered me, I might play the truant and escape to sea; as, to his extreme mortification, my brother Josias had done. He therefore took me sometimes to see masons, coopers, braziers, joiners, and other mechanics, employed at their work; in order to discover the bent of my inclination, and fix it if he could upon some occupation that might retain me on shore. I have since, in consequence of these visits, derived no small pleasure from seeing skilful workmen handle their tools; and it has proved of considerable benefit to have acquired thereby sufficient knowledge to be able to make little things for myself, when I have had no mechanic at hand, and to construct small machines for my experiments, while the idea I have conceived has been fresh and strongly impressed on my imagination.

My father at length decided that I should be a cutler, and I was placed for some days upon trial with my cousin Samuel, son of my uncle Benjamin, who had learned this trade in London, and had established himself at Boston. But the premium he required for my apprenticeship displeasing my father, I was recalled home.

From my earliest years I had been passionately fond of reading, and I laid out in books all the money I could procure. I [15] was particularly pleased with accounts of voyages. My first acquisition was Bunyan's works in small separate volumes. These I afterwards sold in order to buy an historical collection by R. Burton, which consisted of small cheap volumes, amounting in all to about forty or fifty. My father's little library was principally made up of books of practical and polemical theology. I read the greatest part of them. I have since often regretted that at a time when I had so great a thirst for knowledge, more eligible books had not fallen into my hands, as it was then a point decided that I should not be educated for the church. There was also among my father's books, Plutarch's Lives, in which I read continually, and I still regard as advantageously employed the time devoted to them. I found besides a work of De Foe's, entitled an Essay on Projects, from which, perhaps, I derived impressions that have since influenced some of the principal events of my life.

My inclination for books at last determined my father to make me a printer, though he had already a son in that profession. My brother had returned from England in 1717, with a press and types, in order to establish a printing-house at Boston. This business pleased me much better than that of my father, though I had still a predilection for the sea. To prevent the effects which might result from this inclination, my father was impatient to see me engaged with my brother. I held back for some time; at length, however, I suffered myself to be persuaded, and signed my indentures, being then only twelve years of age. It was agreed that I should serve as an apprentice to the age of twenty-one, and should receive [16]
journeyman's wages only during the last year.

In a very short time I made great proficiency in this business, and became very serviceable to my brother. I had now an opportunity of procuring better books. The acquaintance I necessarily formed with booksellers' apprentices, enabled me to borrow a volume now and then, which I never failed to return punctually and without injury. How often has it happened to me to pass the greater part of the night in reading by my bed-side, when the book had been lent me in the evening, and was to be returned the next morning, lest it might be missed or wanted!

At length, Mr. Matthew Adams, an ingenious tradesman, who had a handsome collection of books, and who frequented our printing-house, took notice of me. He invited me to see his library, and had the goodness to lend me any books I was desirous of reading. I then took a strange fancy for poetry, and composed several little pieces. My brother, thinking he might find his account in it, encouraged me, and engaged me to write two ballads. One, called the Light-house Tragedy, contained an account of the shipwreck of captain Worthilake and his two daughters; the other was a sailor's song on the capture of the noted pirate called *Teach*, or *Blackbeard*. They were wretched verses in point of style, mere blind-men's ditties. When printed, he dispatched me about the town to sell them. The first had a prodigious run, because the event was recent, and had made a great noise.

My vanity was flattered by this success; but my father checked my exultation, by ridiculing my productions, and telling [17]
me that versifiers were always poor. I thus escaped the misfortune of being a very wretched poet. But as the faculty of writing prose has been of great service to me in the course of my life, and principally contributed to my advancement, I shall relate by what means, situated as I was, I acquired the small skill I may possess in that way.

There was in the town another young man, a great lover of books, of the name of John Collins, with whom I was intimately connected. We frequently engaged in dispute, and were indeed so fond of argumentation, that nothing was so agreeable to us as a war of words. This contentious temper, I would observe by the bye, is in danger of becoming a very bad habit; and frequently renders a man's company insupportable, as being no otherwise capable of indulgence than by an indiscriminate contradiction. Independently of the acrimony and discord it introduces into conversation, it is often productive of dislike, and even hatred, between persons to whom friendship is indispensibly necessary. I acquired it by reading, while I lived with my father, books of religious controversy. I have since remarked, that men of sense seldom fall into this error: lawyers, fellows of universities, and persons of every profession educated at Edinburgh, excepted.

Collins and I fell one day into an argument, relative to the education of women; namely, whether it was proper to instruct them in the sciences, and whether they were competent to the study. Collins supported the negative, and affirmed that the task was beyond their capacity. I maintained the opposite opinion, a little perhaps for the pleasure of disputing. He was naturally more eloquent than I; words flowed copiously from his lips; and frequently I thought myself vanquished, [18]
more by his volubility than by the force of his arguments. We separated without coming to an agreement upon this point, and as we were not to see each other again for some time, I committed my thoughts to paper, made a fair copy, and sent it

him. He answered, and I replied. Three or four letters had been written by each, when my father chanced to light upon my papers and read them. Without entering into the merits of the cause, he embraced the opportunity of speaking to me upon my manner of writing. He observed, that though I had the advantage of my adversary in correct spelling and pointing, which I owed to my occupation, I was greatly his inferior in elegance of expression, in arrangement, and perspicuity. Of this he convinced me by several examples. I felt the justice of his remarks, became more attentive to language, and resolved to make every effort to improve my style.

Amidst these resolves an odd volume of the Spectator fell into my hands. This was a publication I had never seen. I bought the volume, and read it again and again. I was enchanted with it, thought the style excellent, and wished it were in my power to imitate it. With this view I selected some of the papers, made short summaries of the sense of each period, and put them for a few days aside. I then, without looking at the book, endeavoured to restore the essays to their due form, and to express each thought at length, as it was in the original, employing the most appropriate words that occurred to my mind. I afterwards compared my Spectator with the original; I perceived some faults, which I corrected: but I found that I wanted a fund of words, if I may so express myself, and a facility of recollecting and employing them, which I thought I [19]
should by that time have acquired, had I continued to make verses. The continual need of words of the same meaning, but of different lengths for the measure, or of different sounds for the rhyme, would have obliged me to seek for a variety of synonymes, and have rendered me master of them. From this belief, I took some of the tales of the Spectator and turned them into verse; and after a time, when I had sufficiently forgotten them, I again converted them into prose.

Sometimes also I mingled all my summaries together; and a few weeks after, endeavoured to arrange them in the best order, before I attempted to form the periods and complete the essays. This I did with a view of acquiring method in the arrangement of my thoughts. On comparing afterwards my performance with the original, many faults were apparent, which I corrected; but I had sometimes the satisfaction to think, that, in certain particulars of little importance, I had been fortunate enough to improve the order of thought or the style; and this encouraged me to hope that I should succeed, in time, in writing decently in the English language, which was one of the great objects of my ambition.

The time which I devoted to these exercises, and to reading, was the evening after my day's labour was finished, the morning before it began, and Sundays when I could escape attending divine service. While I lived with my father, he had insisted on my punctual attendance on public worship, and I still indeed considered it as a duty, but a duty which I thought I had no time to practise.

When about sixteen years of age, a work of Tyron's fell into my hands, in which he recommends vegetable diet. I [20]
determined to observe it. My brother being a bachelor, did not keep house, but boarded with his apprentices in a neighbouring family. My refusing to eat animal food was found inconvenient, and I was often scolded for my singularity. I attended to the mode in which Tryon prepared some of his dishes, particularly how to boil potatoes and rice, and make hasty puddings. I then said to my brother, that if he would allow me per week half what he paid for my board, I would undertake to maintain myself. The offer was instantly embraced, and I soon found that of what he gave me, I was able to save half. This was a new fund for the purchase of books; and other advantages resulted to me from the plan. When my brother and his workmen left the printing-house to go to dinner, I remained behind; and dispatching my frugal meal, which frequently consisted of a biscuit only, or a slice of bread and a bunch of raisins, or a bun from the pastry-cook's, with a glass of water, I had the rest of the time, till their return, for study; and my progress therein was proportioned to that clearness of ideas, and quickness of conception, which are the fruit of temperance in eating and drinking.

It was about this period, that having one day been put to the blush for my ignorance in the art of calculation, which I had twice failed to learn while at school, I took Cocker's Treatise of Arithmetic, and went through it by myself with the utmost ease. I also read a book of navigation by Seller and Sturmy, and made myself master of the little geometry it contains, but I never proceeded far in this science. Nearly at the same time I read Locke on the Human Understanding, [21] and the Art of Thinking, by Messrs. du Port Royal.

While labouring to form and improve my style, I met with an English Grammar, which I believe was Greenwood's, having at the end of it two little essays on rhetoric and logic. In the latter I found a model of disputation, after the manner of Socrates. Shortly after I procured Xenophon's work, entitled Memorable Things of Socrates, in which are various examples of the same method. Charmed to a degree of enthusiasm with this mode of disputing, I adopted it, and renouncing blunt contradiction, and direct and positive argument, I assumed the character of an humble questioner. The perusal of Shaftsbury and Collins had made me a sceptic; and being previously so as to many doctrines of Christianity, I found Socrates's method to be both safest for myself, as well as the most embarrassing to those against whom I employed it. It soon afforded me singular pleasure; I incessantly practised it; and became very adroit in obtaining, even from persons of superior understanding, concessions of which they did not foresee the consequence. Thus I involved them in difficulties from which they were unable to extricate themselves, and sometimes obtained victories, which neither my cause nor my arguments merited.

This method I continued to employ for some years; but I afterwards abandoned it by degrees, retaining only the habit of expressing myself with modest diffidence, and never making use, when I advanced any proposition which might be controverted, of the words *certainly*, *undoubtedly*, or any others that might give the appearance of being obstinately attached to my opinion. I rather said, I imagine, I suppose, or it appears to me, that such a thing is so or so, for such and [22] such reasons; or it is so, if I am not mistaken. This habit has, I think, been of considerable advantage to me, when I have had occasion to impress my opinion on the minds of others, and persuade them to the adoption of the measures I have suggested. And since the chief ends of conversation are, to inform or be informed, to please or to persuade, I could wish that intelligent or well-meaning men would not themselves diminish the power they possess of being useful, by a positive and presumptuous manner of expressing themselves, which scarcely ever fails to disgust the hearer, and is only calculated to excite opposition, and defeat every purpose for which the faculty of speech has been bestowed on man. In short, if you wish to inform, a positive and dogmatical manner of advancing your opinion may provoke contradiction, and prevent your being heard with attention. On the other hand, if, with a desire of being informed, and of benefiting by the knowledge of others, you express yourselves as being strongly attached to your own opinions, modest and sensible men, who do not love disputation, will leave you in tranquil possession of your errors. By following such a method, you can rarely hope to please your auditors, conciliate their good-will, or work conviction on those whom you may be desirous of gaining over to your views. Pope judiciously observes,

> Men must be taught, as if you taught them not,
> And things unknown propos'd—as things forgot.

And in the same poem he afterwards advises us

> To speak, though sure, with seeming diffidence.

He might have added to these lines, one that he has coupled elsewhere, in my opinion, with less propriety. It is this: [23]

> For want of modesty is want of sense.

If you ask why I say with *less propriety*, I must give you the two lines together:

Immodest words admit of *no defence*,
For want of decency is want of sense.

Now want of sense, when a man has the misfortune to be so circumstanced, is it not a kind of excuse for want of modesty? And would not the verses have been more accurate if they had been constructed thus:

Immodest words admit *but this defence*,
That want of decency is want of sense.

But I leave the decision of this to better judges than myself.

In 1720, or 1721, my brother began to print a new public paper. It was the second that made its appearance in America, and was entitled, "The New England Courant." The only one that existed before was the "Boston News Letter." Some of his friends, I remember, would have dissuaded him from this undertaking, as a thing that was not likely to succeed; a single newspaper being, in their opinion, sufficient for all America. At present, however, in 1771, there are no less than twenty-five. But he carried his project into execution, and I was employed in distributing the copies to his customers, after having assisted in composing and working them off.

Among his friends he had a number of literary characters, who, as an amusement, wrote short essays for the paper, [24]
which gave it reputation and increased the sale. These gentlemen frequently came to our house. I heard the conversation that passed, and the accounts they gave of the favourable reception of their writings with the public. I was tempted to try my hand among them; but, being still a child as it were, I was fearful that my brother might be unwilling to print in his paper any performance of which he should know me to be the author. I therefore contrived to disguise my hand, and having written an anonymous piece, I placed it at night under the door of the printing-house, where it was found the next morning. My brother communicated it to his friends, when they came as usual to see him, who read it, commented upon it within my hearing, and I had the exquisite pleasure to find that it met with their approbation, and that in the various conjectures they made respecting the author, no one was mentioned who did not enjoy a high reputation in the country for talents and genius. I now supposed myself fortunate in my judges, and began to suspect that they were not such excellent writers as I had hitherto supposed them. Be this as it may, encouraged by this little adventure, I wrote, and sent to press in the same way, many other pieces, which were equally approved: keeping the secret till my slender stock of information and knowledge for such performances was pretty completely exhausted, when I made myself known.

My brother, upon this discovery, began to entertain a little more respect for me; but he still regarded himself as my
master, and treated me as an apprentice. He thought himself entitled to the same services from me, as from any other [25]
person. On the contrary, I conceived that in many instances, he was too rigorous, and that, on the part of a brother, I had a right to expect greater indulgence. Our disputes were frequently brought before my father; and either my brother was generally wrong, or I was the better pleader of the two, for judgment was commonly given in my favour. But my brother was passionate, and often had recourse to blows—a circumstance which I took in very ill part. This severe and tyrannical treatment contributed, I believe, to imprint on my mind that aversion to arbitrary power, which during my whole life I have ever preserved. My apprenticeship became insupportable to me, and I continually sighed for an opportunity of shortening it, which at length unexpectedly offered.

An article inserted in our paper, upon some political subject which I have now forgotten, gave offence to the assembly. My brother was taken into custody, censured, and ordered into confinement for a month, because, as I presume, he would not discover the author. I was also taken up, and examined before the council; but though I gave them no satisfaction, they contented themselves with reprimanding, and then dismissed me; considering me probably as bound, in quality of apprentice, to keep my master's secrets.

The imprisonment of my brother kindled my resentment, notwithstanding our private quarrels. During its continuance, the management of the paper was entrusted to me, and I was bold enough to insert some pasquinades against the governors, which highly pleased my brother, while others began to look upon me in an unfavourable point of view, considering me as a young wit inclined to satire and lampoon.

My brother's enlargement was accompanied with an arbitrary order from the house of the assembly, "That James [26]
Franklin should no longer print the newspaper entitled 'The New England Courant.'" In this conjuncture, we held a consultation of our friends at the printing-house, in order to determine what was proper to be done. Some proposed to evade the order, by changing the title of the paper: but my brother, foreseeing inconveniences that would result from this step, thought it better that it should be in future printed in the name of Benjamin Franklin; and to avoid the censure of the assembly, who might charge him with still printing the paper himself under the name of his apprentice, it was resolved that my old indentures should be given up to me, with a full and entire discharge written on the back, in order to be produced upon an emergency; but that, to secure to my brother the benefit of my service, I should sign a new contract, which should be kept secret during the remainder of the term. This was a very shallow arrangement. It was, however, carried into immediate execution, and the paper continued, in consequence, to make its appearance for some months in my name. At length a new difference arising between my brother and me, I ventured to take advantage of my liberty, presuming that he would not dare to produce the new contract. It was undoubtedly dishonourable to avail myself of this circumstance, and I reckon this action as one of the first errors of my life; but I was little capable of estimating it at its true value, embittered as my mind had been by the recollection of the blows I had received. Exclusively of his passionate treatment of me, my brother was by no means a man of an ill temper, and perhaps my manners had too much impertinence [27]
not to afford it a very natural pretext.

When he knew that it was my determination to quit him, he wished to prevent my finding employment elsewhere. He went to all the printing-houses in the town, and prejudiced the masters against me—who accordingly refused to employ me. The idea then suggested itself to me of going to New York, the nearest town in which there was a printing-office. Farther reflection confirmed me in the design of leaving Boston, where I had already rendered myself an object of suspicion to the governing party. It was probable, from the arbitrary proceedings of the assembly in the affair of my brother, that, by remaining, I should soon have been exposed to difficulties, which I had the greater reason to apprehend, as, from my indiscreet disputes upon the subject of religion, I began to be regarded by pious souls with horror, either as an apostate or an atheist. I came, therefore, to a resolution: but my father, in this instance siding with my brother, presumed that if I attempted to depart openly, measures would be taken to prevent me. My friend Collins undertook to favour my flight. He agreed for my passage with the captain of a New York sloop, to whom he represented me as a young man of his acquaintance, who had an affair with a girl of bad character, whose parents wished to compel me to marry her, and that of consequence I could neither make my appearance, nor go off publicly. I sold part of my books to procure a small sum of money, and went privately on board the sloop. By favour of a good wind, I found myself in three days at New York, nearly three hundred miles from my home, at the age only of seventeen years, without knowing an individual in the place, [28] and with very little money in my pocket.

The inclination I had felt for a sea-faring life had entirely subsided, or I should now have been able to gratify it; but having another trade, and believing myself to be a tolerable workman, I hesitated not to offer my services to old Mr. William Bradford, who had been the first printer in Pennsylvania, but had quitted that province on account of a quarrel with George Keith, the governor. He could not give me employment himself, having little to do, and already as many persons as he wanted; but he told me that his son, a printer at Philadelphia, had lately lost his principal workman, Aquilla Rose, who was dead, and that if I would go thither, he believed that he would engage me. Philadelphia was a hundred miles farther. I hesitated not to embark in a boat in order to repair, by the shortest cut of the sea, to Amboy, leaving my trunk and effects to come after me by the usual and more tedious conveyance. In crossing the bay we met with a squall, which shattered to pieces our rotten sails, prevented us from entering the Kill, and threw us upon Long Island.

During the squall, a drunken Dutchman, who like myself was a passenger in the boat, fell into the sea. At the moment that he was sinking, I seized him by the fore-top, saved him, and drew him on board. This immersion sobered him a little, so that he fell asleep, after having taken from his pocket a volume, which he requested me to dry. This volume I found to be my old favourite Bunyan, in Dutch, a beautiful impression on fine paper, with copper-plate engravings—a dress in which I had never seen it in its original language. I have since learned that it has been translated into almost all the [29] languages of Europe, and next to the Bible, I am persuaded, it is one of the books which has had the greatest spread. Honest John is the first, that I know of, who has mixed narrative and dialogue together; a mode of writing very engaging to the reader, who in the most interesting passages, finds himself admitted as it were into the company, and present at the conversation. De Foe has imitated it with success in his Robinson Crusoe, his Moll Flanders, and other works; as also Richardson in his Pamela, &c.

In approaching the island, we found that we had made a part of the coast where it was not possible to land, on account of the strong breakers produced by the rocky shore. We cast anchor and veered the cable towards the shore. Some men, who stood upon the brink, halloed to us, while we did the same on our part; but the wind was so high, and the waves so noisy, that we could neither of us hear each other. There were some canoes upon the bank, and we called out to them, and made signs to prevail on them to come and take us up; but either they did not understand us, or they deemed our request impracticable, and withdrew. Night came on, and nothing remained for us but to wait quietly the subsiding of the wind; till when, we determined, that is, the pilot and I, to sleep if possible. For that purpose we went below the hatches along with the Dutchman, who was drenched with water. The sea broke over the boat, and reached us in our retreat, so that we were presently as completely drenched as he.

We had very little repose during the whole night: but the wind abating the next day, we succeeded in reaching Amboy [30] before it was dark, after having passed thirty hours without provisions, and with no other drink than a bottle of bad rum, the water upon which we rowed being salt. In the evening I went to bed with a very violent fever. I had somewhere read that cold water, drank plentifully, was a remedy in such cases. I followed the prescription, was in a profuse sweat for the greater part of the night, and the fever left me. The next day I crossed the river in a ferryboat, and continued my journey on foot. I had fifty miles to walk, in order to reach Burlington, where I was told I should find passage-boats that would convey me to Philadelphia. It rained hard the whole day, so that I was wet to the skin. Finding myself fatigued about noon, I stopped at a paltry inn, where I passed the rest of the day and the whole night, beginning to regret that I had quitted my home. I made besides so wretched a figure, that I was suspected to be some runaway servant. This I discovered by the questions that were asked me; and I felt that I was every moment in danger of being taken up as such. The next day, however, I continued my journey, and arrived in the evening at an inn, eight or ten miles from Burlington, that was kept by one Dr. Brown.

This man entered into conversation with me while I took some refreshment, and perceiving that I had read a little, he expressed towards me considerable interest and friendship. Our acquaintance continued during the remainder of his life. I believe him to have been what is called an itinerant doctor; for there was no town in England, or indeed in Europe, of [31] which he could not give a particular account. He was neither deficient in understanding or literature, but he was a sad infidel; and, some years after, wickedly undertook to travesty the Bible, in burlesque verse, as Cotton has travestied Virgil. He exhibited, by this means, many facts in a very ludicrous point of view, which would have given umbrage to weak minds, had his work been published, which it never was.

I spent the night at his house, and reached Burlington the next morning. On my arrival, I had the mortification to learn that the ordinary passage-boats had sailed a little before. This was on a Saturday, and there would be no other boat till the Tuesday following. I returned to the house of an old woman in the town who had sold me some gingerbread to eat on my passage, and I asked her advice. She invited me to take up my abode with her till an opportunity offered for me to embark. Fatigued with having travelled so far on foot, I accepted her invitation. When she understood that I was a printer, she would have persuaded me to stay at Burlington, and set up my trade; but she was little aware of the capital that would be necessary for such a purpose! I was treated while at her house with true hospitality. She gave me with the utmost good-will, a dinner of beef-steaks, and would accept of nothing in return but a pint of ale.

Here I imagined myself to be fixed till the Tuesday in the ensuing week; but walking out in the evening by the river side, I saw a boat with a number of persons in it approach. It was going to Philadelphia, and the company took me in. As there was no wind, we could only make way with our oars. About midnight, not perceiving the town, some of the [32] company were of opinion that we must have passed it, and were unwilling to row any farther; the rest not knowing where we were, it was resolved that we should stop. We drew towards the shore, entered a creek, and landed near some old palisades, which served us for fire-wood, it being a cold night in October. Here we stayed till day, when one of the company found the place in which we were to be Cooper's creek, a little above Philadelphia; which in reality we perceived the moment we were out of the creek. We arrived on Sunday about eight or nine o'clock in the morning, and landed on Market-street wharf.

I have entered into the particulars of my voyage, and shall in like manner describe my first entrance into this city, that you may be able to compare beginnings so little auspicious, with the figure I have since made.

On my arrival at Philadelphia I was in my working dress, my best cloaths being to come by sea. I was covered with dirt; my pockets were filled with shirts and stockings; I was unacquainted with a single soul in the place, and knew not where to seek for a lodging. Fatigued with walking, rowing, and having passed the night without sleep, I was extremely hungry, and all my money consisted of a Dutch dollar, and about a shilling's worth of coppers, which I gave to the boatmen for my passage. As I had assisted them in rowing, they refused it at first; but I insisted on their taking it. A man is sometimes more generous when he has little, than when he has much money; probably because, in the first case, he is desirous of concealing his poverty.

I walked towards the top of the street, looking eagerly on both sides, till I came to Market-street, where I met a child [33] with a loaf of bread. Often had I made my dinner on dry bread. I enquired where he had bought it, and went straight to the baker's shop which he pointed out to me. I asked for some biscuits, expecting to find such as we had at Boston; but they made, it seems, none of that sort at Philadelphia. I then asked for a three-penny loaf; they made no loaves of that price. Finding myself ignorant of the prices, as well as of the different kinds of bread, I desired him to let me have three pennyworth of bread of some kind or other. He gave me three large rolls. I was surprised at receiving so much: I took them, however, and having no room in my pockets, I walked on with a roll under each arm, eating the third. In this manner I went through Market-street to Fourth-street, and passed the house of Mr. Read, the father of my future wife. She was standing at the door, observed me, and thought with reason, that I made a very singular and grotesque appearance.

I then turned the corner, and went through Chesnut-street, eating my roll all the way; and having made this round, I found myself again on Market-street wharf, near the boat in which I arrived. I stepped into it to take a draught of the river water; and finding myself satisfied with my first roll, I gave the other two to a woman and her child, who had come down the river with us in the boat, and was waiting to continue her journey. Thus refreshed, I regained the street, which was now full of well-dressed people, all going the same way. I joined them, and was thus led to a large Quaker's meeting-house near the market-place. I sat down with the rest, and after looking round me for some time, hearing nothing said, and being drowsy from my last night's labour and want of rest, I fell into a sound sleep. In this state I continued till the [34]
assembly dispersed, when one of the congregation had the goodness to wake me. This was consequently the first house I entered, or in which I slept, at Philadelphia.

I began again to walk along the street by the river side; and looking attentively in the face of every one I met, I at length perceived a young quaker whose countenance pleased me. I accosted him, and begged him to inform me where a stranger might find a lodging. We were then near the sign of the three Mariners. They receive travellers here, said he, but it is not a house that bears a good character; if you will go with me, I will shew you a better one. He conducted me to the Crooked-billet, in Water-street. There I ordered something for dinner, and during my meal a number of curious questions were put to me; my youth and appearance exciting the suspicion of my being a runaway. After dinner my drowsiness returned, and I threw myself upon a bed without taking off my cloaths, and slept till six o'clock in the evening, when I was called to supper. I afterwards went to bed at a very early hour, and did not awake till the next morning.

As soon as I got up I put myself in as decent a trim as I could, and went to the house of Andrew Bradford the printer. I found his father in the shop, whom I had seen at New York. Having travelled on horseback, he had arrived at Philadelphia before me. He introduced me to his son, who received me with civility, and gave me some breakfast; but told me he had no occasion at present for a journeyman, having lately procured one. He added, that there was another printer newly settled in the town, of the name of Keimer, who might perhaps employ me; and that in case of refusal, I should be [35]
welcome to lodge at his house, and he would give me a little work now and then, till something better should offer.

The old man offered to introduce me to the new printer. When we were at his house: "Neighbour," said he, "I bring you a young man in the printing business; perhaps you may have need of his services."

Keimer asked me some questions, put a composing stick in my hand to see how I could work, and then said, that at present he had nothing for me to do, but that he should soon be able to employ me. At the same time taking old Bradford for an inhabitant of the town well-disposed towards him, he communicated his project to him, and the prospect he had of success. Bradford was careful not to discover that he was the father of the other printer; and from what Keimer had said, that he hoped shortly to be in possession of the greater part of the business of the town, led him by artful questions, and by starting some difficulties, to disclose all his views, what his hopes were founded upon, and how he intended to proceed. I was present, and heard it all. I instantly saw that one of the two was a cunning old fox, and the other a perfect novice. Bradford left me with Keimer, who was strangely surprised when I informed him who the old man was.

I found Keimer's printing materials to consist of an old damaged press, and a small fount of worn-out English letters, with which he himself was at work upon an elegy on Aquila Rose, whom I have mentioned above, an ingenious young man, and of an excellent character, highly esteemed in the town, secretary to the assembly, and a very tolerable poet. Keimer also made verses, but they were indifferent ones. He could not be said to write in verse, for his method was to set [36] the lines as they flowed from his muse; and as he worked without copy, had but one set of letter-cases, and the elegy would probably occupy all his types, it was impossible for any one to assist him. I endeavoured to put his press in order, which he had not yet used, and of which indeed he understood nothing: and having promised to come and work off his elegy as soon as it should be ready, I returned to the house of Bradford, who gave me some trifle to do for the present, for which I had my board and lodging.

In a few days Keimer sent for me to print off his elegy. He had now procured another set of letter-cases, and had a pamphlet to re-print, upon which he set me to work.

The two Philadelphia printers appeared destitute of every qualification necessary in their profession. Bradford had not been brought up to it, and was very illiterate. Keimer, though he understood a little of the business, was merely a compositor, and wholly incapable of working at the press. He had been one of the French prophets; and knew how to imitate their supernatural agitations. At the time of our first acquaintance he professed no particular religion, but a little of all upon occasion. He was totally ignorant of the world, and a great knave at heart, as I had afterwards, an opportunity of experiencing.

Keimer could not endure that, working with him, I should lodge at Bradford's. He had indeed a house, but it was unfurnished; so that he could not take me in. He procured me a lodging at Mr. Read's, his landlord, whom I have already mentioned. My trunk and effects being now arrived, I thought of making, in the eyes of Miss Read, a more respectable [37] appearance than when chance exhibited me to her view, eating my roll, and wandering in the streets.

From this period I began to contract acquaintance with such young people of the town as were fond of reading, and spent my evenings with them agreeably, while at the same time I gained money by my industry, and, thanks to my frugality, lived contented. I thus forgot Boston as much as possible, and wished every one to be ignorant of the place of my residence, except my friend Collins, to whom I wrote, and who kept my secret.

An incident however arrived, which sent me home much sooner than I had proposed. I had a brother-in-law, of the name of Robert Holmes, master of a trading sloop from Boston to Delaware. Being at Newcastle, forty miles below Philadelphia, he heard of me, and wrote to inform me of the chagrin which my sudden departure from Boston had occasioned my parents, and of the affection which they still entertained for me, assuring me that, if I would return, every thing should be adjusted to my satisfaction; and he was very pressing in his entreaties. I answered his letter, thanked him for his advice, and explained the reasons which had induced me to quit Boston, with such force and clearness, that he was convinced I had been less to blame than he had imagined.

Sir William Keith, governor of the province, was at Newcastle at the time. Captain Holmes, being by chance in his company when he received my letter, took occasion to speak of me, and showed it him. The governor read it, and appeared surprised when he learned my age. He thought me, he said, a young man of very promising talents, and that, of [38] consequence, I ought to be encouraged; that there were at Philadelphia none but very ignorant printers, and that if I were to set up for myself, he had no doubt of my success; that, for his own part, he would procure me all the public business, and would render me every other service in his power. My brother-in-law related all this to me afterwards at Boston; but I knew nothing of it at the time; when one day Keimer and I being at work together near the window, we saw the governor and another gentleman, colonel French, of Newcastle, handsomely dressed, cross the street, and make directly for our house. We heard them at the door, and Keimer believing it to be a visit to himself, went immediately down: but the governor enquired for me, came up stairs, and, with a condescension and politeness to which I had not at all been accustomed, paid me many compliments, desired to be acquainted with me, obligingly reproached me for not having made myself known to him on my arrival in the town, and wished me to accompany him to a tavern, where he and colonel French were going to taste some excellent Madeira wine.

I was, I confess, somewhat surprised, and Keimer appeared thunderstruck. I went, however, with the governor and the colonel to a tavern at the corner of Third-street, where, while we were drinking the Madeira, he proposed to me to establish a printing-house. He set forth the probabilities of success, and himself, and colonel French assured me that I should have their protection and influence in obtaining the printing of the public papers of both governments; and as I appeared to doubt whether my father would assist me in this enterprize, Sir William said that he would give me a letter to [39] him, in which he would represent the advantages of the scheme, in a light which he had no doubt would determine him. It was thus concluded that I should return to Boston by the first vessel, with the letter of recommendation, from the governor to my father. Meanwhile the project was to be kept secret, and I continued to work for Keimer as before.

The governor sent every now and then to invite me to dine with him. I considered this as a very great honour; and I was the more sensible of it, as he conversed with me in the most affable, familiar, and friendly manner imaginable.

Towards the end of April 1724, a small vessel was ready to sail for Boston. I took leave of Keimer, upon the pretext of going to see my parents. The governor gave me a long letter, in which he said many flattering things of me to my father; and strongly recommended the project of my settling at Philadelphia, as a thing which could not fail to make my fortune.

Going down the bay we struck on a flat, and sprung a leak. The weather was very tempestuous, and we were obliged to pump without intermission; I took my turn. We arrived, however, safe and sound at Boston, after about a fortnight's passage.

I had been absent about seven complete months, and my relations, during that interval, had received no intelligence of me; for my brother-in-law, Holmes, was not yet returned, and had not written about me. My unexpected appearance surprized the family; but they were all delighted at seeing me again, and, except my brother, welcomed me home. I went to him at the printing-house. I was better dressed than I had ever been while in his service: I had a complete suit of [40] clothes, new and neat, a watch in my pocket, and my purse was furnished with nearly five pounds sterling in money. He gave me no very civil reception; and having eyed me from head to foot, resumed his work.

The workmen asked me with eagerness where I had been, what sort of a country it was, and how I liked it. I spoke in the highest terms of Philadelphia, the happy life we led there, and expressed my intention of going back again. One of them asking what sort of money we had, I displayed before them a handful of silver, which I drew from my pocket. This was a curiosity to which they were not accustomed, paper being the current money at Boston. I failed not after this to let them see my watch; and at last, my brother continuing sullen and out of humour, I gave them a shilling to drink, and took my leave. This visit stung my brother to the soul; for when, shortly after, my mother spoke to him of a reconciliation, and a desire to see us upon good terms, he told her that I had so insulted him before his men, that he would never forget or forgive it: in this, however, he was mistaken.

The governor's letter appeared to excite in my father some surprize; but he said little. After some days, captain Holmes being returned, he showed it him, asking him if he knew Keith, and what sort of a man he was: adding, that, in his opinion, it proved very little discernment to think of setting up a boy in business, who for three years to come would not be of an age to be ranked in the class of men. Holmes said every thing he could in favour of the scheme; but my father firmly maintained its absurdity, and at last gave a positive refusal. He wrote, however, a civil letter to Sir William, [41] thanking him for the protection he had so obligingly offered me, but refusing to assist me for the present, because he thought me too young to be entrusted with the conduct of so important an enterprise, and which would require so considerable a sum of money.

My old comrade Collins, who was a clerk in the post-office, charmed with the account I gave of my new residence, expressed a desire of going thither; and while I waited my father's determination, he set off before me by land for Rhode Island, leaving his books, which formed a handsome collection in mathematics and natural philosophy, to be conveyed with mine to New York, where he purposed to wait for me.

My father, though he could not approve Sir William's proposal, was yet pleased that I had obtained so advantageous a recommendation as that of a person of his rank, and that my industry and economy had enabled me to equip myself so handsomely in so short a period. Seeing no appearance of accommodating matters between my brother and me, he consented to my return to Philadelphia, advised me to be civil to every body, to endeavour to obtain general esteem, and avoid satire and sarcasm, to which he thought I was too much inclined; adding, that with perseverance and prudent economy, I might, by the time I became of age, save enough to establish myself in business; and that if a small sum should then be wanting, he would undertake to supply it.

This was all I could obtain from him, except some trifling presents, in token of friendship from him and my mother. I [42] embarked once more for New York, furnished at this time with their approbation and blessing. The sloop having touched at Newport in Rhode Island, I paid a visit to my brother John, who had for some years been settled there, and was married. He had always been attached to me, and he received me with great affection. One of his friends, whose name was Vernon, having a debt of about thirty-six pounds due to him in Pennsylvania, begged me to receive it for him, and to keep the money till I should hear from him: accordingly he gave me an order for that purpose. This affair occasioned me, in the sequel, much uneasiness.

At Newport we took on board a number of passengers; among whom were two young women, and a grave and sensible quaker lady with her servants. I had shown an obliging forwardness in rendering the quaker some trifling services, which led her, probably, to feel an interest in my welfare; for when she saw a familiarity take place, and every day increase, between the two young women and me, she took me aside and said: "Young man, I am in pain for thee. Thou hast no parent to watch over thy conduct, and thou seemest to be ignorant of the world, and the snares to which youth is exposed. Rely upon what I tell thee: those are women of bad characters; I perceive it in all their actions. If thou dost not take care, they will lead thee into danger. They are strangers to thee, and I advise thee, by the friendly interest I take in thy preservation, to form no connection with them." As I appeared at first not to think quite so ill of them as she did, she related many things she had seen and heard, which had escaped my attention, but which convinced me that she was in the [43] right. I thanked her for her obliging advice, and promised to follow it.

When we arrived at New York, they informed me where they lodged, and invited me to come and see them. I did not however go, and it was well I did not; for the next day, the captain missing a silver spoon and some other things which had been taken from the cabin, and knowing these women to be prostitutes, procured a search-warrant, found the stolen goods upon them, and had them punished. And thus, after having been saved from one rock concealed under water, upon which the vessel struck during our passage, I escaped another of a still more dangerous nature.

At New York I found my friend Collins, who had arrived some time before. We had been intimate from our infancy, and had read the same books together; but he had the advantage of being able to devote more time to reading and study, and an astonishing disposition for mathematics, in which he left me far behind him. When at Boston, I had been accustomed to pass with him almost all my leisure hours. He was then a sober and industrious lad; his knowledge had gained him a very general esteem, and he seemed to promise to make an advantageous figure in society. But, during my absence, he had unfortunately addicted himself to brandy, and I learned, as well from himself as from the report of others, that every day since his arrival at New York he had been intoxicated, and had acted in a very extravagant manner. He had also played, and lost all his money; so that I was obliged to pay his expences at the inn, and to maintain him during the [44]
rest of his journey; a burthen that was very inconvenient to me.

The governor of New York, whose name was Burnet, hearing the captain say, that a young man who was a passenger in his ship had a great number of books, begged him to bring me to his house. I accordingly went, and should have taken Collins with me, had he been sober. The governor treated me with great civility, shewed me his library, which was a very considerable one, and we talked for some time upon books and authors. This was the second governor who had honoured me with his attention, and to a poor boy, as I was then, these little adventures did not fail to be pleasing.

We arrived at Philadelphia. On the way I received Vernon's money, without which we should have been unable to have finished our journey.

Collins wished to get employment as a merchant's clerk, but either his breath or his countenance betrayed his bad habit; for, though he had recommendations he met with no success, and continued to lodge and eat with me, and at my expence. Knowing that I had Vernon's money, he was continually asking me to lend him some of it, promising to repay me as soon as he should get employment. At last he had drawn so much of this money, that I was extremely alarmed at what might become of me, should he fail to make good the deficiency. His habit of drinking did not at all diminish, and was a frequent source of discord between us; for when he had drank a little too much, he was very head-strong.

Being one day in a boat together on the Delaware, with some other young persons, he refused to take his turn in [45]
rowing. You shall row for me, said he, till we get home.—No, I replied, we will not row for you.—You shall, said he, or remain upon the water all night. As you please.—Let us row, said the rest of the company; what signifies whether he assists or not. But, already angry with him for his conduct in other respects, I persisted in my refusal. He then swore that he would make me row, or would throw me out of the boat; and he made up to me. As soon as he was within my reach, I took him by the collar, gave him a violent thrust, and threw him head foremost into the river. I knew that he was a good swimmer, and was therefore under no apprehensions for his life. Before he could turn himself, we were able, by a few strokes of our oars, to place ourselves out of his reach; and whenever he touched the boat, we asked him if he would row striking his hands at the same time with the oars, to make him let go his hold. He was nearly suffocated with rage, but obstinately refused making any promise to row. Perceiving, at length, that his strength began to be exhausted, we took him into the boat, and conveyed him home in the evening completely drenched. The utmost coldness subsisted between us

after this adventure. At last the captain of a West-India ship, who was commissioned to procure a tutor for the children of a gentleman at Barbadoes, meeting with Collins, offered him the place. He accepted it, and took his leave of me, promising to discharge the debt he owed me with the first money he should receive; but I have heard nothing of him since.

The violation of the trust reposed in me by Vernon, was one of the first great errors of my life; and it proves that my father was not mistaken when he supposed me too young to be intrusted with the management of important affairs. But [46] Sir William, upon reading his letter, thought him too prudent. There was a difference, he said, between individuals: years of maturity were not always accompanied with discretion, neither was youth in every instance devoid of it. Since your father, added he, will not set you up in business, I will do it myself. Make out a list of what will be wanted from England, and I will send for the articles. You shall repay me when you can. I am determined to have a good printer here, and I am sure you will succeed. This was said with so much seeming cordiality, that I suspected not for an instant the sincerity of the offer. I had hitherto kept the project, with which Sir William had inspired me, of settling in business, a secret at Philadelphia, and I still continued to do so. Had my reliance on the governor been known, some friend better acquainted with his character than myself, would doubtless have advised me not to trust him; for I afterwards learned he was universally known to be liberal of promises, which he had no intention to perform. But having never solicited him, how could I suppose his offers to be deceitful?—On the contrary, I believed him to be the best man in the world.

I gave him an inventory of a small printing-office, the expence of which I had calculated at about a hundred pounds sterling. He expressed his approbation; but asked, if my presence in England, that I might choose the characters myself, and see that every article was good in its kind, would not be an advantage? You will also be able, said he, to form some acquaintance there, and establish a correspondence with stationers and booksellers. This I acknowledged was desirable. That being the case, added he, hold yourself in readiness to go with the Annis. This was the annual vessel, and the only [47] one, at that time, which made regular voyages between the ports of London and Philadelphia. But the Annis was not to sail for some months. I therefore continued to work with Keimer, unhappy respecting the sum which Collins had drawn from me, and almost in continual agony at the thoughts of Vernon, who fortunately made no demand of his money till several years after.

In the account of my first voyage from Boston to Philadelphia, I omitted, I believe, a trifling circumstance, which will not, perhaps, be out of place here. During a calm which stopped us above Block Island, the crew employed themselves in fishing for cod, of which they caught a great number. I had hitherto adhered to my resolution of not eating any thing that had possessed life; and I considered on this occasion, agreeably to the maxims of my master Tryon, the capture of every fish as a sort of murder, committed without provocation, since these animals had neither done, nor were capable of doing the smallest injury to any one that should justify the measure. This mode of reasoning I conceived to be unanswerable. Meanwhile, I had formerly been extremely fond of fish; and when one of these cod was taken out of the frying-pan, I thought its flavour delicious. I hesitated some time between principle and inclination, till at last recollecting, that when the cod had been opened, some small fish were found in its belly, I said to myself, if you eat one another, I see no reason why we may not eat you. I accordingly dined on the cod with no small degree of pleasure, and have since continued to eat like the rest of mankind, returning only occasionally to my vegetable plan. How convenient does it prove to be a *rational* [48] *animal*, that knows how to find or invent a plausible pretext for whatever it has an inclination to do!

I continued to live upon good terms with Keimer, who had not the smallest suspicion of my projected establishment. He still retained a portion of his former enthusiasm; and, being fond of argument, we frequently disputed together. I was so much in the habit of using my Socratic method, and had so frequently puzzled him by my questions, which appeared at first very distant from the point in debate, yet nevertheless led to it by degrees, involving him in difficulties and contradictions from which he was unable to extricate himself, that he became at last ridiculously cautious, and would scarcely answer the most plain and familiar question without previously asking me—What would you infer from that? Hence he formed so high an opinion of my talents for refutation, that he seriously proposed to me to become his colleague in the establishment of a new religious sect. He was to propagate the doctrine by preaching, and I to refute every opponent.

When he explained to me his tenets, I found many absurdities which I refused to admit, unless he would agree in turn to adopt some of my opinions. Keimer wore his beard long, because Moses had somewhere said, "Thou shalt not mar the corners of thy beard." He likewise observed the Sabbath; and these were with him two very essential points. I disliked them both: but I consented to adopt them, provided he would agree to abstain from animal food. I doubt, said he, whether my constitution will be able to support it. I assured him on the contrary he would find himself the better for it. He was [49] naturally a glutton, and I wished to amuse myself by starving him. He consented to make trial of this regimen, if I would bear him company; and in reality we continued it for three months. A woman in the neighbourhood prepared and brought us our victuals, to whom I gave a list of forty dishes; in the composition of which there were entered neither flesh nor fish. This fancy was the more agreeable to me as it turned to good account; for the whole expence of our living did not exceed for each eighteen pence a week.

I have since that period observed several Lents with the greatest strictness, and have suddenly returned again to my ordinary diet, without experiencing the smallest inconvenience; which has led me to regard as of no importance the advice commonly given, of introducing gradually such alterations of regimen.

I continued it cheerfully, but poor Keimer suffered terribly. Tired of the project, he sighed for the fleshpots of Egypt. At length he ordered a roast pig, and invited me and two of our female acquaintance to dine with him; but the pig being ready a little too soon, he could not resist the temptation, and eat it all up before we arrived.

During the circumstances I have related, I had paid some attentions to Miss Read. I entertained for her the utmost esteem and affection; and I had reason to believe that these sentiments were mutual. But we were both young, scarcely more than eighteen years of age; and as I was on the point of undertaking a long voyage, her mother thought it prudent to prevent matters being carried top far for the present, judging that, if marriage was our object, there would be more [50] propriety in it after my return, when, as at least I expected, I should be established in my business. Perhaps, also, she thought my expectations were not so well founded as I imagined.

My most intimate acquaintance at this time were Charles Osborne, Joseph Watson, and James Ralph: young men who were all fond of reading. The two first were clerks to Mr. Charles Brockdon, one of the principal attornies in the town, and the other clerk to a merchant. Watson was an upright, pious, and sensible young man: the others were somewhat more loose in their principles of religion, particularly Ralph, whose faith, as well as that of Collins, I had contributed to shake; each of whom made me suffer a very adequate punishment. Osborne was sensible, and sincere and affectionate in his friendships, but too much inclined to the critic in matters of literature. Ralph was ingenious and shrewd, genteel in his address, and extremely eloquent. I do not remember to have met with a more agreeable speaker. They were both enamoured of the muses, and had already evinced their passion by some small poetical productions.

It was a custom with us to take a charming walk on Sundays, in the woods that border the Skuylkil. Here we read together, and afterwards conversed on what we read. Ralph was disposed to give himself up entirely to poetry. He flattered himself that he should arrive at great eminence in the art, and even acquire a fortune. The sublimest poets, he pretended, when they first began to write, committed as many faults as himself. Osborne endeavoured to dissuade him, by assuring him that he had no genius for poetry, and advised him to stick to the trade in which he had been brought up. In [51] the road of commerce, said he, you will be sure, by diligence and assiduity, though you have no capital, of so far succeeding as to be employed as a factor; and may thus, in time, acquire the means of setting up for yourself. I concurred in these sentiments, but at the same time expressed my approbation of amusing ourselves sometimes with poetry, with a view to improve our style. In consequence of this it was proposed, that, at our next meeting, each of us should bring a copy of verses of his own composition. Our object in this competition was to benefit each other by our mutual remarks, criticisms, and corrections; and as style and expression were all we had in view, we excluded every idea of invention, by agreeing that our task should be a version of the eighteenth psalm, in which is described the descent of the Deity.

The time of our meeting drew near, when Ralph called upon me, and told me that his performance was ready. I informed him that I had been idle, and, not much liking the task, had done nothing. He shewed me his piece, and asked me what I thought of it. I expressed myself in terms of warm approbation; because it really appeared to have considerable merit. He then said, Osborne will never acknowledge the smallest degree of excellence in any production of mine. Envy alone dictates to him a thousand animadversions. Of you he is not so jealous: I wish, therefore, you would take the verses, and produce them as your own. I will pretend not to have had leisure to write any thing. We shall then see in what manner he will speak of them. I agreed to this little artifice, and immediately transcribed the verses to prevent all suspicion. [52]

We met. Watson's performance was the first that was read; it had some beauties, but many faults. We next read Osborne's, which was much better. Ralph did it justice, remarking a few imperfections, and applauding such parts as were excellent. He had himself nothing to show. It was now my turn. I made some difficulty; seemed as if I wished to be excused; pretended that I had had no time to make corrections, &c. No excuse, however, was admissible, and, the piece must be produced. It was read, and re-read. Watson and Osborne immediately resigned the palm, and united in applauding it. Ralph alone made a few remarks, and proposed some alterations; but I defended my text. Osborne agreed with me, and told Ralph that he was no more able to criticise than he was able to write.

When Osborne was alone with me, he expressed himself still more strongly in favour of what he considered as my performance. He pretended that he had put some restraint upon himself before, apprehensive of my construing his commendation into flattery. But who would have supposed, said he, Franklin to be capable of such a composition? What painting—what energy—what fire! He has surpassed the original. In his common conversation he appears not to have a choice of words; he hesitates, and is at a loss—and yet, good God, how he writes!

At our next meeting Ralph discovered the trick we had played Osborne, who was rallied without mercy.

By this adventure Ralph was fixed in his determination of becoming a poet. I left nothing unattempted to divert him [53] from his purpose; but he persevered, till at last the reading of Pope[3] effected his cure: he became, however, a very tolerable prose-writer. I shall speak more of him hereafter; but as I shall probably have no farther occasion to mention the other two, I ought to observe here that Watson died a few years after in my arms. He was greatly regretted, for he was the best of our society. Osborne went to the islands, where he gained considerable reputation as a barrister, and was getting money; but he died young. We had seriously engaged, that whoever died first should return (if possible) and pay a friendly visit to the survivor, to give him an account of the other world—but he has never fulfilled his engagement.

The governor appeared to be fond of my company, and frequently invited me to his house. He always spoke of his intention of settling me in business, as a point that was decided. I was to take with me letters of recommendation to a number of his friends, and particularly a letter of credit, in order to obtain the necessary sum for the purchase of my press, types, and paper. He appointed various times for me to come for these letters, which would certainly be ready, and when I came, always put me off to another day.

These successive delays continued till the vessel, whose departure had been several times deferred, was on the point of setting sail; when I again went to Sir William's house, to receive my letters and take leave of him. I saw his secretary, Dr. Bard, who told me that the governor was extremely busy writing, but that he would be down at Newcastle before the vessel, and that the letters would be delivered to me there. [54]

Ralph, though he was married and had a child, determined to accompany me in this voyage. His object was supposed to be the establishing a correspondence with some mercantile houses, in order to sell goods by commission; but I afterwards learned that, having reason to be dissatisfied with the parents of his wife, he proposed to himself to leave her on their hands, and never return to America again.

Having taken leave of my friends, and interchanged promises of fidelity with Miss Read, I quitted Philadelphia. At Newcastle the vessel came to anchor. The governor was arrived, and I went to his lodgings. His secretary received me with great civility, told me on the part of the governor that he could not see me then, as he was engaged in affairs of the utmost importance, but that he would send the letters on board, and that he wished me, with all his heart, a good voyage, and speedy return. I returned, somewhat astonished, to the ship, but still without entertaining the slightest suspicion.

Mr. Hamilton, a celebrated barrister of Philadelphia, had taken a passage to England for himself and his son, and, in conjunction with Mr. Denham, a quaker, and Messrs. Oniam and Russel, proprietors of a forge in Maryland, had agreed for the whole cabin, so that Ralph and I were obliged to take up our lodging with the crew. Being unknown to every body in the ship, we were looked upon as of the common order of people: but Mr. Hamilton and his son, (it was James, who [55] was afterwards governor,) left us at Newcastle, and returned to Philadelphia, where he was recalled at a very great expence, to plead the cause of a vessel that had been seized; and just as we were about to sail, colonel French came on board, and shewed me many civilities. The passengers upon this paid me more attention, and I was invited, together with my friend Ralph, to occupy the place in the cabin which the return of the Mr. Hamiltons had made vacant; an offer which we very readily accepted.

Having learned that the dispatches of the governor had been brought on board by colonel French, I asked the captain for the letters that were to be entrusted to my care. He told me that they were all put together in the bag, which he could not open at present; but before we reached England, he would give me an opportunity of taking them out. I was satisfied with this answer, and we pursued our voyage.

The company in the cabin were all very sociable, and we were perfectly well off as to provisions, as we had the advantage of the whole of Mr. Hamilton's, who had laid in a very plentiful stock. During the passage, Mr. Denham contracted a friendship for me, which ended only with his life: in other respects the voyage was by no means an agreeable one, as we had much bad weather.

When we arrived in the river, the captain was as good as his word, and allowed me to search in the bag for the governor's letters. I could not find a single one with my name written on it, as committed to my care; but I selected six or seven, which I judged from the direction to be those that were intended for me; particularly one to Mr. Basket the king's [56] printer, and another to a stationer, who was the first person I called upon. I delivered him the letter as coming from governor Keith. "I have no acquaintance (said he) with any such person;" and opening the letter, "Oh, it is from Riddlesden!" he exclaimed. "I have lately discovered him to be a very arrant knave, and wish to have nothing to do either with him or his letters." He instantly put the letter into my hand, turned upon his heel, and left me, to serve some customers.

I was astonished at finding these letters were not from the governor. Reflecting, and putting circumstances together, I then began to doubt his sincerity. I rejoined my friend Denham, and related the whole affair to him. He let me at once into Keith's character, told me there was not the least probability of his having written a single letter; that no one who knew him ever placed any reliance on him, and laughed at my credulity in supposing that the governor would give me a letter of credit, when he had no credit for himself. As I showed some uneasiness respecting what step I should take, he advised me to try to get employment in the house of some printer. You may there, said he, improve yourself in business, and you will be able to settle yourself the more advantageously when you return to America.

We knew already as well as the stationer, attorney Riddlesden to be a knave. He had nearly ruined the father of Miss Read, by drawing him in to be his security. We learned from his letter, that he was secretly carrying on an intrigue, in concert with the governor, to the prejudice of Mr. Hamilton, who it was supposed would by this time be in Europe. [57] Denham, who was Hamilton's friend, was of opinion that he ought to be made acquainted with it; and in reality, the instant he arrived in England, which was very soon after, I waited on him, and, as much from good-will to him, as from resentment against the governor, put the letter into his hands. He thanked me very sincerely, the information it contained being of consequence to him; and from that moment bestowed on me his friendship, which afterwards proved on many occasions serviceable to me.

But what are we to think of a governor who could play so scurvy a trick, and thus grossly deceive a poor young lad, wholly destitute of experience? It was a practice with him. Wishing to please every body, and having little to bestow, he was lavish of promises. He was in other respects sensible and judicious, a very tolerable writer, and a good governor for the people; though not so for the proprietaries, whose instructions he frequently disregarded. Many of our best laws were his work, and established during his administration.

Ralph and I were inseparable companions. We took a lodging together at three and sixpence a-week, which was as much as we could afford. He met with some relations in London, but they were poor, and not able to assist him. He now, for the first time, informed me of his intention to remain in England, and that he had no thoughts of ever returning to Philadelphia. He was totally without money; the little he had been able to raise having barely sufficed for his passage. I had still fifteen pistoles remaining; and to me he had from time to time recourse, while he tried to get employment. [58]

At first, believing himself possessed of talents for the stage, he thought of turning actor; but Wilkes, to whom he applied, frankly advised him to renounce the idea, as it was impossible he should succeed. He next proposed to Roberts, a bookseller in Paternoster-row, to write a weekly paper in the manner of the Spectator, upon terms to which Roberts would not listen. Lastly, he endeavoured to procure employment as a copyist, and applied to the lawyers and stationers about the Temple; but he could find no vacancy.

As to myself, I immediately got engaged at Palmer's, at that time a noted printer in Bartholomew-close, with whom I continued nearly a year. I applied very assiduously to my work; but I expended with Ralph almost all that I earned. Plays, and other places of amusement which we frequented together, having exhausted my pistoles, we lived after this from hand to mouth. He appeared to have entirely forgotten his wife and child, as I also, by degrees, forgot my engagements with Miss Read, to whom I never wrote more than one letter, and that merely to inform her that I was not likely to return soon. This was another grand error of my life, which I should be desirous of correcting were I to begin my career again.

I was employed at Palmer's on the second edition of Woolaston's Religion of Nature. Some of his arguments appearing to me not to be well-founded, I wrote a small metaphysical treatise, in which I animadverted on those passages. It was entitled a "Dissertation on Liberty and Necessity, Pleasure and Pain." I dedicated it to my friend Ralph, and printed a small number of copies. Palmer upon this treated me with more consideration, and regarded me as a young man of talents; [59] though he seriously took me to task for the principles of my pamphlet, which he looked upon as abominable. The printing of this work was another error of my life.

While I lodged in Little Britain I formed acquaintance with a bookseller of the name of Wilcox, whose shop was next door to me. Circulating libraries were not then in use. He had an immense collection of books of all sorts. We agreed that, for a reasonable retribution, of which I have now forgotten the price, I should have free access to his library, and take what books I pleased, which I was to return when I had read them. I considered this agreement as a very great advantage; and I derived from it as much benefit as was in my power.

My pamphlet falling into the hands of a surgeon, of the name of Lyons, author of a book entitled, "Infallibility of Human Judgment," was the occasion of a considerable intimacy between us. He expressed great esteem for me, came frequently to see me, in order to converse upon metaphysical subjects, and introduced me to Dr. Mandeville, author of the Fable of the Bees, who had instituted a club at a tavern in Cheapside, of which he was the soul: he was a facetious and very amusing character. He also introduced me, at Batson's coffee-house, to Dr. Pemberton, who promised to give me an opportunity of seeing Sir Isaac Newton, which I very ardently desired; but he never kept his word.

I had brought some curiosities with me from America; the principal of which was a purse made of the asbestos, which [60] fire only purifies. Sir Hans Sloane hearing of it, called upon me, and invited me to his house in Bloomsbury-square, where, after showing me every thing that was curious, he prevailed on me to add this piece to his collection; for which he paid me very handsomely.

There lodged in the same house with us a young woman, a milliner, who had a shop by the side of the Exchange. Lively and sensible, and having received an education somewhat above her rank, her conversation was very agreeable. Ralph read plays to her every evening. They became intimate. She took another lodging, and he followed her. They lived for some time together; but Ralph being without employment, she having a child, and the profits of her business not sufficing for the maintenance of three, he resolved to quit London, and try a country school. This was a plan in which he thought himself likely to succeed; as he wrote a fine hand, and was versed in arithmetic and accounts. But considering the office as beneath him, and expecting some day to make a better figure in the world, when he should be ashamed of its being known that he had exercised a profession so little honourable, he changed his name, and did me the honour to assume mine. He wrote to me soon after his departure, informing me that he was settled at a small village in Berkshire. In his letter he recommended Mrs. T***, the milliner, to my care, and requested an answer, directed to Mr. Franklin, schoolmaster, at N***.

He continued to write to me frequently, sending me large fragments of an epic poem he was composing, and which he begged of me to criticise and correct. I did so, but not without endeavouring to prevail on him to renounce this pursuit. [61]

Young had just published one of his Satires. I copied and sent him a great part of it; in which the author demonstrates the folly of cultivating the muses, from the hope, by their instrumentality, of rising in the world. It was all to no purpose; paper after paper of his poem continued to arrive every post.

Meanwhile Mrs. T*** having lost, on his account, both her friends and her business, was frequently in distress. In this dilemma she had recourse to me; and to extricate her from difficulties, I lent her all the money I could spare. I felt a little too much fondness for her. Having at that time no ties of religion, and taking advantage of her necessitous situation, I attempted liberties, (another error of my life,) which she repelled with becoming indignation. She informed Ralph of my conduct; and the affair occasioned a breach between us. When he returned to London, he gave me to understand that he considered all the obligations he owed me as annihilated by this proceeding; whence I concluded that I was never to expect the payment of what money I had lent him, or advanced on his account. I was the less afflicted at this, as he was wholly unable to pay me; and as, by losing his friendship, I was relieved at the same time from a very heavy burden.

I now began to think of laying by some money. The printing-house of Watts, near Lincoln's-Inn-Fields, being a still more considerable one than that in which I worked, it was probable I might find it more advantageous to be employed there. I offered myself, and was accepted; and in this house I continued during the remainder of my stay in London. [62]

On my entrance I worked at first as a pressman, conceiving that I had need of bodily exercise, to which I had been accustomed in America, where the printers work alternately as compositors and at the press. I drank nothing but water. The other workmen, to the number of about fifty, were great drinkers of beer. I carried occasionally a large form of letters in each hand, up and down stairs, while the rest employed both hands to carry one. They were surprised to see, by this and many other examples, that the *American Aquatic*, as they used to call me, was stronger than those who drank porter. The beer-boy had sufficient employment during the whole day in serving that house alone. My fellow pressman drank every day a pint of beer before breakfast, a pint with bread and cheese for breakfast, one between breakfast and dinner, one at dinner, one again about six o'clock in the afternoon, and another after he had finished his day's work. This custom appeared to me abominable; but he had need, he said, of all this beer, in order to acquire strength to work.

I endeavoured to convince him that the bodily strength furnished by the beer, could only be in proportion to the solid part of the barley dissolved in the water of which the beer was composed; that there was a larger portion of flour in a penny loaf, and that consequently if he ate this loaf, and drank a pint of water with it, he would derive more strength from it than from a pint of beer. This reasoning, however, did not prevent him from drinking his accustomed quantity of beer, and paying every Saturday night a score of four or five shillings a-week for this cursed beverage; an expence from which [63]
I was wholly exempt. Thus do these poor devils continue all their lives in a state of voluntary wretchedness and poverty.

At the end of a few weeks, Watts having occasion for me above stairs as a compositor, I quitted the press. The compositors demanded of me garnish money a-fresh. This I considered as an imposition, having already paid below. The master was of the same opinion, and desired me not to comply. I thus remained two or three weeks out of the fraternity. I was consequently looked upon as excommunicated; and whenever I was absent, no little trick that malice could suggest was left unpractised upon me. I found my letters mixed, my pages transposed, my matter broken, &c. &c. all which was attributed to the spirit that haunted the chapel,[4] and tormented those who were not regularly admitted. I was at last obliged to submit to pay, notwithstanding the protection of the master; convinced of the folly of not keeping up a good understanding with those among whom we are destined to live.

After this I lived in the utmost harmony with my fellow-labourers, and soon acquired considerable influence among them. I proposed some alterations in the laws of the chapel, which I carried without opposition. My example prevailed with several of them to renounce their abominable practice of bread and cheese with beer; and they procured, like me, from a neighbouring house, a good basin of warm gruel, in which was a small slice of butter, with toasted bread and [64] nutmeg. This was a much better breakfast, which did not cost more than a pint of beer, namely, three halfpence, and at the same time preserved the head clearer. Those who continued to gorge themselves with beer, often lost their credit with the publican, from neglecting to pay their score. They had then recourse to me, to become security for them; *their light*, as they used to call it, *being out*. I attended at the pay-table every Saturday evening, to take up the little sum which I had made myself answerable for; and which sometimes amounted to nearly thirty shillings a-week.

This circumstance, added to my reputation of being a tolerable good *gabber*, or, in other words, skilful in the art of burlesque, kept up my importance in the chapel. I had besides recommended myself to the esteem of my master by my assiduous application to business, never observing Saint Monday. My extraordinary quickness in composing always procured me such work as was most urgent, and which is commonly best paid; and thus my time passed away in a very pleasant manner.

My lodging in Little Britain being too far from the printing-house, I took another in Duke-street, opposite the Roman Catholic chapel. It was at the back of an Italian warehouse. The house was kept by a widow, who had a daughter, a servant, and a shop-boy; but the latter slept out of the house. After sending to the people with whom I lodged in Little Britain, to enquire into my character, she agreed to take me in at the same price, three and sixpence a-week; contenting herself, she said, with so little, because of the security she should derive, as they were all women, from having a man lodger in the house.

She was a woman rather advanced in life, the daughter of a clergyman. She had been educated a Protestant; but her [65] husband, whose memory she highly revered, had converted her to the Catholic religion. She had lived in habits of intimacy with persons of distinction; of whom she knew various anecdotes as far back as the time of Charles II. Being subject to fits of the gout, which often confined her to her room, she was sometimes disposed to see company. Hers was so amusing to me, that I was glad to pass the evening with her as often as she desired it. Our supper consisted only of half an anchovy a piece, upon a slice of bread and butter, with half a pint of ale between us. But the entertainment was in her conversation.

The early hours I kept, and the little trouble I occasioned in the family, made her loth to part with me; and when I mentioned another lodging I had found, nearer the printing-house, at two shillings a week, which fell in with my plan of saving, she persuaded me to give it up, making herself an abatement of two shillings: and thus I continued to lodge with her, during the remainder of my abode in London, at eighteen pence a week.

In a garret of the house there lived, in the most retired manner, a lady seventy years of age, of whom I received the following account from my landlady. She was a Roman Catholic. In her early years she had been sent to the continent, and entered a convent with the design of becoming a nun; but the climate not agreeing with her constitution, she was obliged to return to England, where, as there were no monasteries, she made a vow to lead a monastic life, in as rigid a manner as circumstances would permit. She accordingly disposed of all her property to be applied to charitable uses, [66] reserving to herself only twelve pounds a year; and of this small pittance she gave a part to the poor, living on water gruel, and never making use of fire but to boil it. She had lived in this garret a great many years, without paying rent to the successive Catholic inhabitants that had kept the house; who indeed considered her abode with them as a blessing. A priest came every day to confess her. I have asked her, said my landlady, how, living as she did, she could find so much employment for a confessor? To which she answered, that it was impossible to avoid vain thoughts.

I was once permitted to visit her. She was cheerful and polite, and her conversation agreeable. Her apartment was neat; but the whole furniture consisted of a mattress, a table, on which were a crucifix and a book, a chair, which she gave me to sit on, and over the mantle-piece a picture of St. Veronica displaying her handkerchief, on which was seen the miraculous impression of the face of Christ, which she explained to me with great gravity. Her countenance was pale, but she had never experienced sickness; and I may adduce her as another proof how little is sufficient to maintain life and health.

At the printing house I contracted an intimacy with a sensible young man of the name of Wygate, who, as his parents were in good circumstances, had received a better education than is common among printers. He was a tolerable Latin scholar, spoke French fluently, and was fond of reading. I taught him, as well as a friend of his, to swim, by taking them twice only into the river; after which they stood in need of no farther assistance. We one day made a party to go by water [67]
to Chelsea, in order to see the College, and Don Soltero's curiosities. On our return, at the request of the company, whose curiosity Wygate had excited, I undressed myself, and leaped into the river. I swam from near Chelsea the whole way to Blackfriars, exhibiting, during my course, a variety of feats of activity and address, both upon the surface of the water, as well as under it. This sight occasioned much astonishment and pleasure to those to whom it was new. In my youth I took great delight in this exercise. I knew, and could execute, all the evolutions and positions of Thevenot; and I added to them some of my own invention, in which I endeavoured to unite gracefulness and utility. I took a pleasure in displaying them all on this occasion, and was highly flattered with the admiration they excited.

Wygate, besides his being desirous of perfecting himself in this art, was the more attached to me from there being, in other respects, a conformity in our tastes and studies. He at length proposed to me to make the tour of Europe with him, maintaining ourselves at the same time by working at our profession. I was on the point of consenting, when I mentioned it to my friend Mr. Denham, with whom I was glad to pass an hour whenever I had leisure. He dissuaded me from the project, and advised me to think of returning to Philadelphia, which he was about to do himself. I must relate in this place a trait of this worthy man's character.

He had formerly been in business at Bristol, but failing, he compounded with his creditors, and departed for America,
where, by assiduous application as a merchant, he acquired in a few years a very considerable fortune. Returning to [68]
England in the same vessel with myself, as I have related above, he invited all his old creditors to a feast. When assembled, he thanked them for the readiness with which they had received his small composition; and, while they expected nothing more than a simple entertainment, each found under his plate, when it came to be removed, a draft upon a banker for the residue of his debt, with interest.

He told me that it was his intention to carry back with him to Philadelphia a great quantity of goods, in order to open a store; and he offered to take me with him in the capacity of clerk, to keep his books, in which he would instruct me, copy letters, and superintend the store. He added, that as soon as I had acquired a knowledge of mercantile transactions, he would improve my situation, by sending me with a cargo of corn and flour to the American islands, and by procuring me other lucrative commissions; so that, with good management and economy, I might in time begin business with advantage for myself.

I relished these proposals. London began to tire me; the agreeable hours I had passed at Philadelphia presented themselves to my mind, and I wished to see them revive. I consequently engaged myself to Mr. Denham, at a salary of fifty pounds a year. This was, indeed less than I earned as a compositor, but then I had a much fairer prospect. I took leave therefore, as I believed for ever, of printing, and gave myself up entirely to my new occupation, spending all my time either in going from house to house with Mr. Denham to purchase goods, or in packing them up, or in expediting the workmen, &c. &c. When every thing, however, was on board, I had at last a few days leisure.

During this interval, I was one day sent for by a gentleman, whom I knew only by name. It was Sir William Wyndham. [69] I went to his house. He had by some means heard of my performances between Chelsea and Blackfriars, and that I had taught the art of swimming to Wygate and another young man in the course of a few hours. His two sons were on the point of setting out on their travels; he was desirous that they should previously learn to swim, and offered me a very liberal reward if I would undertake to instruct them. They were not yet arrived in town, and the stay I should make was uncertain; I could not therefore accept his proposal. I was led, however, to suppose from this incident, that if I had wished to remain in London, and open a swimming school, I should perhaps have gained a great deal of money. This idea struck me so forcibly that, had the offer been made sooner, I should have dismissed the thought of returning as yet to America. Some years after, you and I had a more important business to settle with one of the sons of Sir William Wyndham, then Lord Egremont. But let us not anticipate events.

I thus passed about eighteen months in London, working almost without intermission at my trade, avoiding all expence on my own account, except going now and then to the play, and purchasing a few books. But my friend Ralph kept me poor. He owed me about twenty-seven pounds, which was so much money lost; and when considered as taken from my little savings, was a very great sum. I had, notwithstanding this, a regard for him, as he possessed many amiable qualities. But though I had done nothing for myself in point of fortune, I had increased my stock of knowledge, either by the many [70] excellent books I had read, or the conversation of learned and literary persons with whom I was acquainted.

We sailed from Gravesend the 23d of July, 1726. For the incidents of my voyage I refer you to my Journal, where you will find all its circumstances minutely related. We landed at Philadelphia on the 11th of the following October.

Keith had been deprived of his office of governor, and was succeeded by Major Gordon. I met him walking in the streets as a private individual. He appeared a little ashamed at seeing me, but passed on without saying any thing.

I should have been equally ashamed myself at meeting Miss Read, had not her family, justly despairing of my return after reading my letter, advised her to give me up, and marry a potter, of the name of Rogers; to which she consented: but he never made her happy, and she soon separated from him, refusing to cohabit with him, or even bear his name, on account of a report which prevailed, of his having another wife. His skill in his profession had seduced Miss Read's parents; but he was as bad a subject as he was excellent as a workman. He involved himself in debt, and fled, in the year 1727 or 1728, to the West Indies, where he died.

During my absence Keimer had taken a more considerable house, in which he kept a shop, that was well supplied with paper, and various other articles. He had procured some new types, and a number of workmen; among whom, however, there was not one who was good for any thing; and he appeared not to want business.

Mr. Denham took a warehouse in Water-street, where we exhibited our commodities. I applied myself closely, studied [71] accounts, and became in a short time very expert in trade. We lodged and ate together. He was sincerely attached to me, and acted towards me as if he had been my father. On my side, I respected and loved him. My situation was happy; but it was a happiness of no long duration.

Early in February, 1727, when I entered into my twenty-second year, we were both taken ill. I was attacked with a pleurisy, which had nearly carried me off; I suffered terribly, and considered it as all over with me. I felt indeed a sort of disappointment when I found myself likely to recover, and regretted that I had still to experience, sooner or later, the same disagreeable scene again.

I have forgotten what was Mr. Denham's disorder; but it was a tedious one, and he at last sunk under it. He left me a small legacy in his will, as a testimony of his friendship; and I was once more abandoned to myself in the wide world, the warehouse being confided to the care of testamentary executor, who dismissed me.

My brother-in-law, Holmes, who happened to be at Philadelphia, advised me to return to my former profession; and Keimer offered me a very considerable salary if I would undertake the management of his printing-office, that he might devote himself entirely to the superintendence of his shop. His wife and relations in London had given me a bad character of him; and I was loth, for the present, to have any concern with him. I endeavoured to get employment as a clerk to a merchant; but not readily finding a situation, I was induced to accept Keimer's proposal.

The following were the persons I found in his printing-house: [72]

Hugh Meredith, a Pennsylvanian, about thirty-five years of age. He had been brought up to husbandry, was honest, sensible, had some experience, and was fond of reading; but too much addicted to drinking.

Stephen Potts, a young rustic, just broke from school, and of rustic education, with endowments rather above the common order, and a competent portion of understanding and gaiety; but a little idle. Keimer had engaged these two at very low wages, which he had promised to raise every three months a shilling a week, provided their improvement in the typographic art should merit it. This future increase of wages was the bait he had made use of to ensnare them. Meredith was to work at the press, and Potts to bind books, which he had engaged to teach them, though he understood neither himself.

John Savage, an Irishman, who had been brought up to no trade, and whose service, for a period of four years, Keimer had purchased of the captain of a ship. He was also to be a pressman.

George Webb, an Oxford scholar, whose time he had in like manner bought for four years, intending him for a compositor. I shall speak more of him presently.

Lastly, David Harry, a country lad, who was apprenticed to him.

I soon perceived that Keimer's intention, in engaging me at a price so much above what he was accustomed to give, was, that I might form all these raw journeymen and apprentices, who scarcely cost him any thing, and who, being indentured, would, as soon as they should be sufficiently instructed, enable him to do without me. I nevertheless adhered [73] to my agreement. I put the office in order, which was in the utmost confusion, and brought his people by degrees, to pay attention to their work, and to execute it in a more masterly style.

It was singular to see an Oxford scholar in the condition of a purchased servant. He was not more than eighteen years of age, and the following are the particulars he gave me of himself. Born at Gloucester, he had been educated at a grammar-school, and had distinguished himself among the scholars by his superior style of acting, when they represented

dramatic performances. He was a member of a literary club in the town; and some pieces of his composition, in prose as well as in verse, had been inserted in the Gloucester papers. From hence he was sent to Oxford, where he remained about a year: but he was not contented, and wished above all things to see London, and become an actor. At length, having received fifteen guineas to pay his quarter's board, he decamped with the money, from Oxford, hid his gown in a hedge, and travelled to London. There, having no friend to direct him, he fell into bad company, soon squandered his fifteen guineas, could find no way of being introduced to the actors, became contemptible, pawned his cloaths, and was in want of bread. As he was walking along the streets, almost famished with hunger, and not knowing what to do, a recruiting-bill was put into his hand, which offered an immediate treat and bounty-money to whoever was disposed to serve in America. He instantly repaired to the house of rendezvous, inlisted himself, was put on board a ship and conveyed to America, [74]
without ever writing a line to inform his parents what was become of him. His mental vivacity, and good natural disposition, made him an excellent companion; but he was indolent, thoughtless, and to the last degree imprudent.

John, the Irishman, soon ran away. I began to live very agreeably with the rest. They respected me, and the more so as they found Keimer incapable of instructing them, and as they learned something from me every day. We never worked on a Saturday, it being Keimer's Sabbath, so that I had two days a week for reading.

I increased my acquaintance with persons of information and knowledge in the town. Keimer himself treated me with great civility, and apparent esteem; and I had nothing to give me uneasiness but my debt to Vernon, which I was unable to pay, my savings as yet being very little. He had the goodness, however, not to ask me for the money.

Our press was frequently in want of the necessary quantity of letter, and there was no such trade as that of letter-founder in America. I had seen the practice of this art at the house of James, in London, but had at the time paid it very little attention; I however, contrived to fabricate a mould. I made use of such letters as we had for punches, founded new letters of lead in mattrices of clay, and thus supplied in a tolerable manner the wants that were most pressing.

I also, upon occasion, engraved various ornaments, made ink, gave an eye to the shop—in short, I was in every respect the *factotum*. But useful as I made myself, I perceived that my services became every day of less importance, in proportion as the other men improved; and when Keimer paid me my second quarter's wages, he gave me to understand [75]
they were too heavy, and that he thought I ought to make an abatement. He became by degrees less civil, and assumed more the tone of master. He frequently found fault, was difficult to please, and seemed always on the point of coming to an open quarrel with me.

I continued, however, to bear it patiently, conceiving that his ill humour was partly occasioned by the derangement and embarrassment of his affairs. At last a slight incident broke our connection. Hearing a noise in the neighbourhood, I put my head out at the window, to see what was the matter. Keimer being in the street, observed me, and in a loud and angry tone bid me to mind my work; adding some reproachful words, which piqued me the more, as they were uttered in the street; and the neighbours, whom the same noise attracted to the windows, were witnesses of the manner in which I was treated. He immediately came up to the printing-room, where he continued to exclaim against me. The quarrel became warm on both sides, and he gave me notice to quit him at the expiration of three months, as had been agreed upon between us; regretting that he was obliged to give me so long a term. I told him that his regret was superfluous, as I was ready to quit him instantly; and I took my hat and came out of the house, begging Meredith to take care of some things which I left, and bring them to my lodgings.

Meredith came to me in the evening. We talked for some time upon the quarrel that had taken place. He had conceived a great veneration for me, and was sorry I should quit the house, while he remained in it. He dissuaded me from returning [76] to my native country, as I began to think of doing. He reminded me that Keimer owed more than he possessed; that his creditors began to be alarmed; that he kept his shop in a wretched state, often selling things at prime cost for the sake of ready money, and continually giving credit without keeping any accounts; that of consequence he must very soon fail, which would occasion a vacancy from which I might derive advantage. I objected my want of money. Upon which he informed me that his father had a very high opinion of me, and, from a conversation that had passed between them, he was sure he would advance whatever might be necessary to establish us, if I was willing to enter into partnership with him. "My time with Keimer," added he, "will be at an end next spring. In the mean time we may send to London for our press and types. I know that I am no workman; but if you agree to the proposal, your skill in the business will be balanced by the capital I shall furnish, and we will share the profits equally." His proposal was reasonable, and I fell in with it. His father, who was then in town, approved of it. He knew that I had some ascendancy over his son, as I had been able to prevail on him to abstain for a long time from drinking brandy; and he hoped that, when more closely connected with him, I should cure him entirely of this unfortunate habit.

I gave the father a list of what it would be necessary to import from London. He took it to a merchant, and the order was given. We agreed to keep the secret till the arrival of the materials, and I was in the mean time to procure work, if possible, in another printing-house; but there was no place vacant, and I remained idle. After some days, Keimer having [77] the expectation of being employed to print some New Jersey money-bills, that would require types and engravings which I only could furnish, and fearful that Bradford, by engaging me, might deprive him of this undertaking, sent me a very civil message, telling me that old friends ought not to be disunited on account of a few words, which were the effect only of a momentary passion, and inviting me to return to him. Meredith persuaded me to comply with the invitation, particularly as it would afford him more opportunities of improving himself in the business, by means of my instructions. I did so; and we lived upon better terms than before our separation.

He obtained the New Jersey business; and, in order to execute it, I constructed a copper-plate printing-press! the first that had been seen in the country. I engraved various ornaments and vignettes for the bills; and we repaired to Burlington together, where I executed the whole to the general satisfaction; and he received a sum of money for this work, which enabled him to keep his head above water for a considerable time longer.

At Burlington I formed an acquaintance with the principal personages of the province; many of whom were commissioned by the assembly to superintend the press, and to see that no more bills were printed than the law had prescribed. Accordingly they were constantly with us, each in his turn; and he that came, commonly brought with him a friend or two to bear him company. My mind was more cultivated by reading than Keimer's; and it was for this reason, probably, that they set more value on my conversation. They took me to their houses, introduced me to their friends, and [78] treated me with the greatest civility; while Keimer, though master, saw himself a little neglected. He was, in fact, a strange animal, ignorant of the common modes of life, apt to oppose with rudeness generally received opinions, an enthusiast in certain points of religion, disgustingly unclean in his person, and a little knavish withal.

We remained there nearly three months, and at the expiration of this period I could include in the list of my friends, Judge Allen, Samuel Bustil, secretary of the province, Isaac Pearson, Joseph Cooper, several of the Smiths, all members of the assembly, and Isaac Decon, inspector-general. The last was a shrewd and subtle old man. He told me, that, when a boy, his first employment had been that of carrying clay to the brick-makers; that he did not learn to write till he was somewhat advanced in life; and that he was afterwards employed as an underling to a surveyor, who taught him his trade, and that by industry he had at last acquired a competent fortune. "I foresee," said he one day to me, "that you will soon supplant this man," speaking of Keimer, "and get a fortune in the business at Philadelphia." He was wholly ignorant at the time, of my intention of establishing myself there, or any where else. These friends were very serviceable to me in the end, as was I also, upon occasion, to some of them; and they have continued ever since their esteem for me.

Before I relate the particulars of my entrance into business, it may be proper to inform you what was at that time the [79] state of my mind as to moral principles, that you may see the degree of influence they had upon the subsequent events of my life.

My parents had given me betimes religious impressions; and I received from my infancy a pious education in the principles of Calvinism. But scarcely was I arrived at fifteen years of age, when, after having doubted in turn of different tenets, according as I found them combated in the different books that I read, I began to doubt of revelation itself. Some volumes against deism fell into my hands. They were said to be the substance of sermons preached at Boyle's lecture. It happened that they produced on me an effect precisely the reverse of what was intended by the writers; for the arguments of the deists, which were cited in order to be refuted, appeared to me much more forcible than the refutation itself. In a word, I soon became a perfect deist. My arguments perverted some other young persons, particularly Collins and Ralph. But in the sequel, when I recollected that they had both used me extremely ill, without the smallest remorse; when I considered the behaviour of Keith, another free-thinker, and my own conduct towards Vernon and Miss Read, which at times gave me great uneasiness, I was led to suspect that this doctrine, though it might be true, was not very useful. I began to entertain a less favourable opinion of my London pamphlet to which I had prefixed as a motto, the following lines of Dryden:

Whatever is—is right; though purblind man
Sees but a part of the chain, the nearest link,
His eyes not carrying to the equal beam
That poises all above.

And of which the object was to prove, from the attributes of God, his goodness, wisdom, and power, that there could be [80] no such thing as evil in the world; that vice and virtue did not in reality exist, and were nothing more than vain distinctions. I no longer regarded it as so blameless a work as I had formerly imagined; and I suspected that some error must have imperceptibly glided into my argument, by which all the inferences I had drawn from it had been affected, as frequently happens in metaphysical reasonings. In a word, I was at last convinced that truth, probity, and sincerity in transactions between man and man, were of the utmost importance to the happiness of life; and I resolved from that moment, and wrote the resolution in my journal, to practise them as long as I lived.

Revelation, indeed, as such, had no influence on my mind; but I was of opinion that, though certain actions could not be bad merely because revelation had prohibited them, or good because it enjoined them, yet it was probable that those actions were prohibited because they were bad for us, or enjoined because advantageous in their nature, all things considered. This persuasion, divine providence, or some guardian angel, and perhaps a concurrence of favourable circumstances co-operating, preserved me from all immorality, or gross and *voluntary*, injustice, to which my want of religion was calculated to expose me, in the dangerous period of youth, and in the hazardous situations in which I sometimes found myself, among strangers, and at a distance from the eye and admonitions of my father. I may say *voluntary*, because the errors into which I had fallen, had been in a manner the forced result either of my own inexperience, or the dishonesty of others. Thus, before I entered on my new career, I had imbibed solid principles, and a [81] character of probity. I knew their value; and I made a solemn engagement with myself never to depart from them.

I had not long returned from Burlington before our printing materials arrived from London. I settled my accounts with Keimer, and quitted him, with his own consent, before he had any knowledge of our plan. We found a house to let near the market. We took it; and to render the rent less burdensome, (it was then twenty-four pounds a year, but I have since known it let for seventy,) we admitted Thomas Godfrey, a glazier, with his family, who eased us of a considerable part of it; and with him we agreed to board.

We had no sooner unpacked our letters, and put our press in order, than a person of my acquaintance, George House, brought us a countryman, whom he had met in the streets enquiring for a printer. Our money was almost exhausted by the number of things we had been obliged to procure. The five shillings we received from this countryman, the first fruits of our earnings, coming so seasonably, gave me more pleasure than any sum I have since gained; and the recollection of the gratitude I felt on this occasion to George House, has rendered me often more disposed, than perhaps I should otherwise have been, to encourage young beginners in trade.

There are in every country morose beings, who are always prognosticating ruin. There was one of this stamp at Philadelphia. He was a man of fortune, declining in years, had an air of wisdom, and a very grave manner of speaking. His name was Samuel Mickle. I knew him not; but he stopped one day at my door, and asked me if I was the young man [82] who had lately opened a new printing-house. Upon my answering in the affirmative, he said he was very sorry for me, as it was an expensive undertaking, and the money that had been laid out upon it would be lost, Philadelphia being a place falling into decay; its inhabitants having all, or nearly all of them, been obliged to call together their creditors. That he knew, from undoubted fact, the circumstances which might lead us to suppose the contrary, such as new buildings, and the advanced price of rent, to be deceitful appearances, which, in reality, contributed to hasten the general ruin; and he gave me so long a detail of misfortunes, actually existing, or which were soon to take place, that he left me almost in a state of despair. Had I known this man before I entered into trade, I should doubtless never have ventured. He continued, however, to live in this place of decay, and to declaim in the same style, refusing for many years to buy a house because all was going to wreck; and in the end I had the satisfaction to see him pay five times as much for one as it would have cost him had he purchased it when he first began his lamentations.

I ought to have related, that, during the autumn of the preceding year, I had united the majority of well-informed persons of my acquaintance into a club, which we called by the name of the *Junto*, and the object of which was to improve our understandings. We met every Friday evening. The regulations I drew up, obliged every member to propose, in his turn, one or more questions upon some point of morality, politics, or philosophy, which were to be discussed by the society; and to read, once in three months, an essay of his own composition, on whatever subject he pleased. Our debates [83] were under the direction of a president, and were to be dictated only by a sincere desire of truth; the pleasure of disputing, and the vanity of triumph having no share in the business; and in order to prevent undue warmth, every expression which implied obstinate adherence to an opinion, and all direct contradiction, were prohibited, under small pecuniary penalties.

The first members of our club were Joseph Breintnal, whose occupation was that of a scrivener. He was a middle-aged man, of a good natural disposition, strongly attached to his friends, a great lover of poetry, reading every thing that came in his way, and writing tolerably well, ingenious in many little trifles, and of an agreeable conversation.

Thomas Godfrey, a skilful, though self-taught mathematician, and who was afterwards the inventor of what now goes by the name of Hadley's quadrant; but he had little knowledge out of his own line, and was insupportable in company, always requiring, like the majority of mathematicians that had fallen in my way, an unusual precision in every thing that is said, continually contradicting, or making trifling distinctions; a sure way of defeating all the ends of conversation. He very soon left us.

Nicholas Scull, a surveyor, and who became afterwards, surveyor-general. He was fond of books, and wrote verses.

William Parsons, brought up to the trade of a shoe-maker, but who, having a taste for reading, had acquired a profound knowledge of mathematics. He first studied them with a view to astrology, and was, afterwards, the first to laugh at his [84] folly. He also became surveyor-general.

William Mawgridge, a joiner, and very excellent mechanic; and in other respects a man of solid understanding.

Hugh Meredith, Stephen Potts, and George Webb, of whom I have already spoken.

Robert Grace, a young man of fortune; generous, animated, and witty; fond of epigrams, but more fond of his friends.

And lastly, William Coleman, at that time a merchant's clerk, and nearly of my own age. He had a cooler and clearer head, a better heart, and more scrupulous morals, than almost any other person I have ever met with. He became a very respectable merchant, and one of our provincial judges. Our friendship subsisted, without interruption, for more than forty years, till the period of his death; and the club continued to exist almost as long.

This was the best school of politics and philosophy that then existed in the province; for our questions, which were read a week previous to their discussion, induced us to peruse attentively such books as were written upon the subjects proposed, that we might be able to speak upon them more pertinently. We thus acquired the habit of conversing more agreeably; every object being discussed conformably to our regulations, and in a manner to prevent mutual disgust. To this circumstance may be attributed the long duration of the club; which I shall have frequent occasion to mention as I proceed.

I have introduced it here, as being one of the means on which I had to count for success in my business, every member [85] exerting himself to procure work for us. Breintnal, among others, obtained for us, on the part of the Quakers, the printing of forty sheets of their history; of which the rest was to be done by Keimer. Our execution of this work was by no means masterly; as the price was very low. It was in folio, upon *pro patria* paper, and in the *pica* letter, with heavy notes in the smallest type. I composed a sheet a-day, and Meredith put it to the press. It was frequently eleven o'clock at night, sometimes later, before I had finished my distribution for the next day's task; for the little things which our friends occasionally sent us, kept us back in this work: but I was so determined to compose a sheet a-day, that one evening, when my form was imposed, and my day's work, as I thought, at an end, an accident having broken this form, and deranged two complete folio pages, I immediately distributed, and composed them anew before I went to bed.

This unwearied industry, which was perceived by our neighbours, began to acquire us reputation and credit. I learned, among other things, that our new printing-house being the subject of conversation at a club of merchants, who met every evening, it was the general opinion that it would fail; there being already two printing-houses in the town, Keimer's and Bradford's. But Dr. Bard, whom you and I had occasion to see, many years after, at his native town of St. Andrew's, in Scotland, was of a different opinion. "The industry of this Franklin, (said he,) is superior to any thing of the kind I ever witnessed. I see him still at work when I return from the club at night, and he is at it again in the morning before his neighbours are out of bed." This account struck the rest of the assembly, and shortly after, one of its members came to our house, and offered to supply us with articles of stationary; but we wished not as yet to embarrass ourselves with keeping a shop. It is not for the sake of applause that I enter so freely into the particulars of my industry, but that such of my descendants as shall read these memoirs may know the use of this virtue, by seeing in the recital of my life the effects it operated in my favour. [86]

George Webb, having found a friend who lent him the necessary sum to buy out his time of Keimer, came one day to offer himself to us as a journeyman. We could not employ him immediately; but I foolishly told him, under the rose, that I intended shortly to publish a new periodical paper, and that we should then have work for him. My hopes of success, which I imparted to him, were founded on the circumstance, that the only paper we had in Philadelphia at that time, and which Bradford printed, was a paltry thing, miserably conducted, in no respect amusing, and which yet was profitable. I consequently supposed that a good work of this kind could not fail of success. Webb betrayed my secret to Keimer, who, to prevent me, immediately published the *prospectus* of a paper that he intended to institute himself, and in which Webb was to be engaged.

I was exasperated at this proceeding, and, with a view to counteract them, not being able at present to institute my own paper, I wrote some humourous pieces in Bradford's, under the title of the Busy Body[5]; and which was continued for [87] several months by Breintnal. I hereby fixed the attention of the public upon Bradford's paper; and the *prospectus* of Keimer, which we turned into ridicule, was treated with contempt. He began, notwithstanding, his paper; and after continuing it for nine months, having at most not more than ninety subscribers, he offered it me for a mere trifle. I had for some time been ready for such an engagement; I therefore instantly took it upon myself, and, in a few years, it proved extremely profitable to me.

I perceive that I am apt to speak in the first person, though our partnership still continued. It is, perhaps, because, in fact, the whole business devolved upon me. Meredith was no compositor, and but an indifferent pressman; and it was rarely that he abstained from hard drinking. My friends were sorry to see me connected with him; but I contrived to derive from it the utmost advantage the case admitted.

Our first number produced no other effect than any other paper which had appeared in the province, as to type and printing; but some remarks, in my peculiar style of writing, upon the dispute which then prevailed between governor Burnet and the Massachusetts assembly, struck some persons as above mediocrity, caused the paper and its editors to be talked of, and in a few weeks, induced them to become our subscribers. Many others followed their example; and our subscription continued to increase. This was one of the first good effects of the pains I had taken to learn to put my ideas on paper. I derived this farther advantage from it, that the leading men of the place, seeing in the author of this publication a man so well able to use his pen, thought it right to patronize and encourage me. [88]

The votes, laws, and other public pieces, were printed by Bradford. An address of the house of assembly to the governor had been executed by him in a very coarse and incorrect manner. We reprinted it with accuracy and neatness, and sent a copy to every member. They perceived the difference; and it so strengthened the influence of our friends in the assembly, that we were nominated its printer for the following year.

Among these friends I ought not to forget one member in particular, Mr. Hamilton, whom I have mentioned in a former part of my narrative, and who was now returned from England. He warmly interested himself for me on this occasion, as he did likewise on many others afterwards; having continued his kindness to me till his death.

About this period Mr. Vernon reminded me of the debt I owed him, but without pressing me for payment. I wrote a handsome letter on the occasion, begging him to wait a little longer, to which he consented; and as soon as I was able I paid him, principal and interest, with many expressions of gratitude; so that this error of my life was in a manner atoned for.

But another trouble now happened to me, which I had not the smallest reason to expect. Meredith's father, who, according to our agreement, was to defray the whole expence of our printing materials, had only paid a hundred pounds. Another hundred was still due, and the merchant being tired of waiting, commenced a suit against us. We bailed the action, but with the melancholy prospect, that, if the money was not forthcoming at the time fixed, the affair would come [89]
to issue, judgment be put in execution, our delightful hopes be annihilated, and ourselves entirely ruined; as the type and press must be sold, perhaps, at half their value, to pay the debt.

In this distress, two real friends, whose generous conduct I have never forgotten, and never shall forget while I retain the remembrance of any thing, came to me separately, without the knowledge of each other, and without my having applied to either of them. Each offered me whatever money might be necessary to take the business into my own hands, if the thing was practicable, as they did not like I should continue in partnership with Meredith, who, they said, was frequently seen drunk in the streets, and gambling at ale-houses, which very much injured our credit. These friends were William Coleman and Robert Grace. I told them, that while there remained any probability that the Merediths would fulfil their part of the compact, I could not propose a separation, as I conceived myself to be under obligations to them for what they had done already, and were still disposed to do, if they had the power; but, in the end, should they fail in their engagement, and our partnership be dissolved, I should then think myself at liberty to accept the kindness of my friends.

Things remained for some time in this state. At last, I said one day to my partner, "Your father is, perhaps, dissatisfied with your having a share only in the business, and is unwilling to do for two, what he would do for you alone. Tell me frankly if that be the case, and I will resign the whole to you, and do for myself as well as I can."—"No, (said he,) my [90]
father has really been disappointed in his hopes; he is not able to pay, and I wish to put him to no farther inconvenience. I see that I am not at all calculated for a printer; I was educated as a farmer, and it was absurd in me to come here, at thirty years of age, and bind myself apprentice to a new trade. Many of my countrymen are going to settle in North Carolina, where the soil is exceedingly favourable. I am tempted to go with them, and to resume my former occupation. You will doubtless find friends who will assist you. If you will take upon yourself the debts of the partnership, return my father the hundred pounds he has advanced, pay my little personal debts, and give me thirty pounds and a new saddle, I will renounce the partnership, and consign over the whole stock to you."

I accepted this proposal without hesitation. It was committed to paper, and signed and sealed without delay. I gave him what he demanded, and he departed soon after for Carolina, from whence he sent me, in the following year, two long letters, containing the best accounts that had yet been given of that country, as to climate, soil, agriculture, &c. for he was well versed in these matters. I published them in my newspaper, and they were received with great satisfaction.

As soon as he was gone, I applied to my two friends, and not wishing to give a disobliging preference to either of them, I accepted from each, half what he had offered me, and which it was necessary I should have. I paid the partnership debts, and continued the business on my own account; taking care to inform the public, by advertisement, of the partnership [91]
being dissolved. This was, I think, in the year 1729, or thereabout.

Nearly at the same period, the people demanded a new emission of paper money; the existing and only one that had taken place in the province, and which amounted to fifteen thousand pounds, being soon to expire. The wealthy inhabitants, prejudiced against every sort of paper currency, from the fear of its depreciation, of which there had been an instance in the province of New England, to the injury of its holders, strongly opposed the measure. We had discussed this affair in our Junto, in which I was on the side of the new emission; convinced that the first small sum, fabricated in 1723, had done much good in the province, by favouring commerce, industry, and population, since all the houses were now inhabited, and many others building; whereas I remembered to have seen, when I first paraded the streets of Philadelphia eating my roll, the majority of those in Walnut-street, Second-street, Fourth-street, as well as a great number in Chesnut and other streets, with papers on them signifying that they were to be let; which made me think at the time that the inhabitants of the town were deserting it one after another.

Our debates made me so fully master of the subject, that I wrote and published an anonymous pamphlet, entitled, "An Enquiry into the Nature and Necessity of a Paper currency." It was very well received by the lower and middling class of people; but it displeased the opulent, as it increased the clamour in favour of the new emission. Having, however, no writer among them capable of answering it, their opposition became less violent; and there being in the house of assembly [92]
a majority for the measure, it passed. The friends I had acquired in the house, persuaded that I had done the country essential service on this occasion, rewarded me by giving me the printing of the bills. It was a lucrative employment, and proved a very seasonable help to me; another advantage which I derived from having habituated myself to write.

Time and experience so fully demonstrated the utility of paper currency, that it never after experienced any considerable opposition; so that it soon amounted to 55,000*l.* and in the year 1739, to 80,000*l.* It has since risen, during the last war, to 350,000*l.*, trade, buildings and population, having in the interval continually increased: but I am now convinced that there are limits beyond which paper money would be prejudicial.

I soon after obtained, by the influence of my friend Hamilton, the printing of the Newcastle paper money, another profitable work, as I then thought it, little things appearing great to persons of moderate fortune; and they were really great to me, as proving great encouragements. He also procured me the printing of the laws and votes of that government, which I retained as long as I continued in the business.

I now opened a small stationer's shop. I kept bonds and agreements of all kinds, drawn up in a more accurate form than had yet been seen in that part of the world; a work in which I was assisted by my friend Breintnal. I had also paper, parchment, pasteboard, books, &c. One Whitemash, an excellent compositor, whom I had known in London, came to offer himself, I engaged him: and he continued constantly and diligently to work with me. I also took an apprentice, the son of Aquila Rose.

I began to pay, by degrees, the debt I had contracted; and, in order to insure my credit and character as a tradesman, I [93]
took care not only to be *really* industrious and frugal, but also to avoid every appearance of the contrary. I was plainly dressed, and never seen in any place of public amusement. I never went a fishing or hunting. A book, indeed, enticed me sometimes from my work, but it was seldom, by stealth, and occasioned no scandal; and to show that I did not think myself above my profession, I conveyed home, sometimes in a wheelbarrow, the paper I purchased at the warehouses.

I thus obtained the reputation of being an industrious young man, and very punctual in his payments. The merchants who imported articles of stationary solicited my custom; others offered to furnish me with books, and my little trade went on prosperously.

Meanwhile the credit and business of Keimer diminishing every day, he was at last forced to sell his stock to satisfy his creditors; and he betook himself to Barbadoes, where he lived for sometime in a very impoverished state. His apprentice, David Harry, whom I had instructed while I worked for Keimer, having bought his materials, succeeded him in the business. I was apprehensive, at first, of finding in Harry a powerful competitor, as he was allied to an opulent and respectable family; I therefore proposed a partnership, which, happily for me, he rejected with disdain. He was extremely proud, thought himself a fine gentleman, lived extravagantly, and pursued amusements which suffered him to be scarcely ever at home; of consequence he became in debt, neglected his business, and business neglected him. Finding in a short [94] time nothing to do in the country, he followed Keimer to Barbadoes, carrying his printing materials with him. There the apprentice employed his old master as a journeyman. They were continually quarrelling; and Harry still getting in debt, was obliged at last to sell his press and types, and return to his old occupation of husbandry in Pennsylvania. The person who purchased them employed Keimer to manage the business; but he died a few years after.

I had now at Philadelphia no competitor but Bradford, who, being in easy circumstances, did not engage in the printing of books, except now and then as workmen chanced to offer themselves; and was not anxious to extend his trade. He had, however, one advantage over me, as he had the direction of the post-office, and was of consequence supposed to have better opportunities of obtaining news. His paper was also supposed to be more advantageous to advertising customers; and in consequence of that supposition, his advertisements were much more numerous than mine: this was a source of great profit to him, and disadvantageous to me. It was to no purpose that I really procured other papers, and distributed my own, by means of the post; the public took for granted my inability in this respect; and I was indeed unable to conquer it in any other mode than by bribing the post-boys, who served me only by stealth, Bradford being so illiberal as to forbid them. This treatment of his excited my resentment; and my disgust was so rooted, that, when I afterwards succeeded him in the post-office, I took care to avoid copying his example.

I had hitherto continued to board with Godfrey, who, with his wife and children, occupied part of my house, and half of [95] the shop for his business; at which indeed he worked very little, being always absorbed by mathematics. Mrs. Godfrey formed a wish of marrying me to the daughter of one of her relations. She contrived various opportunities of bringing us together, till she saw that I was captivated; which was not difficult, the lady in question possessing great personal merit. The parents encouraged my addresses, by inviting me continually to supper, and leaving us together, till at last it was time to come to an explanation. Mrs. Godfrey undertook to negociate our little treaty. I gave her to understand, that I expected to receive with the young lady a sum of money that would enable me at least to discharge the remainder of the debt for my printing materials. It was then, I believe, not more than a hundred pounds. She brought me for answer, that they had no such sum at their disposal. I observed that it might easily be obtained, by a mortgage on their house. The reply to this was, after a few days interval, that they did not approve of the match; that they had consulted Bradford, and found that the business of a printer was not lucrative; that my letters would soon be worn out, and must be supplied with new ones; that Keimer and Harry had failed, and that, probably, I should do so too. Accordingly they forbade me the house, and the young lady was confined. I know not if they had really changed their minds, or if it was merely an artifice, supposing our affections to be too far engaged for us to desist, and that we should contrive to marry secretly, which would leave them at liberty to give or not as they pleased. But, suspecting this motive, I never went again to their house.

Some time after, Mrs. Godfrey informed me that they were very favourably disposed towards me, and wished me to [96] renew the acquaintance; but I declared a firm resolution never to have any thing more to do with the family. The Godfreys expressed some resentment at this: and as we could no longer agree, they changed their residence, leaving me in possession of the whole house. I then resolved to take no more lodgers. This affair having turned my thoughts to marriage, I looked around me, and made overtures of alliance in other quarters: but I soon found that the profession of a printer being generally looked upon as a poor trade, I could expect no money with a wife, at least, if I wished her to possess any other charm. Meanwhile, that passion of youth, so difficult to govern, had often drawn me into intrigues with despicable women who fell in my way; which were not unaccompanied with expence and inconvenience, besides the perpetual risk of injuring my health, and catching a disease which I dreaded above all things. But I was fortunate enough to escape this danger.

As a neighbour and old acquaintance, I had kept up a friendly intimacy with the family of Miss Read. Her parents had retained an affection for me from the time of my lodging in their house. I was often invited thither; they consulted me about their affairs, and I had been sometimes serviceable to them. I was touched with the unhappy situation of their daughter, who was almost always melancholy, and continually seeking solitude. I regarded my forgetfulness and inconstancy, during my abode in London, as the principal cause of her misfortune, though her mother had the candour to attribute the fault to herself, rather than to me, because after having prevented our marriage previously to my departure, [97]
she had induced her to marry another in my absence.

Our mutual affection revived; but there existed great obstacles to our union. Her marriage was considered, indeed, as not being valid, the man having, it was said, a former wife still living in England; but of this it was difficult to obtain a proof at so great a distance; and though a report prevailed of his being dead, yet we had no certainty of it; and supposing it to be true, he had left many debts, for the payment of which his successor might be sued. We ventured, nevertheless, in spite of all these difficulties; and I married her on the 1st of September, 1730. None of the inconveniences we had feared happened to us. She proved to me a good and faithful companion, and contributed essentially to the success of my shop. We prospered together, and it was our mutual study to render each other happy. Thus I corrected, as well as I could, this great error of my youth.

Our club was not at that time established at a tavern. We held our meetings at the house of Mr. Grace, who appropriated a room to the purpose. Some member observed one day, that as our books were frequently quoted in the course of our discussions, it would be convenient to have them collected in the room in which we assembled, in order to be consulted upon occasion; and that, by thus forming a common library of our individual collections, each would have the advantage of using the books of all the other members, which would nearly be the same as if he possessed them all himself. The idea was approved, and we accordingly brought such books as we thought we could spare, which were placed at the end of the [98]
club-room. They amounted not to so many as we expected; and through we made considerable use of them, yet some inconveniences resulting, from want of care, it was agreed, after about a year, to discontinue the collection; and each took away such books as belonged to him.

It was now that I first started the idea of establishing, by subscription, a public library, I drew up the proposals, had them ingrossed in form by Brockden the attorney, and my project succeeded, as will be seen in the sequel.

[The life of Dr. Franklin, as written by himself, so far as it has yet been communicated to the world, breaks off in this place. We understand that it was continued by him somewhat farther, and we hope that the remainder will, at some future period, be communicated to the public. We have no hesitation in supposing that every reader will find himself greatly interested by the frank simplicity and the philosophical discernment by which these pages are so eminently characterized. We have therefore thought proper, in order as much as possible to relieve his regret, to subjoin the following continuation, by one of the Doctor's intimate friends. It is extracted from an American periodical publication, and was written by the late Dr. Stuber,[6] of Philadelphia.]

[99]

The promotion of literature had been little attended to in Pennsylvania. Most of the inhabitants were too much immersed in business to think of scientific pursuits; and those few, whose inclinations led them to study, found it difficult to gratify them, from the want of libraries sufficiently large. In such circumstances, the establishment of a public library was an important event. This was first set on foot by Franklin, about the year 1731. Fifty persons subscribed forty shillings each, and agreed to pay ten shillings annually. The number increased; and in 1742, the company was incorporated by the name of "The Library Company of Philadelphia." Several other companies were formed in this city in imitation of it. These were all at length united with the Library Company of Philadelphia, which thus received a considerable accession of books and property. It now contains about eight thousand volumes on all subjects, a philosophical apparatus, and a well-chosen collection of natural and artificial curiosities. For its support the company now possesses landed property of considerable value. They have lately built an elegant house in Fifth-street, in the front of [100]
which will be erected a marble statue of their founder, Benjamin Franklin.

This institution was greatly encouraged by the friends of literature in America and in Great Britain. The Penn family distinguished themselves by their donations. Amongst the earliest friends of this institution must be mentioned the late Peter Collinson, the friend and correspondent of Dr. Franklin. He not only made considerable presents himself, and obtained others from his friends, but voluntarily undertook to manage the business of the Company in London, recommending books, purchasing and shipping them. His extensive knowledge, and zeal for the promotion of science, enabled him to execute this important trust with the greatest advantage. He continued to perform these services for more than thirty years, and uniformly refused to accept of any compensation. During this time, he communicated to the directors every information relative to improvements and discoveries in the arts, agriculture, and philosophy.

The beneficial influence of this institution was soon evident. The terms of subscription to it were so moderate that it was accessible to every one. Its advantages were not confined to the opulent. The citizens in the middle and lower walks of life were equally partakers of them. Hence a degree of information was extended amongst all classes of people. The example was soon followed. Libraries were established in various places, and they are now become very numerous in the United States, and particularly in Pennsylvania. It is to be hoped that they will be still more widely extended, and that [101]
information will be every where increased. This will be the best security for maintaining our liberties. A nation of well informed men, who have been taught to know and prize the rights which God has given them, cannot be enslaved. It is in the regions of ignorance that tyranny reigns. It flies before the light of science. Let the citizens of America, then, encourage institutions calculated to diffuse knowledge amongst the people; and amongst these, public libraries are not the least important.

In 1732, Franklin began to publish Poor Richard's Almanack. This was remarkable for the numerous and valuable concise maxims which it contained, all tending to exhort to industry and frugality. It was continued for many years. In the almanack for the last year, all the maxims were collected in an address to the reader, entitled, The Way to Wealth. This has been translated into various languages, and inserted in different publications. It has also been printed on a large sheet, and may be seen framed in many houses in this city. This address contains, perhaps, the best practical system of economy that ever has appeared. It is written in a manner intelligible to every one, and which cannot fail of convincing every reader of the justice and propriety of the remarks and advice which it contains. The demand for this almanack was so great, that ten thousand have been sold in one year; which must be considered as a very large number, especially when we reflect, that this country was, at that time, but thinly peopled. It cannot be doubted that the salutary maxims contained in these almanacks must have made a favourable impression upon many of the readers of them.

It was not long before Franklin entered upon his political career. In the year 1736, he was appointed clerk to the general [102] assembly of Pennsylvania, and was re-elected by succeeding assemblies for several years, until he was chosen a representative for the city of Philadelphia.

Bradford, the printer, mentioned above, was possessed of some advantages over Franklin, by being post-master, thereby having an opportunity of circulating his paper more extensively, and thus rendering it a better vehicle for advertisements, &c. Franklin, in his turn, enjoyed these advantages, by being appointed post-master of Philadelphia in 1737. Bradford, while in office, had acted ungenerously towards Franklin, preventing as much as possible the circulation of his paper. He had now an opportunity of retaliating; but his nobleness of soul prevented him from making use of it.

The police of Philadelphia had early appointed watchmen, whose duty it was to guard the citizens against the midnight robber, and to give an immediate alarm in case of fire. This duty is, perhaps, one of the most important that can be committed to any set of men. The regulations, however, were not sufficiently strict. Franklin saw the dangers arising from this cause, and suggested an alteration, so as to oblige the guardians of the night to be more watchful over the lives and property of the citizens. The propriety of this was immediately perceived, and a reform was effected.

There is nothing more dangerous to growing cities than fires. Other causes operate slowly, and almost imperceptibly; but these in a moment render abortive the labours of ages. On this account there should be, in all cities, ample provisions to prevent fires from spreading. Franklin early saw the necessity of these; and, about the year 1728, formed the first fire [103] company in this city. The example was soon followed by others; and there are now numerous fire companies in the city and liberties. To these may be attributed in a great degree the activity in extinguishing fires, for which the citizens of Philadelphia are distinguished, and the inconsiderable damage this city has sustained from this cause. Some time after, Franklin suggested the plan for an association for insuring houses from losses by fire, which was adopted; and the association continues to this day. The advantages experienced from it have been great.

From the first settlement of Pennsylvania, a spirit of dispute appears to have prevailed among its inhabitants. During the life-time of William Penn, the constitution had been three times altered. After this period the history of Pennsylvania is little else than a recital of the quarrels between the proprietaries, or their governors, and the assembly. The proprietaries contended for the right of exempting their land from taxes; to which the assembly would by no means consent. This subject of dispute interfered in almost every question, and prevented the most salutary laws from being enacted. This at times subjected the people to great inconveniences. In the year 1774, during a war between France and Great Britain, some French and Indians had made inroads upon the frontier inhabitants of the province, who were unprovided for such an attack. It became necessary that the citizens should arm for their defence. Governor Thomas recommended to the assembly, who were then sitting, to pass a militia law. To this they would agree only upon condition, that he should give [104] his assent to certain laws, which appeared to them calculated to promote the interests of the people. As he thought these laws would be injurious to the proprietaries, he refused his assent to them; and the assembly broke up without passing a militia bill. The situation of the province was at this time truly alarming: exposed to the continual inroad of an enemy, and destitute of every means of defence. At this crisis Franklin stepped forth, and proposed to a meeting of the citizens of Philadelphia, a plan of a voluntary association for the defence of the province. This was approved of, and signed by twelve hundred persons immediately. Copies were circulated without delay through the province; and in a short time the number of signatures amounted to ten thousand. Franklin was chosen colonel of the Philadelphia regiment; but he did not think proper to accept of the honour.

Pursuits of a different nature now occupied the greatest part of his attention for some years. He engaged in a course of electrical experiments, with all the ardor and thirst for discovery which characterized the philosophers of that day. Of all the branches of experimental philosophy, electricity had been least explored. The attractive power of amber is mentioned by Theophrastus and Pliny, and from them, by later naturalists. In the year 1600, Gilbert, an English physician, enlarged considerably the catalogue of substances which have the property of attracting light bodies. Boyle, Otto Guericke, a burgomaster of Magdeburg, celebrated as the inventor of the air-pump, Dr. Wall, and Sir Isaac Newton added some facts. Guericke first observed the repulsive power of electricity, and the light and noise produced by it. In 1709, Hawkesbec [105]
communicated some important observations and experiments to the world. For several years electricity was entirely neglected, until Mr. Grey applied himself to it, in 1728, with great assiduity. He and his friend Mr. Wheeler, made a great variety of experiments, in which they demonstrated, that electricity may be communicated from one body to another, even without being in contact, and in this way may be conducted to a great distance. Mr. Grey afterwards found, that, by suspending rods of iron by silk or hair lines, and bringing an excited tube under them, sparks might be drawn, and a light perceived at the extremities in the dark. M. du Faye, intendant of the French king's gardens, made a number of experiments, which added not a little to the science. He made the discovery of two kinds of electricity, which he called *vitreous* and *resinous*; the former produced by rubbing glass, the latter from excited sulphur, sealing-wax, &c. But this he afterwards gave up as erroneous. Between the years 1739 and 1742, Desaguliers made a number of experiments, but added little of importance. He first used the terms *conductors* and *electrics per se*. In 1742, several ingenious Germans engaged in this subject, of these the principal were, professor Boze of Wittemberg, professor Winkler of Leipsic, Gordon, a Scotch Benedictine monk, professor of philosophy at Erfurt, and Dr. Ludolf, of Berlin. The result of their researches astonished the philosophers of Europe. Their apparatus was large, and by means of it they were enabled to collect large quantities of the electric fluid, and thus to produce phenomena which had been hitherto unobserved. They killed small birds, and set spirits on fire. Their experiments excited the curiosity of other philosophers. Collinson, about the year 1745, [106]
sent to the Library Company of Philadelphia, an account of these experiments, together with a tube, and directions how to use it. Franklin, with some of his friends, immediately engaged in a course of experiments, the result of which is well known. He was enabled to make a number of important discoveries, and to propose theories to account for various phenomena, which have been universally adopted, and which bid fair to endure for ages. His observations he communicated in a series of letters, to his friend Collinson, the first of which is dated March 28, 1747. In these he shews 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 honour of this, without hesitation; although the English have claimed it for their countryman, Dr. Watson. Watson's paper is dated January 21, 1748; Franklin's July 11, 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 shewed 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 [107]
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 present 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 [108] centry-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 shade, 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 [109] 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 laboured, was much pleased with it, and repeated the experiments with success. He prevailed on his friend, M. D'Alibard, 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 XV., hearing of these experiments, expressed a wish to be a spectator of them. A course of experiments was given at the seat of the D'Ayen, at St. Germain, by M. de Lor. The applauses which the king bestowed [110] upon Franklin, excited in Buffon, D'Alibard, 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. D'Alibard at Marly-la-ville, and De Lor at his house in the *Estrapade* at Paris, some of the highest ground in that capital. D'Alibard's machine first shewed signs of electricity. On the 10th of May, 1752, a thunder cloud passed over it, in the absence of M. D'Alibard, and a number of sparks were drawn from it by Coiffier, joiner, with whom D'Alibard 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. D'Alibard, 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 signalised 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 Richman 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, [111] 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 honour 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 incontestibly due to Franklin. D'Alibard, who made the first experiments in France, says, that he only followed the tract which Franklin had pointed out.

It has been of late asserted, that the honour 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 presideal of Nerac; the English paragraphs probably refer to the [112] 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 19, 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 labours 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. [113]
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 D'Alibard and Beccaria were the most distinguished. The opposition has gradually ceased, and the Franklinian system is now universally adopted, where science flourishes.

The important practical use which Franklin made of his discoveries, the securing of houses from injury by lightning, has been already mentioned. Pointed conductors are now very common in America; but prejudice has hitherto prevented their general introduction into Europe, notwithstanding the most undoubted proofs of their utility have been given. But
mankind can with difficulty be brought to lay aside practices, or to adopt new ones. And perhaps we have more reason, to [114]
be surprised, that a practice however rational, which was proposed about forty years ago, should in that time have been adopted in so many places, than that it has not universally prevailed. It is only by degrees that the great body of mankind can be led into new practices, however salutary their tendency. It is now nearly eighty years since inoculation was introduced into Europe and America; and it is so far from being general at present, that it will, require one or two centuries to render it so.

In the year 1745, Franklin published an account of his new-invented Pennsylvania fire-places, in which he minutely and accurately states the advantages of different kinds of fire-places; and endeavours to show that the one which he describes is to be preferred to any other. This contrivance has given rise to the open stoves now in general use, which, however, differ from it in construction, particularly in not having an air-box at the back, through which a constant supply of air, warmed in its passage, is thrown into the room. The advantages of this are, that as a stream of warm air is continually flowing into the room, less fuel is necessary to preserve a proper temperature, and the room may be so tightened as that no air may enter through cracks—the consequence of which are colds, tooth-aches, &c.

Although philosophy was a principal object of Franklin's pursuit for several years, he confined himself not to this. In the year 1747, he became a member of the general assembly of Pennsylvania, as a burgess for the city of Philadelphia.

Warm disputes subsisted at this time between the assembly and the proprietaries; each contending for what they conceived [115] to be their just rights. Franklin, a friend to the rights of man from his infancy, soon distinguished himself as a steady opponent of the unjust schemes of the proprietaries. He was soon looked up to as the head of the opposition; and to him have been attributed many of the spirited replies of the assembly, to the messages of the governors. His influence in the body was very great. This arose not from any superior powers of eloquence; he spoke but seldom, and he never was known to make any thing like an elaborate harangue. His speeches often consisted of a single sentence, or of a well-told story, the moral of which was always obviously to the point. He never attempted the flowery fields of oratory. His manner was plain and mild. His style in speaking was, like that of his writings, simple, unadorned, and remarkably concise. With this plain manner, and his penetrating and solid judgment, he was able to confound the most eloquent and subtle of his adversaries, to confirm the opinions of his friends, and to make converts of the unprejudiced who had opposed him. With a single observation, he has rendered of no avail an elegant and lengthy discourse, and determined the fate of a question of importance.

But he was not contented with thus supporting the rights of the people. He wished to render them permanently secure, which can only be done by making their value properly known; and this must depend upon increasing and extending information to every class of men. We have already seen that he was the founder of the public library, which contributed greatly towards improving the minds of the citizens. But this was not sufficient. The schools then subsisting were in [116] general of little utility. The teachers were men ill qualified for the important duty which they had undertaken; and, after all, nothing more could be obtained than the rudiments of a common English education. Franklin drew up a plan of an academy, to be erected in the city of Philadelphia, suited to "the state of an infant country;" but in this, as in all his plans, he confined not his views to the present time only. He looked forward to the period when an institution on an enlarged plan would become necessary. With this view, he considered his academy as "a foundation for posterity to erect a seminary of learning more extensive, and suitable to future circumstances." In pursuance of this plan, the constitutions were drawn up and signed on the 13th of November, 1749. In these, twenty-four of the most respectable citizens of Philadelphia were named as trustees. In the choice of these, and in the formation of his plan, Franklin is said to have consulted chiefly with Thomas Hopkinson, Esq; the Rev. Richard Peters, then secretary of the province, Tench Francis, Esq. attorney-general, and Dr. Phineas Bond.

The following article shews a spirit of benevolence worthy of imitation; and, for the honour of our city, we hope that it continues to be in force.

"In case of the disability of the *rector*, or any master (established on the foundation by receiving a certain salary) through sickness, or any other natural infirmity, whereby he may be reduced to poverty, the trustees shall have power to contribute to his support, in proportion to his distress and merit, and the stock in their hands."

The last clause of the fundamental rules is expressed in language so tender and benevolent, so truly parental, that it will [117] do everlasting honour to the hearts and heads of the founders.

"It is hoped and expected that the trustees will make it their pleasure, and in some degree their business, to visit the academy often; to encourage and countenance the youth, to countenance and assist the masters, and, by all means in their power, advance the usefulness and reputation of the design; that they will look on the students as, in some measure, their own children, treat them with familiarity and affection; and when they have behaved well, gone through their studies, and are to enter the world, they shall zealously unite, and make all the interest that can be made to promote and establish them, whether in business, offices, marriages, or any other thing for their advantage, in preference to all other persons whatsoever, even of equal merit."

The constitutions being signed and made public, with the names of the gentlemen proposing themselves as trustees and founders, the design was so well approved of by the public-spirited citizens of Philadelphia, that the sum of eight hundred pounds per annum, for five years, was in the course of a few weeks subscribed for carrying it into execution; and in the beginning of January following (viz. 1750) three of the schools were opened, namely, the Latin and Greek schools, the Mathematical school, and the English school. In pursuance of an article in the original plan, a school for educating sixty boys and thirty girls (in the charter since called the Charitable School) was opened; and amidst all the difficulties with [118]
which the trustees have struggled in respect to their funds, has still been continued full for the space of forty years; so that allowing three years education for each boy and girl admitted into it, which is the general rule, at least twelve hundred children have received in it the chief part of their education, who might otherwise, in a great measure, have been left without the means of instruction. And many of those who have been thus educated, are now to be found among the most useful and reputable citizens of this state.

The institution, thus successfully begun, continued daily to flourish, to the great satisfaction of Dr. Franklin; who, notwithstanding the multiplicity of his other engagements and pursuits, at that busy stage of his life, was a constant attendant at the monthly visitations and examinations of the schools, and made it his particular study, by means of his extensive correspondence abroad, to advance the reputation of the seminary, and to draw students and scholars to it from different parts of America and the West Indies. Through the interposition of his benevolent and learned friend, Peter Collinson, of London, upon the application of the trustees, a charter of incorporation, dated July 13, 1753, was obtained from the honourable proprietors of Pennsylvania, Thomas Penn and Richard Penn, Esqrs. accompanied with a liberal benefaction of five hundred pounds sterling; and Dr. Franklin now began in good earnest to please himself with the hopes of a speedy accomplishment of his original design, viz. the establishment of a perfect institution, upon the plan of the European colleges and universities; for which his academy was intended as a nursery or foundation. To elucidate this fact, [119]
is a matter of considerable importance in respect to the memory and character of Dr. Franklin as a philosopher, and as the friend and patron of learning and science; for, notwithstanding what is expressly declared by him in the preamble to the constitutions, viz. that the academy was begun for "teaching the Latin and Greek languages, with all useful branches of the arts and sciences, suitable to the state of an infant country, and laying a foundation for posterity to erect a seminary of learning more extensive, and suitable to their future circumstances;" yet it has been suggested of late, as upon Dr. Franklin's authority, that the Latin and Greek, or the dead languages, are an incumbrance upon a scheme of liberal education, and that the engrafting or founding a college, or more extensive seminary, upon his academy, was without his approbation or agency, and gave him discontent. If the reverse of this does not already appear from what has been quoted above, the following letters will put the matter beyond dispute. They were written by him to a gentleman, who had at that time published the idea of a college, suited to the circumstances of a young country (meaning New-York) a copy of which having been sent to Dr. Franklin for his opinion, gave rise to that correspondence which terminated about a year afterwards, in erecting the college upon the foundation of the academy, and establishing that gentleman at the head of both, where he still continues, after a period of thirty-six years, to preside with distinguished reputation.

From these letters also, the state of the academy, at that time, will be, seen.

FOOTNOTES:

[1] As a proof that Franklin was anciently the common name of an order or rank in England, see Judge Fortesque, *De laudibus legum Angliæ*, written about the year 1412, in which is the following passage, to shew that good juries might easily be formed in any part of England:

"Regio etiam ilia, ita respersa refertaque est *posessoribus terrarum* et agrorum, quod in ea, villula tam parva reperiri non poterit, in qua non est *miles*, *armiger*, vel pater-familias, qualis ibidem *franklin* vulgariter nuncupatur, magnis ditatus possessionibus, nec non libere tenentes et alii *valecti* plurimi, suis patrimoniis sufficientes, ad faciendum juratam, in forma prænotata."

"Moreover, the same country is so filled and replenished with landed menne, that therein so small a thorpe cannot be found wherein dwelleth not a knight, an esquire, or such a householder as is there commonly called a *franklin*, enriched with great possessions; and also other freeholders and many yeomen, able for their livelihoods to make a jury in form aforementioned."

OLD TRANSLATION.

Chaucer too, calls his country gentleman a *franklin*; and, after describing his good housekeeping, thus characterizes him:

This worthy franklin bore a purse of silk
Fix'd to his girdle, white as morning milk;
Knight of the shire, first justice at th' assize,
To help the poor, the doubtful to advise.
In all employments, generous, just he prov'd,
Renown'd for courtesy, by all belov'd.

[2] Town in the island of Nantucket.

[3] Probably the Dunciad, where we find him thus immortalized by the author:

Silence, ye wolves, while Ralph to Cynthia howls,
And makes night hideous—answer him, ye owls!

[4] Printing houses in general are thus denominated by the workmen: the *spirit* they call by the name of *Ralph*.

[5] A manuscript note in the file of the American Mercury, preserved in the Philadelphia library, says, that Franklin wrote the five first numbers, and part of the eighth.

[6] Dr. Stuber was born in Philadelphia, of German parents. He was sent, at an early age, to the university, where his genius, diligence and amiable temper, soon acquired him the particular notice and favour of those under whose immediate direction he was placed. After passing through the common course of study, in a much shorter time than usual, he left the university, at the age of sixteen, with great reputation. Not long after, he entered on the study of physic; and the zeal with which he pursued it, and the advances he made, gave his friends reason to form the most flattering prospects of his future eminence and usefulness in the profession. As Dr. Stuber's circumstances were very moderate, he did not think this pursuit well calculated to improve them. He therefore relinquished it, after he had obtained a degree in the profession, and qualified himself to practise with credit and success; and immediately entered on the study of the law. While in pursuit of the last mentioned object, he was prevented by a premature death from reaping the fruit of those

talents with which he was endowed, and of a youth spent in the ardent and successful pursuit of useful and elegant literature.

"*Philad. April 19th, 1753.*

"Sir,

"I received your favour of the 11th instant, with your new[7] piece on *Education*, which I shall carefully peruse, and give you my sentiments of it, as you desire, by next post.

"I believe the young gentlemen, your pupils, may be entertained and instructed here, in mathematics and philosophy, to satisfaction. Mr. Alison[8] (who was educated at Glasgow) has been long accustomed to teach the latter, and Mr. Grew[9] the former; and I think their pupils make great progress. Mr. Alison has the care of the Latin and Greek school, but as he has now three good assistants,[10] he can very well afford some hours every day for the instruction of those who are engaged in higher studies. The mathematical school is pretty well furnished with instruments. The English library is a good one; and we have belonging to it a middling apparatus for experimental philosophy, and propose speedily to complete it. The Loganian library, one of the best collections in America, will shortly be opened; so that neither books nor instruments will be wanting; and as we are determined always to give good salaries, we have reason to believe we may have always an opportunity of choosing good masters; upon which indeed, the success of the whole depends. We are [121] obliged to you for your kind offers in this respect, and when you are settled in England, we may occasionally make use of your friendship and judgment.—

"If it suits your conveniency to visit Philadelphia before you return to Europe, I shall be extremely glad to see and converse with you here, as well as to correspond with you after your settlement in England; for an acquaintance and communication with men of learning, virtue, and public spirit, is one of my greatest enjoyments.

"I do not know whether you ever happened to see the first proposals I made for erecting this academy. I send them inclosed. They had (however imperfect) the desired success, being followed by a subscription of four thousand pounds, towards carrying them into execution. And as we are fond of receiving advice, and are daily improving by experience, I am in hopes we shall, in a few years, see a *perfect institution*.

"I am, very respectfully, &c.

"B. FRANKLIN.

"*Mr. W. Smith, Long-Island.*"

FOOTNOTES:

[7] A general idea of the college of Mirania.

[8] The Rev. and learned Mr. Francis Alison, afterwards D. D. and vice-provost of the college.

[9] Mr. Theophilus Grew, afterwards professor of mathematics in the college.

[10] Those assistants were at that time Mr. Charles Thomson, late secretary to congress, Mr. Paul Jackson, and Mr. Jacob Duche.

"*Philad. May 3d, 1753.*

"Sir,

"Mr. Peters has just now been with me, and we have compared notes on your new piece. We find nothing in the scheme of education, however excellent, but what is, in our opinion, very practicable. The great difficulty will be to find the [122] Aratus[11], and other suitable persons, to carry it into execution; but such may be had if proper encouragement be given. We have both received great pleasure in the perusal of it. For my part, I know not when I have read a piece that has more affected me—so noble and just are the sentiments, so warm and animated the language; yet as censure from your friends may be of more use, as well as more agreeable to you than praise, I ought to mention, that I wish you had omitted not only the quotation from the Review[12], which you are now justly dissatisfied with, but those expressions of resentment against your adversaries, in pages 65 and 79. In such cases, the noblest victory is obtained by neglect, and by shining on.

"Mr. Allen has been out of town these ten days; but before he went he directed me to procure him six copies of your piece. Mr. Peters has taken ten. He proposed to have written to you; but omits it, as he expects so soon to have the pleasure of seeing you here. He desires me to present his affectionate compliments to you, and to assure you that you will be very welcome to him. I shall only say, that you may depend on my doing all in my power to make your visit to [123] Philadelphia agreeable to you.

"I am, &c.

"B. FRANKLIN.

"*Mr. Smith.*"

FOOTNOTES:

[11] The name given to the principal or head of the ideal college, the system of education in which hath nevertheless been nearly realized, or followed as a model, in the college and academy of Philadelphia, and some other American seminaries, for many years past.

[12] The quotation alluded to (from the London Monthly Review for 1749,) was judged to reflect too severely on the discipline and government of the English universities of Oxford and Cambridge, and was expunged from the following editions of this work.

"*Philad. Nov. 27th, 1753.* [120]

"DEAR SIR,

"Having written you fully, *via* Bristol, I have now little to add. Matters relating to the academy remain in *statu quo*. The trustees would be glad to see a rector established there, but they dread entering into new engagements till they are got out of debt; and I have not yet got them wholly over to my opinion, that a good professor, or teacher of the higher branches of learning, would draw so many scholars as to pay great part, if not the whole of his salary. Thus, unless the proprietors (of the province) shall think fit to put the finishing hand to our institution, it must, I fear, wait some few years longer before it can arrive at that state of perfection, which to me it seems now capable of; and all the pleasure I promised myself in seeing you settled among us, vanishes into smoke.

"But good Mr. Collinson writes me word, that no endeavours of his shall be wanting; and he hopes, with the archbishop's assistance, to be able to prevail with our proprietors[13]. I pray God grant them success.

"My son presents his affectionate regards, with, dear Sir, [124]

"Your's, &c.

"B. FRANKLIN.

"P. S. I have not been favoured with a line from you since your arrival in England."

FOOTNOTE:

[13] Upon the application of archbishop Herring and P. Collinson, Esq. at Dr. Franklin's request, (aided by the letters of Mr. Allen and Mr. Peters,) the Hon. Thomas Penn, Esq. subscribed an annual sum, and afterwards gave at least 5000*l.* to the founding or engrafting the college upon the academy.

"*Philad. April 18th, 1754.*

"DEAR SIR,

"I have had but one letter from you since your arrival in England, which was but a short one, *via* Boston, dated October 18th, acquainting me that you had written largely by Captain Davis.—Davis was lost, and with him your letters, to my great disappointment.—Mesnard and Gibbon have since arrived here, and I hear nothing from you. My comfort is, an imagination that you only omit writing because you are coming, and propose to tell me every thing *viva voce*. So not knowing whether this letter will reach you, and hoping either to see or hear from you by the Myrtilla, Captain Budden's ship, which is daily expected, I only add, that I am, with great esteem and affection

"Your's, &c.

"B. FRANKLIN.

"*Mr. Smith.*"

About a month after the date of this last letter, the gentleman to whom it was addressed arrived in Philadelphia, and was immediately placed at the head of the seminary; whereby Dr. Franklin and the other trustees were enabled to prosecute their plan, for perfecting the institution, and opening the college upon the large and liberal foundation on which it now stands; for which purpose they obtained their additional charter, dated May 27th, 1755. [125]

Thus far we thought it proper to exhibit in one view Dr. Franklin's services in the foundation and establishment of this seminary. He soon afterwards embarked for England, in the public service of his country; and having been generally employed abroad, in the like service, for the greatest part of the remainder of his life, (as will appear in our subsequent account of the same) he had but few opportunities of taking any further active part in the affairs of the seminary, until his final return in the year 1785, when he found its charters violated, and his ancient colleagues, the original founders, deprived of their trust, by an act of the legislature; and although his own name had been inserted amongst the new trustees, yet he declined to take his seat among them, or any concern in the management of their affairs, till the institution was restored by law to its original owners. He then assembled his old colleagues at his own house, and being chosen their president, all their future meetings were, at his request, held there, till within a few months of his death, when with reluctance, and at their desire, lest he might be too much injured by his attention to their business, he suffered them to meet at the college.

Franklin not only gave birth to many useful institutions himself, but he was also instrumental in promoting those which had originated with other men. About the year 1752, an eminent physician of this city, Dr. Bond, considering the deplorable state of the poor when visited with disease, conceived the idea of establishing an hospital. Notwithstanding very great exertions on his part, he was able to interest few people so far in his benevolent plan, as to obtain subscriptions from them. Unwilling that his scheme should prove abortive, he sought the aid of Franklin, who readily engaged in the business, both by using his influence with his friends, and by stating the advantageous influence of the proposed institution in his paper. These efforts were attended with success. Considerable sums were subscribed; but they were still short of what was necessary. Franklin now made another exertion. He applied to the assembly; and, after some opposition, obtained leave to bring in a bill, specifying, that as soon as two thousand pounds were subscribed, the same sum should be drawn from the treasury by the speaker's warrant, to be applied to the purposes of the institution. The opposition, as the sum was granted upon a contingency which they supposed would never take place, were silent, and the bill passed. The friends of the plan now redoubled their efforts, to obtain subscriptions to the amount stated in the bill, and were soon [126] successful. This was the foundation of the Pennsylvanian Hospital, which, with the Bettering-house, and Dispensary, bears ample testimony of the humanity of the citizens of Philadelphia.

Dr. Franklin had conducted himself so well in the office of post-master, and had shown himself to be so well acquainted [127] with the business of that department, that it was thought expedient to raise him to a more dignified station. In 1753 he was appointed deputy post-master general for the British colonies. The profits arising from the postage of letters formed no inconsiderable part of the revenue, which the crown of Great Britain derived from these colonies. In the hands of Franklin, it is said, that the post-office in America, yielded annually thrice as much as that of Ireland.

The American colonies were much exposed to depredations on their frontiers, by the Indians; and more particularly whenever a war took place between France and England. The colonies, individually, were either too weak to take efficient measures for their own defence, or they were unwilling to take upon themselves the whole burden of erecting forts and maintaining garrisons, whilst their neighbours, who partook equally with themselves of the advantages, contributed nothing to the expence. Sometimes also the disputes, which subsisted between the governors and assemblies, prevented the adoption of means of defence; as we have seen was the case in Pennsylvania in 1745. To devise a plan of union between the colonies, to regulate this and other matters, appeared a desirable object. To accomplish this, in the year 1754, commissioners from New Hampshire, Massachussets, Rhode Island, New Jersey, Pennsylvania, and Maryland, met at Albany. Dr. Franklin attended here, as a commissioner from Pennsylvania, and produced a plan, which, from the place of meeting, has been usually termed, "The Albany plan of Union." This proposed, that application should be made for an act of parliament, to establish in the colonies a general government, to be administered by a president-general, appointed by [128] the crown, and by a grand council, consisting of members, chosen by the representatives of the different colonies; their number to be in direct proportion to the sums paid by each colony into the general treasury, with this restriction, that no colony should have more than seven, nor less than two representatives. The whole executive authority was committed to the president-general. The power of legislation was lodged in the grand council and president-general jointly; his consent being made necessary to passing a bill into a law. The power vested in the president and council was, to declare war and peace, and to conclude treaties with the Indian nations; to regulate trade with, and to make purchases of vacant lands from them, either in the name of the crown, or of the union; to settle new colonies, to make laws for governing these until they should be erected into separate governments; and to raise troops, build forts, and fit out armed vessels, and to use other means for the general defence; and, to effect these things, a power was given to make laws, laying such duties, imposts, or taxes, as they should find necessary, and as would be least burdensome to the people. All laws were to be sent to England for the king's approbation; and unless disapproved of within three years, were to remain in force. All officers in the land or sea service were to be nominated by the president-general, and approved of by the general council; civil officers were to be nominated by the council, and approved of by the president. Such are the outlines of the plan proposed, for the consideration of the congress, by Dr. Franklin. After several days' discussion, it was unanimously agreed to by the [129] commissioners, a copy transmitted to each assembly, and one to the king's council. The fate of it was singular. It was disapproved of by the ministry of Great Britain, because it gave too much power to the representatives of the people; and it was rejected by every assembly, as giving to the president-general, the representative of the crown, an influence greater than appeared to them proper, in a plan of government intended for freemen. Perhaps this rejection, on both sides, is the strongest proof that could be adduced of the excellence of it, as suited to the situation of America and Great Britain at that time. It appears to have steered exactly in the middle between the opposite interests of both.

Whether the adoption of this plan would have prevented the separation of America from Great Britain, is a question which might afford much room for speculation. It may be said, that, by enabling the colonies to defend themselves, it would have removed the pretext upon which the stamp-act, tea-act, and other acts of the British parliament, were passed; which excited a spirit of opposition, and laid the foundation for the separation of the two countries. But, on the other hand, it must be admitted, that the restriction laid by Great Britain upon our commerce, obliging us to sell our produce to her citizens only, and to take from them various articles, of which, as our manufactures were discouraged, we stood in need, at a price greater than that for which they could have been obtained from other nations, must inevitably produce dissatisfaction, even though no duties were imposed by the parliament; a circumstance which might still have taken place. [130]
Besides, as the president-general was to be appointed by the crown, he must, of necessity, be devoted to its views, and would, therefore, refuse his assent to any laws, however salutary to the community, which had the most remote tendency to injure the interests of his sovereign. Even should they receive his assent, the approbation of the king was to be necessary; who would indubitably, in every instance, prefer the advantage of his home dominions to that of his colonies. Hence would ensue perpetual disagreements between the council and the president-general, and thus, between the people of America and the crown of Great Britain:—While the colonies continued weak, they would be obliged to submit, and as soon as they acquired strength they would become more urgent in their demands, until, at length, they would shake off the yoke, and declare themselves independent.

Whilst the French were in possession of Canada, their trade with the natives extended very far; even to the back of the British settlements. They were disposed, from time to time, to establish posts within the territory, which the English claimed as their own. Independent of the injury to the fur trade, which was considerable, the colonies suffered this further inconvenience, that the Indians were frequently instigated to commit depredations on their frontiers. In the year 1753, encroachments were made upon the boundaries of Virginia. Remonstrances had no effect. In the ensuing year, a body of men were sent out under the command of Mr. Washington, who, though a very young man, had, by his conduct in the preceding year, shewn himself worthy of such an important trust. Whilst marching to take possession of the post at the [131]
junction of the Allegany and Monongahela, he was informed that the French had already erected a fort there. A detachment of their men marched against him. He fortified himself as strongly as time and circumstances would admit. A superiority of numbers soon obliged him to surrender *Fort Necessity*. He obtained honourable terms for himself and men, and returned to Virginia. The government of Great Britain now thought it necessary to interfere. In the year 1755, General Braddock, with some regiments of regular troops, and provincial levies, was sent to dispossess the French of the posts upon which they had seized. After the men were all ready, a difficulty occurred, which had nearly prevented the expedition. This was the want of waggons. Franklin now stepped forward, and with the assistance of his son, in a little time procured a hundred and fifty. Braddock unfortunately fell into an ambuscade, and perished, with a number of his men. Washington, who had accompanied him as an aid-de-camp, and had warned him, in vain, of his danger, now displayed great military talents in effecting a retreat of the remains of the army, and in forming a junction with the rear, under colonel Dunbar, upon whom the chief command now devolved. With some difficulty they brought their little body to a place of safety; but they found it necessary to destroy their waggons and baggage, to prevent them falling into the hands of the enemy. For the waggons which he had furnished, Franklin had given bonds to a large amount. The owners declared their intention of obliging him to make a restitution of their property. Had they put their threats in execution, ruin must inevitably have been the consequence. Governor Shirley, finding that he had incurred these debts for the service of [132]
government, made arrangements to have them discharged, and released Franklin from his disagreeable situation.

The alarm spread through the colonies, after the defeat of Braddock, was very great. Preparations to arm were every where made. In Pennsylvania, the prevalence of the Quaker interest prevented the adoption of any system of defence, which would compel the citizens to bear arms. Franklin introduced into the assembly a bill for organizing a militia, by which every man was allowed to take arms or not, as to him should appear fit. The Quakers, being thus left at liberty, suffered the bill to pass; for although their principles would not suffer them to fight, they had no objection to their neighbours fighting for them. In consequence of this act a very respectable militia was formed. The sense of impending danger infused a military spirit in all, whose religious tenets were not opposed to war. Franklin was appointed colonel of a regiment in Philadelphia, which consisted of 1200 men.

The north-western frontier being invaded by the enemy, it became necessary to adopt measures for its defence. Franklin was directed by the governor to take charge of this. A power of raising men, and of appointing officers to command them, was vested in him. He soon levied a body of troops, with which he repaired to the place at which their presence was necessary. Here he built a fort, and placed a garrison in such a posture of defence, as would enable them to withstand the inroads, to which the inhabitants had previously been exposed. He remained here for some time, in order the more [133] completely to discharge the trust committed to him. Some business of importance at length rendered his presence necessary in the assembly, and he returned to Philadelphia.

The defence of her colonies was a great expence to Great Britain. The most effectual mode of lessening this was, to put arms into the hands of the inhabitants, and to teach them their use. But England wished not that the Americans should become acquainted with their own strength. She was apprehensive, that, as soon as this period arrived, they would no longer submit to that monopoly of their trade, which to them was highly injurious, but extremely advantageous to the mother-country. In comparison with the profits of this, the expence of maintaining armies and fleets to defend them was trifling. She fought to keep them dependent upon her for protection; the best plan which could be devised for retaining them in peaceable subjection. The least appearance of a military spirit was therefore to be guarded against, and, although a war then raged, the act for organizing a militia was disapproved of by the ministry. The regiments which had been formed under it were disbanded, and the defence of the province entrusted to regular troops.

The disputes between the proprietaries and the people continued in full force, although a war was raging on the frontiers. Not even the sense of danger was sufficient to reconcile, for ever so short a time, their jarring interests. The assembly still insisted upon the justice of taxing the proprietary estates, but the governors constantly refused their assent to this measure, without which no bill could pass into a law. Enraged at the obstinacy, and what they conceived to be [134] unjust proceedings of their opponents, the assembly at length determined to apply to the mother-country for relief. A petition was addressed to the king, in council, stating the inconveniencies under which the inhabitants laboured, from the attention of the proprietaries to their private interests, to the neglect of the general welfare of the community, and praying for redress. Franklin was appointed to present this address, as agent for the province of Pennsylvania, and departed from America in June, 1757. In conformity to the instructions which he had received from the legislature, he held a conference with the proprietaries who then resided in England, and endeavoured to prevail upon them to give up the long contested point. Finding that they would harken to no terms of accommodation, he laid his petition before the Council. During this time governor Denny assented to a law imposing a tax, in which no discrimination was made in favour of the estates of the Penn family. They, alarmed at this intelligence, and Franklin's exertions, used their utmost endeavours to prevent the royal sanction being given to this law, which they represented as highly iniquitous, designed to throw the burden of supporting government upon them, and calculated to produce the most ruinous consequences to them and their posterity.

The cause was amply discussed before the privy Council. The Penns found here some strenuous advocates; nor were there wanting some who warmly espoused the side of the people. After some time spent in debate, a proposal was made, that Franklin should solemnly engage, that the assessment of the tax should be so made, as that the proprietary estates should pay no more than a due proportion. This he agreed to perform; the Penn family withdrew their opposition, and tranquillity [135]
was thus once more restored to the province.

The mode in which this dispute was terminated is a striking proof of the high opinion entertained of Franklin's integrity and honour, even by those who considered him as inimical to their views. Nor was their confidence ill-founded. The assessment was made upon the strictest principles of equity; and the proprietary estates bore only a proportionable share of the expences of supporting government.

After the completion of this important business, Franklin remained at the court of Great Britain, as agent for the province of Pennsylvania. The extensive knowledge which he possessed of the situation of the colonies, and the regard which he always manifested for their interests, occasioned his appointment to the same office by the colonies of Massachussets, Maryland, and Georgia. His conduct, in this situation, was such as rendered him still more dear to his countrymen.

He had now an opportunity of indulging in the society of those friends, whom his merits had procured him while at a distance. The regard which they had entertained for him was rather increased by a personal acquaintance. The opposition which had been made to his discoveries in philosophy gradually ceased, and the rewards of literary merit were abundantly conferred upon him. The Royal Society of London, which had at first refused his performances admission into its transactions, now thought it an honour to rank him amongst its fellows. Other societies of Europe were equally ambitious of calling him a member. The university of St. Andrew's, in Scotland, conferred upon him the degree of Doctor of Laws. [136]
Its example was followed by the universities of Edinburgh and Oxford. His correspondence was sought for by the most eminent philosophers of Europe. His letters to these abound with true science, delivered in the most simple unadorned manner.

The province of Canada was at this time in the possession of the French, who had originally settled it. The trade with the Indians, for which its situation was very convenient, was exceedingly lucrative. The French traders here found a market for their commodities, and received in return large quantities of rich furs, which they disposed of at a high price in Europe. Whilst the possession of this country was highly advantageous to France, it was a grievous inconvenience to the inhabitants of the British colonies. The Indians were almost generally desirous to cultivate the friendship of the French, by whom they were abundantly supplied with arms and ammunition. Whenever a war happened, the Indians were ready to fall upon the frontiers: and this they frequently did, even when Great Britain and France were at peace. From these considerations, it appeared to be the interest of Great Britain to gain the possession of Canada. But the importance of such an acquisition was not well understood in England. Franklin about this time published his Canada pamphlet, in which he, in a forcible manner, pointed out the advantages which would result from the conquest of this province.

An expedition against it was planned, and the command given to General Wolfe. His success is well known. At the treaty in 1762, France ceded Canada to Great Britain, and by her cession of Louisiana, at the same time, relinquished all [137]
her possessions on the continent of America.

Although Dr. Franklin was now principally occupied with political pursuits, he found time for philosophical studies. He extended his researches in electricity, and made a variety of experiments, particularly on the tourmalin. The singular properties which this stone possesses of being electrified on one side positively and on the other negatively, by heat alone, without friction, had been but lately observed.

Some experiments on the cold produced by evaporation, made by Dr. Cullen, had been communicated to Dr. Franklin, by Professor Simpson, of Glasgow. These he repeated, and found, that, by the evaporation of æther in the exhausted receiver of an air-pump, so great a degree of cold was produced in a summer's day, that water was converted into ice. This discovery he applied to the solution of a number of phenomena, particularly a singular fact, which philosophers had endeavoured in vain to account for, viz. that the temperature of the human body, when in health, never exceeds 96 degrees of Fahrenheit's thermometer, though the atmosphere which surrounds it may be heated to a much greater degree. This he attributed to the increased perspiration, and consequent evaporation, produced by the heat.

In a letter to Mr. Small, of London, dated in May, 1760, Dr. Franklin makes a number of observations, tending to show that, in North America, north-east storms begin in the south-west parts. It appears, from actual observations, that a north-east storm, which extended a considerable distance, commenced at Philadelphia near four hours before it was felt at [138] Boston. He endeavoured to account for this, by supposing that, from heat, some rarefaction takes place about the gulph of Mexico, that the air further north rushes in, and is succeeded by the cooler and denser air still farther north, and that thus a continual current is at length produced.

The tone produced by rubbing the brim of a drinking-glass with a wet finger, had been generally known. A Mr. Puckeridge, an Irishman, by placing on a table a number of glasses of different sizes, and tuning them by partly filling them with water, endeavoured to form an instrument capable of playing tunes. He was prevented by an untimely end, from bringing his invention to any degree of perfection. After his death some improvements were made upon his plan. The sweetness of the tones induced Dr. Franklin to make a variety of experiments; and he at length formed that elegant instrument which he has called the *Armonica*.

In the summer of 1762, he returned to America. On his passage he observed the singular effect produced by the agitation of a vessel, containing oil, floating on water. The surface of the oil remains smooth and undisturbed, whilst the water is agitated with the utmost commotion. No satisfactory explanation of this appearance has, we believe, ever been given.

Dr. Franklin received the thanks of the assembly of Pennsylvania, "as well for the faithful discharge of his duty to that province in particular, as for the many and important services done to America in general, during his residence in Great Britain." A compensation of 5000*l.*, Pennsylvania currency, was also decreed him for his services during six years.

During his absence he had been annually elected member of the assembly. On his return to Pennsylvania he again took [139] his seat in this body, and continued a steady defender of the liberties of the people.

In December 1762, a circumstance which caused great alarm in the province took place. A number of Indians had resided in the county of Lancaster, and conducted themselves uniformly as friends to the white inhabitants. Repeated depredations on the frontiers had exasperated the inhabitants to such a degree, that they determined on revenge upon every Indian. A number of persons, to the number of about 120, principally inhabitants of Donegal and Peckstang or Paxton township, in the county of York, assembled; and, mounted on horseback, proceeded to the settlement of these harmless and defenceless Indians, whose number had now been reduced to about twenty. The Indians had received intelligence of the attack which was intended against them, but disbelieved it. Considering the white people as their friends, they apprehended no danger from them. When the party arrived at the Indian settlement, they found only some women and children, and a few old men, the rest being absent at work. They murdered all whom they found, and amongst others the chief Shaheas, who had been always distinguished for his friendship to the whites. This bloody deed excited much indignation in the well-disposed part of the community.

The remainder of these unfortunate Indians, who by absence, had escaped the massacre, were conducted to Lancaster, and lodged in the gaol as a place of security. The governor issued a proclamation expressing the strongest disapprobation of the action, offering a reward for the discovery of the perpetrators of the deed, and prohibiting all injuries to the [140] peaceable Indians in future. But, notwithstanding this, a party of the same men shortly after marched to Lancaster, broke open the gaol, and inhumanly butchered the innocent Indians, who had been placed there for security. Another proclamation was issued, but it had no effect. A detachment marched down to Philadelphia, for the express purpose of murdering some friendly Indians, who had been removed to the city for safety. A number of the citizens armed in their defence. The quakers, whose principles are opposed to fighting, even in their own defence, were most active upon this occasion. The rioters came to Germantown. The governor fled for safety to the house of Dr. Franklin, who, with some others, advanced to meet the Paxton boys, as they were called, and had influence enough to prevail upon them to relinquish their undertaking, and return to their homes.

The disputes between the proprietaries and the assembly, which, for a time, had subsided, were again revived. The proprietaries were dissatisfied with the concessions made in favour of the people, and made great struggles to recover the privilege of exempting their estates from taxation, which they had been induced to give up.

In 1763, the assembly passed a militia-bill, to which the governor refused to give his assent, unless the assembly would agree to certain amendments which he proposed. These consisted in increasing the fines, and in some cases, substituting death for fines. He wished too, that the officers should be appointed altogether by himself, and not be nominated by the people, as the bill had proposed. These amendments the assembly considered as inconsistent with the spirit of liberty. [141] They would not adopt them—the governor was obstinate, and the bill was lost.

These, and various other circumstances, encreased the uneasiness which subsisted between the proprietaries and the assembly, to such a degree, that, in 1764, a petition to the king was agreed to by the house, praying an alteration from a *proprietary* to a *regal* government. Great opposition was made to this measure, not only in the house, but in the public prints. A speech of Mr. Dickenson on the subject was published, with a preface by Dr. Smith, in which great pains were taken to show the impropriety and impolicy of this proceeding. A speech of Mr. Galloway, in reply to Mr. Dickenson, was published, accompanied with a preface by Dr. Franklin, in which he ably opposed the principles laid down in the preface to Mr. Dickenson's speech. This application to the throne produced no effect. The proprietary government was still continued.

At the election of a new assembly, in the fall of 1764, the friends of the proprietaries made great exertions to exclude those of the adverse party; and they obtained a small majority in the city of Philadelphia. Franklin now lost his seat in the house, which he had held for fourteen years. On the meeting of the assembly, it appeared there was still a decided majority of Franklin's friends. He was immediately appointed provincial agent, to the great chagrin of his enemies, who made a solemn protest against his appointment, which was refused admission upon the minutes, as being unprecedented. It was, however, published in the papers, and produced a spirited reply from him, just before his departure for England. [142]

The disturbances produced in America by Mr. Grenville's stamp-act, and the opposition made to it, are well known. Under the marquis of Rockingham's administration, it appeared expedient to endeavour to calm the minds of the colonists; and the repeal of the odious tax was contemplated. Amongst other means of collecting information on the disposition of the people to submit to it, Dr. Franklin was called to the bar of the house of commons. The examination which he underwent was published, and contains a striking account of the extent and accuracy of his information, and the facility with which he communicated his sentiments. He represented facts in so strong a point of view, that the inexpediency of the act must have appeared clear to every unprejudiced mind. The act, after some opposition, was repealed, about a year after it was enacted, and before it had ever been carried into execution.

In the year 1766, he made a visit to Holland and Germany, and received the greatest marks of attention from men of science. In his passage through Holland he learned from the watermen the effect which a diminution of the quantity of water in canals has, in impeding the progress of boats. Upon his return to England, he was led to make a number of experiments, all of which tended to confirm the observation. These, with an explanation of the phenomenon, he communicated in a letter to his friend, Sir John Pringle, which will be found among his philosophical pieces.

In the following year he travelled into France, where he met a no less favorable reception than he had experienced in [143]
Germany. He was introduced to a number of literary characters, and to the king, Louis XV.

Several letters written by Hutchinson, Oliver, and others, to persons in eminent stations in Great Britain, came into the hands of Dr. Franklin. These contained the most violent invectives against the leading characters of the state of Massachussets, and strenuously advised the prosecution of vigorous measures, to compel the people to obedience to the measures of the ministry. These he transmitted to the legislature, by whom they were published. Attested copies of them were sent to Great Britain, with an address, praying the king to discharge from office persons who had rendered themselves so obnoxious to the people, and who had shown themselves so unfriendly to their interests. The publication of these letters produced a duel between Mr. Whately and Mr. Temple, each of whom was suspected of having been instrumental in procuring them. To prevent any farther disputes on this subject, Dr. Franklin, in one of the public papers, declared that he had sent them to America, but would give no information concerning the manner in which he had obtained them—nor was this ever discovered.

Shortly after, the petition of the Massachussets assembly was taken up for examination, before the privy council. Dr. Franklin attended, as agent for the assembly; and here a torrent of the most violent and unwarranted abuse was poured upon him by the solicitor-general, Wedderburne, who was engaged as council for Oliver and Hutchinson. The petition was declared to be scandalous and vexatious, and the prayer of it refused. [144]

Although the parliament of Great Britain had repealed the stamp-act, it was only upon the principle of expediency. They still insisted upon their right to tax the colonies; and, at the same time that the stamp-act was repealed, an act was passed, declaring the right of parliament to bind the colonies in all cases whatsoever. This language was used even by the most strenuous opposers of the stamp-act: and, amongst others, by Mr. Pitt. This right was never recognized by the colonists; but, as they flattered themselves that it would not be exercised, they were not very active in remonstrating against it. Had this pretended right been suffered to remain dormant, the colonists would cheerfully have furnished their quota of supplies, in the mode to which they had been accustomed; that is, by acts of their own assemblies, in consequence of requisitions from the secretary of state. If this practice had been pursued, such was the disposition of the colonies towards their mother-country, that, notwithstanding the disadvantages under which they laboured, from restraints upon their trade, calculated solely for the benefit of the commercial and manufacturing interests of Great Britain, a separation of the two countries might have been a far distant event. The Americans, from their earliest infancy, were taught to venerate a people from whom they were descended; whose language, laws, and manners, were the same as their own. They looked up to them as models of perfection; and, in their prejudiced minds, the most enlightened nations of Europe were considered as almost barbarians, in comparison with Englishmen. The name of an Englishman conveyed to [145] an American the idea of every thing good and great. Such sentiments instilled into them in early life, what but a repetition of unjust treatment could have induced them to entertain the most distant thought of separation! The duties on glass, paper, leather, painters' colours, tea, &c. the disfranchisement of some of the colonies; the obstruction to the measures of the legislature in others, by the king's governors; the contemptuous treatment of their humble remonstrances, stating their grievances, and praying a redress of them, and other violent and oppressive measures, at length excited an ardent spirit of opposition. Instead of endeavouring to allay this by a more lenient conduct, the ministry seemed resolutely bent upon reducing the colonies to the most slavish obedience to their decrees. But this only tended to aggravate. Vain were all the efforts made use of to prevail upon them to lay aside their designs, to convince them of the impossibility of carrying them into effect, and of the mischievous consequences which must ensue from a continuance of the attempts. They persevered, with a degree of inflexibility scarcely paralleled.

The advantages which Great Britain derived from her colonies were so great, that nothing but a degree of infatuation, little short of madness, could have produced a continuance of measures calculated to keep up a spirit of uneasiness, which might occasion the slightest wish for a separation. When we consider the great improvements in the science of government, the general diffusion of the principles of liberty amongst the people of Europe, the effects which these have [146] already produced in France, and the probable consequences which will result from them elsewhere, all of which are the offspring of the American revolution, it cannot but appear strange, that events of so great moment to the happiness of mankind, should have been ultimately occasioned by the wickedness or ignorance of a British ministry.

Dr. Franklin left nothing untried to prevail upon the ministry to consent to a change of measures. In private conversations, and in letters to persons in government, he continually expatiated upon the impolicy and injustice of their conduct towards America; and stated, that, notwithstanding the attachment of the colonists to the mother-country, a repetition of ill treatment must ultimately alienate their affections. They listened not to his advice. They blindly persevered in their own schemes, and left to the colonists no alternative, but opposition, or unconditional submission. The latter accorded not with the principles of freedom, which they had been taught to revere. To the former they were compelled, though reluctantly, to have recourse.

Dr. Franklin, finding all efforts to restore harmony between Great Britain and her colonies useless, returned to America in the year 1775; just after the commencement of hostilities. The day after his return he was elected by the legislature of Pennsylvania a delegate to congress. Not long after his election a committee was appointed, consisting of Mr. Lynch, Mr. Harrison, and himself, to visit the camp at Cambridge, and, in conjunction with the commander in chief, to endeavour to convince the troops, whose term of enlistment was about to expire, of the necessity of their continuing in the field, and [147] persevering in the cause of their country.

In the fall of the same year he visited Canada, to endeavour to unite them in the common cause of liberty; but they could not be prevailed upon to oppose the measures of the British government. M. Le Roy, in a letter annexed to Abbé Fauchet's eulogium of Dr. Franklin, states, that the ill success of this negociation was occasioned, in a great degree, by religious animosities, which subsisted between the Canadians and their neighbours, some of whom had at different times burnt their chapels.

When Lord Howe came to America, in 1776, vested with power to treat with the colonists, a correspondence took place between him and Dr. Franklin, on the subject of a reconciliation. Dr. Franklin was afterwards appointed, together with John Adams, and Edward Rutledge, to wait upon the commissioners, in order to learn the extent of their powers. These were found to be only to grant pardons upon submission. Such terms which could not be accepted; and the object of the commissioners was not obtained.

The momentous question of independence was shortly after brought into view, at a time when the fleets and armies, which were sent to enforce obedience, were truly formidable. With an army, numerous indeed, but ignorant of discipline, and entirely unskilled in the art of war, without money, without a fleet, without allies, and with nothing but the love of liberty to support them, the colonists determined to separate from a country, from which they had experienced a repetition [148] of injury and insult. In this question, Dr. Franklin was decidedly in favour of the measure proposed, and had great influence in bringing others to his sentiments.

The public mind had been prepared for this event, by Mr. Paine's celebrated pamphlet, *Common Sense*. There is good reason to believe that Dr. Franklin had no inconsiderable share, at least, in furnishing materials for this work.

In the convention which assembled at Philadelphia in 1776, for the purpose of establishing a new form of government for the state of Pennsylvania, Dr. Franklin was chosen president. The late constitution of this state, which was the result of their deliberations, may be considered as a digest of his principles of government. The single legislature, and the plural executive, seem to have been his favourite tenets.

In the latter end of 1776, Dr. Franklin was appointed to assist in the negociation which had been set on foot by Silas Deane at the court of France. A conviction of the advantages of a commercial intercourse with America, and a desire of weakening the British empire by dismembering it, first induced the French court to listen to proposals of an alliance. But they shewed rather a reluctance to the measure, which, by Dr. Franklin's address, and particularly by the success of the American arms against general Burgoyne, was at length overcome; and in February, 1778, a treaty of alliance, offensive and defensive, was concluded; in consequence of which France became involved in the war with Great Britain.

Perhaps no person could have been found more capable of rendering essential services to the United States at the court [149] of France, than Dr. Franklin. He was well known as a philosopher, and his character was held in the highest estimation. He was received with the greatest marks of respect by all the literary characters; and this respect was extended amongst all classes of men. His personal influence was hence very considerable. To the effects of this were added those of various performances which he published, tending to establish the credit and character of the United States. To his exertions in this way, may, in no small degree, be ascribed the success of the loans negociated in Holland and France, which greatly contributed to bring the war to a conclusion.

The repeated ill success of their arms, and more particularly the capture of Cornwallis and his army, at length convinced the British nation of the impossibility of reducing the Americans to subjection. The trading interest particularly became clamorous for peace. The ministry were unable longer to oppose their wishes. Provisional articles of peace were agreed to, and signed at Paris on the 30th of November, 1782, by Dr. Franklin, Mr. Adams, Mr. Jay, and Mr. Laurens, on the part of the United States; and by Mr. Oswald on the part of Great Britain. These formed the basis of the definitive treaty, which was concluded the 3d of September, 1783, and signed by Dr. Franklin, Mr. Adams, and Mr. Jay, on the one part, and by Mr. David Hartly on the other.

On the third of April, 1783, a treaty of amity and commerce, between the United States and Sweden, was concluded at Paris, by Dr. Franklin and the Count Von Krutz.

A similar treaty with Prussia was concluded in 1785, not long before Dr. Franklin's departure from Europe. [150]

Dr. Franklin did not suffer his political pursuits to engross his whole attention. Some of his performances made their appearance in Paris. The object of these was generally the promotion of industry and economy.

In the year 1784, when animal magnetism made great noise in the world, particularly at Paris, it was thought a matter of such importance, that the king appointed commissioners to examine into the foundation of this pretended science. Dr. Franklin was one of the number. After a fair and diligent examination, in the course of which Mesmer repeated a number of experiments, in the presence of the commissioners, some of which were tried upon themselves, they determined that it was a mere trick, intended to impose upon the ignorant and credulous—Mesmer was thus interrupted in his career to wealth and fame, and a most insolent attempt to impose upon the human understanding baffled.

The important ends of Dr. Franklin's mission being completed by the establishment of American independence, and the infirmities of age and disease coming upon him, he became desirous of returning to his native country. Upon application to congress to be recalled, Mr. Jefferson was appointed to succeed him in 1785. Some time in September of the same year Dr. Franklin arrived in Philadelphia. He was shortly after chosen member of the supreme executive council for the city; and soon after was elected president of the same.

When a convention was called to meet in Philadelphia, in 1787, for the purpose of giving more energy to the [151] government of the union, by revising and amending the articles of confederation, Dr. Franklin was appointed a delegate from the State of Pennsylvania. He signed the constitution which they proposed for the union, and gave it the most unequivocal marks of his approbation.

A society for political enquiries, of which Dr. Franklin was president, was established about this period. The meetings were held at his house. Two or three essays read in this society were published. It did not long continue.

In the year 1787, two societies were established in Philadelphia, founded on the principles of the most liberal and refined humanity—*The Philadelphia Society for alleviating the miseries of public prisons; and the Pennsylvania Society for promoting the abolition of slavery, the relief of free negroes unlawfully held in bondage, and the improvement of the condition of the African race.* Of each of these Dr. Franklin was president. The labours of these bodies have been crowned with great success; and they continue to prosecute, with unwearied diligence, the laudable designs for which they were established.

Dr. Franklin's increasing infirmities prevented his regular attendance at the council-chamber; and, in 1788, he retired wholly from public life.

His constitution had been a remarkably good one. He had been little subject to disease, except an attack of the gout occasionally, until about the year 1781, when he was first attacked with symptoms of the calculous complaint, which [152] continued during his life. During the intervals of pain from this grievous disease, he spent many cheerful hours, conversing in the most agreeable and instructive manner. His faculties were entirely unimpaired, even to the hour of his death.

His name, as president of the abolition society, was signed to the memorial presented to the house of representatives of the United States, on the 12th of February, 1789, praying them to exert the full extent of power vested in them by the constitution, in discouraging the traffic of the human species. This was his last public act. In the debates to which this memorial gave rise, several attempts were made to justify the trade. In the Federal Gazette of March 25th, there appeared an essay, signed Historicus, written by Dr. Franklin, in which he communicated a speech, said to have been delivered in the Divan of Algiers, in 1687, in opposition to the prayer of the petition of a sect called *Erika*, or purists, for the abolition of piracy and slavery. This pretended African speech was an excellent parody of one delivered by Mr. Jackson, of Georgia. All the arguments urged in favour of negro slavery, are applied with equal force to justify the plundering and enslaving of Europeans. It affords, at the same time, a demonstration of the futility of the arguments in defence of the slave trade, and of the strength of mind and ingenuity of the author, at his advanced period of life. It furnished too, a no less convincing proof of his power of imitating the style of other times and nations, than his celebrated parable against persecution. And as the latter led many persons to search the scriptures with a view to find, it, so the former caused many [153]
persons to search the book-stores and libraries, for the work from which it was said to be extracted.

In the beginning of April following, he was attacked with a fever and complaint of his breast, which terminated his existence. The following account of his last illness was written by his friend and physician, Dr. Jones.

"The stone, with which he had been afflicted for several years, had for the last twelve months confined him chiefly to his bed; and during the extremely painful paroxysms, he was obliged to take large doses of laudanum to mitigate his tortures—still, in the intervals of pain, he not only amused himself with reading and conversing cheerfully with his family, and a few friends who visited him, but was often employed in doing business of a public as well as private nature, with various persons who waited on him for that purpose; and in every instance displayed, not only that readiness and disposition of doing good, which was the distinguishing characteristic of his life, but the fullest and clearest possession of his uncommon mental abilities; and not unfrequently indulged himself in those *jeux d'esprit* and entertaining anecdotes, which were the delight of all who heard him.

"About sixteen days before his death, he was seized with a feverish indisposition, without any particular symptoms attending it, till the third or fourth day, when he complained of a pain in the left breast, which increased till it became extremely acute, attended with a cough and laborious breathing. During this state, when the severity of his pains sometimes drew forth a groan of complaint, he would observe—that he was afraid he did not hear it as he ought— [154]
acknowledged his grateful sense of the many blessings he had received from the Supreme Being, who had raised him from small and low beginnings to such high rank and consideration among men—and made no doubt but his present afflictions were kindly intended to wean him from a world, in which he was no longer fit to act the part assigned him. In this frame of body and mind he continued till five days before his death, when his pain and difficulty of breathing entirely left him, and his family were flattering themselves with the hopes of his recovery, when an imposthumation, which had formed itself in his lungs, suddenly burst and discharged a great quantity of matter, which he continued to throw up while he had sufficient strength to do it, but, as that failed, the organs of respiration became gradually oppressed—a calm lethargic state succeeded—and, on the 17th of April, 1790, about eleven o'clock at night, he quietly expired, closing a long and useful life of eighty-four years and three months."

It may not be amiss to add to the above account, that Dr. Franklin, in the year 1735, had a severe pleurisy, which terminated in an abscess of the left lobe of his lungs, and he was then almost suffocated with the quantity and suddenness of the discharge. A second attack of a similar nature happened some years after this, from which he soon recovered, and did not appear to suffer any inconvenience in his respiration from these diseases.

The following epitaph on himself, was written by him many years previous to his death:—

[155]

THE BODY

OF

BENJAMIN FRANKLIN,

PRINTER.

(LIKE THE COVER OF AN OLD BOOK,

ITS CONTENTS TORN OUT,

AND STRIPT OF ITS LETTERING AND GILDING)

LIES HERE FOOD FOR WORMS;

YET THE WORK ITSELF SHALL NOT BE LOST,

FOR IT WILL (AS HE BELIEVED) APPEAR ONCE MORE

IN A NEW

AND MORE BEAUTIFUL EDITION

CORRECTED AND AMENDED

BY

THE AUTHOR.[14]

EXTRACTS

FROM THE LAST WILL AND TESTAMENT OF

DR. FRANKLIN.

With regard to my books, those I had in France, and those I left in Philadelphia, being now assembled together here, and a catalogue made of them, it is my intention to dispose of the same as follows:

My "History of the Academy of Sciences," in sixty or seventy volumes quarto, I give to the philosophical society of Philadelphia, of which I have the honour to be president. My collection in folio of "*Les Arts et les Metiers*," I give to the American philosophical society, established in New England, of which I am a member. My quarto edition of the same, [156] "*Arts et Metiers*," I give to the library company of Philadelphia. Such and so many of my books as I shall mark, in the said catalogue, with the name of my grandson Benjamin Franklin Bache, I do hereby give to him: and such and so many of my books, as I shall mark in the said catalogue with the name of my grandson William Bache, I do hereby give to him: and such as shall be marked with the name of Jonathan Williams, I hereby give to my cousin of that name. The residue and remainder of all my books, manuscripts, and papers, I do give to my grandson William Temple Franklin. My share in the library company of Philadelphia I give to my grandson Benjamin Franklin Bache, confiding that he will permit his brothers and sisters to share in the use of it.

I was born in Boston, New England, and owe my first instructions in literature to the free grammar-schools established there. I therefore give one hundred pounds sterling to my executors, to be by them, the survivors or survivor of them, paid over to the managers or directors of the free-schools in my native town of Boston, to be by them, or the person or persons who shall have the superintendance and management of the said schools, put out to interest, and so continued at interest for ever; which interest annually shall be laid out in silver medals, and given as honorary rewards annually by the directors of the said free-schools, for the encouragement of scholarship in the said schools, belonging to the said town, in such manner as to the discretion of the select men of the said town shall seem meet.

Out of the salary that may remain due to me, as president of the state, I give the sum of two thousand pounds to my executors, to be by them, the survivors or survivor of them, paid over to such person or persons as the legislature of this state, by an act of assembly, shall appoint to receive the same, in trust, to be employed for making the Schuylkil navigable. [157]

During the number of years I was in business as a stationer, printer, and post-master, a great many small sums became due to me for books, advertisements, postage of letters, and other matters, which were not collected, when, in 1757, I was sent by the assembly to England as their agent—and, by subsequent appointments, continued there till 1775—when, on my return, I was immediately engaged in the affairs of congress, and sent to France in 1776, where I remained nine years, not returning till 1785; and the said debts not being demanded in such a length of time, are become in a manner obsolete, yet are nevertheless justly due.—These as they are stated in my great folio ledger, E, I bequeath to the contributors of the Pennsylvania hospital; hoping that those debtors, and the descendants of such as are deceased, who now, as I find, make some difficulty of satisfying such antiquated demands as just debts, may, however, be induced to pay or give them as charity to that excellent institution. I am sensible that much must inevitably be lost; but I hope something considerable may be recovered. It is possible too, that some of the parties charged may have existing old unsettled accounts against me: in which case the managers of the said hospital will allow and deduct the amount, or pay the balance, if they find it against me.

I request my friends, Henry Hill, Esq. John Jay, Esq. Francis Hopkinson, Esq. and Mr. Edward Duffield, of Bonfield, in Philadelphia county, to be the executors of this my last will and testament, and I hereby nominate and appoint them for that purpose. [158]

I would have my body buried with as little expence or ceremony as may be.

PHILADELPHIA,
July 17, 1778.

CODICIL.

I Benjamin Franklin, in the foregoing or annexed last will and testament, having further considered the same, do think proper to make and publish the following codicil, in addition thereto.

It having long been a fixed and political opinion of mine, that in a democratical state, there ought to be no offices of profit, for the reasons I had given in an article of my drawing in our constitution, it was my intention, when I accepted the office of president, to devote the appointed salary to some public use; accordingly I had already, before I made my last will in July last, given large sums of it to colleges, schools, building of churches, &c.; and in that will I bequeathed two thousand pounds more to the state, for the purpose of making the Schuylkil navigable; but understanding since, that such a sum will do but little, towards accomplishing such a work, and that project is not likely to be undertaken for many years to come—and having entertained another idea, which I hope may be more extensively useful, I do hereby revoke and [159]
annul the bequest, and direct that the certificates I have of what remains due to me of that salary, be sold towards raising the sum of two thousand pounds sterling, to be disposed of as I am now about to order.

It has been an opinion, that he who receives an estate from his ancestors, is under some obligation to transmit the same to posterity. This obligation lies not on me, who never inherited a shilling from any ancestor or relation. I shall, however, if it is not diminished by some accident before my death, leave a considerable estate among my descendants and relations. The above observation is made merely as some apology to my family, for my making bequests that do not appear to have any immediate relation to their advantage.

I was born in Boston, New England, and owe my first instructions in literature to the free grammar schools established there. I have, therefore, considered those schools in my will.

But I am also under obligations to the state of Massachussets, for having, unasked, appointed me formerly their agent, with a handsome salary, which continued some years; and although I accidentally lost in their service, by transmitting governor Hutchinson's letters, much more than the amount of what they gave me, I do not think that ought in the least to diminish my gratitude. I have considered that, among artisans, good apprentices are most likely to make good citizens, and having myself been bred to a manual art, printing, in my native town, and afterwards assisted to set up my business in Philadelphia by kind loans of money from two friends there, which was the foundation of my fortune, and of all the utility in life that may be ascribed to me—I wish to be useful even after my death, if possible, in forming and advancing other [160]
young men, that may be serviceable to their country in both these towns.

To this end I devote two thousand pounds sterling, which I give, one thousand thereof to the inhabitants of the town of Boston, in Massachussets, and the other thousand to the inhabitants of the city of Philadelphia, in trust, to and for the uses, intents, and purposes, herein after mentioned and declared.

The said sum of one thousand pounds sterling, if accepted by the inhabitants of the town of Boston, shall be managed under the direction of the select men, united with the ministers of the oldest episcopalian, congregational, and presbyterian churches in that town, who are to let out the same at five per cent. per annum, to such young married artificers, under the age of twenty-five years, as have served an apprenticeship in the said town, and faithfully fulfilled the duties required in their indentures, so as to obtain a good moral character from at least two respectable citizens, who are willing to become sureties in a bond, with the applicants, for the re-payment of the money so lent, with interest, according to the terms hereinafter prescribed; all which bonds are to be taken for Spanish milled dollars, or the value thereof in

current gold coin: and the manager shall keep a bound book, or books, wherein shall be entered the names of those who shall apply for, and receive the benefit of this institution, and of their sureties, together with the sums lent, the dates, and other necessary and proper records, respecting the business and concerns of this institution: and as these loans are intended to assist young married artificers, in setting up their business, they are to be proportioned by the discretion of the [161]
managers, so as not to exceed sixty pounds sterling to one person, nor to be less than fifteen pounds.

And if the number of appliers so entitled should be so large as that the sum will not suffice to afford to each as much as might otherwise not be improper, the proportion to each shall be diminished, so as to afford to every one some assistance. These aids may, therefore, be small at first, but as the capital increases by the accumulated interest, they will be more ample. And in order to serve as many as possible in their turn, as well as to make the re-payment of the principal borrowed more easy, each borrower shall be obliged to pay with the yearly interest, one tenth part of the principal; which sums of principal and interest so paid in, shall be again let out to fresh borrowers. And it is presumed, that there will be always found in Boston virtuous and benevolent citizens, willing to bestow a part of their time in doing good to the rising generation, by superintending and managing this institution gratis; it is hoped that no part of the money will at any time lie dead, or be diverted to other purposes, but be continually augmenting by the interest, in which case, there may in time be more than the occasion in Boston may require; and then some may be spared to the neighbouring or other towns, in the said state of Massachusetts, which may desire to have it, such towns engaging to pay punctually the interest, and the proportion of the principal annually to the inhabitants of the town of Boston. If this plan is executed, and succeeds, as projected, for one hundred years, the sum will then be one hundred and thirty thousand pounds, of which I would have the [162]
managers of the donation to the town of Boston then lay out, at their discretion, one hundred thousand pounds in public works, which may be judged of most general utility to the inhabitants; such as fortifications, bridges, aqueducts, public buildings, baths, pavements, or whatever may make living in the town more convenient to its people, and render it more agreeable to strangers resorting thither for health, or a temporary residence. The remaining thirty-one thousand pounds I would have continued to be let out to interest, in the manner above directed, for one hundred years; as I hope it will have been found that the institution has had a good effect on the conduct of youth, and been of service to many worthy characters and useful citizens. At the end of this second term, if no unfortunate accident has prevented the operation, the sum will be four millions and sixty-one thousand pounds sterling, of which I leave one million and sixty-one thousand pounds to the disposition and management of the inhabitants of the town of Boston, and the three millions to the disposition of the government of the state—not presuming to carry my views farther.

All the directions herein given respecting the disposition and management of the donation to the inhabitants of Boston, I would have observed respecting that to the inhabitants of Philadelphia; only, as Philadelphia is incorporated, I request the corporation of that city to undertake the management, agreeable to the said directions: and I do hereby vest them with full and ample powers for that purpose. And having considered that the covering its ground-plat with buildings and pavements, which carry off most of the rain, and prevent its soaking into the earth, and renewing and purifying the [163]
springs, whence the water of the wells must gradually grow worse, and in time be unfit for use, as I find has happened in all old cities; I recommend, that, at the end of the first hundred years, if not done before, the corporation of the city employ a part of the hundred thousand pounds in bringing by pipes the water of Wissahickon-creek into the town, so as to supply the inhabitants, which I apprehend may be done without great difficulty, the level of that creek being much above that of the city, and may be made higher by a dam. I also recommend making the Schuylkil completely navigable. At the end of the second hundred years, I would have the disposition of the four millions and sixty-one thousand pounds divided between the inhabitants of the city of Philadelphia and the government of Pennsylvania, in the same manner as herein

directed with respect to that of the inhabitants of Boston and the government of Massachusetts. It is my desire that this institution should take place, and begin to operate within one year after my decease, for which purpose due notice should be publicly given, previous to the expiration of that year, that those for whose benefit this establishment is intended may make their respective applications: and I hereby direct my executors, the survivor or survivors of them, within six months after my decease, to pay over the said sum of two thousand pounds sterling to such persons as shall be duly appointed by the select men of Boston, and the corporation of Philadelphia, to receive and take charge of their respective sums of one thousand pounds each, for the purposes aforesaid. Considering the accidents to which all human affairs and projects are [164] subject in such a length of time, I have, perhaps, too much flattered myself with a vain fancy, that these dispositions, if carried into execution, will be continued without interruption, and have the effects proposed: I hope, however, that if the inhabitants of the two cities should not think fit to undertake the execution, they will at least accept the offer of these donations, as a mark of my good will, token of my gratitude, and testimony of my desire to be useful to them even after my departure. I wish, indeed, that they may both undertake to endeavour the execution of my project, because I think, that, though unforeseen difficulties may arise, expedients will be found to remove them, and the scheme be found practicable. If one of them accepts the money with the conditions, and the other refuses, my will then is, that both sums be given to the inhabitants of the city accepting; the whole to be applied to the same purposes, and under the same regulations directed for the separate parts; and, if both refuse, the money remains of course in the mass of my estate, and it is to be disposed of therewith, according to my will made the seventeenth day of July, 1788.

My fine crab-tree walking-stick, with a gold head curiously wrought in the form of the cap of Liberty, I give to my friend, and the friend of mankind, General Washington. If it was a sceptre, he has merited it, and would become it.

FOOTNOTE:

[14] This epitaph first appeared in a Boston news-paper established and printed by Dr. Franklin. E.

[165]

LETTERS AND PAPERS

ON

ELECTRICITY.

[166]

It may not be improper to present the reader with the following extract from the preface to the first edition of Dr. Franklin's papers on electricity, which, as we have stated in the advertisement, formed a pamphlet only. [167]

"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."

With respect to the general merit and originality of the experiments and hypothesis of Dr. Franklin, as described and explained in these letters, the following is the testimony of one of the first natural philosophers of his age—the late Dr. Priestly, in his History of Electricity.

"Nothing was ever written upon the subject of electricity which was more generally read and admired in all parts of [168]
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."*

LETTERS AND PAPERS

ON

PHILOSOPHICAL SUBJECTS.

ELECTRICITY.

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

INTRODUCTORY LETTER.

Philadelphia, March 28, 1747.

Sir,

Your kind present of an electric tube, with directions for using it, has put several of us[15] 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. [170] 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.

FOOTNOTES:

[15] i. e. of the *Library-Company*, an institution of the author's, founded 1730. To which company the present was made[16].

[16] Where notes occur without a signature, in the Philosophical, or other Papers, they are generally notes of the author.—Editor.

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

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

Philadelphia, July 11, 1747.

Sir,

In my last I informed you that, in pursuing our electrical enquiries, 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, [171]

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 cieling, 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 [172]
will no more conduct electricity than sealing-wax.

To shew that points will *throw off*[17] as well as *draw off* the electrical fire; lay a long sharp needle upon the shot, and you cannot electrise 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[18]; and while it remains there, the gun-barrel, or rod, cannot by applying the tube to the other end be electrised 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. 1. By sifting fine sand on it; this does it gradually. 2. By breathing on it. 3. By making a smoke about it from burning wood[19]. 4. 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- [173]
hot iron do it likewise; but not at so great a distance. Smoke from dry rosin dropt 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.

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[20].

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 [174]
wheels, and the various phenomena resulting, I could, if I had time, fill you a sheet[21]. The impossibility of electrising 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 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 electrised, 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 appear to be electrised.

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. [175]

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 abovementioned 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 electrised: 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 electrising, 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 electrised *positively*; *A*, *negatively*. Or rather, *B* is electrised *plus*; *A*, *minus*. And we daily in our experiments electrise bodies *plus* or *minus*, as we think proper.—To electrise *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 [176] 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 shewn; 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 cieling to the gun-barrel, thence to the sphere, and so electrised 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 electrised *minus*; *i. e.* 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 electrise a person twenty or more times running, with a touch of the finger on the wire, thus: He stands on wax. Give him the electrised bottle in his hand. Touch the wire with your finger, and then touch his hand or face; there are sparks every [177] time[22].—We encrease 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 electrised 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 shock'd. 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 linnen 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 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 every where upon the gold like a flash of lightning: not upon the leather, nor, if you touch the leather instead of the gold. [178] 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[23]. 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 grind-stone. 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[24].

I am, &c.

B. FRANKLIN.

FOOTNOTES:

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

[18] 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.

[19] 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 vapour its portion of the fire, which it had attracted and attached to itself.

[20] 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 electrised shot, through which rarefied air the electric fluid could more readily pass.

[21] 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.

[22] 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.

[23] Our tubes are made here of green glass, 27 or 30 inches long, as big as can be grasped.

[24] This simple easily-made machine was a contrivance of Mr. Syng's.

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

Philadelphia, Sept. 1, 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 electrised, from a non-electric electrised 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[25].

2. At the same time that the wire and the top of the bottle, &c. is electrised *positively* or *plus*, the bottom of the bottle is electrised *negatively* or *minus*, in exact proportion: *i. e.* whatever quantity of electrical fire is thrown in at the top, an equal [180] quantity goes out of the bottom[26]. To understand this, suppose the common quantity of electricity in each part of the bottle, before the operation begins, is equal to 20; and at every stroke of the tube, suppose a quantity equal to 1 is thrown in; then, after the first stroke, the quantity contained in the wire and upper part of the bottle will be 21, in the bottom 19. After the second, the upper part will have 22, the lower 18, and so on, till, after 20 strokes, the upper part will have a quantity of electrical fire equal to 40, 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 [181] not yet electrised, 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 electrised, 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[27]. Thus, place an electrised bottle on clean glass or dry wax, and you will not, by touching the wire, get out the fire from the top. 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 compress, 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.

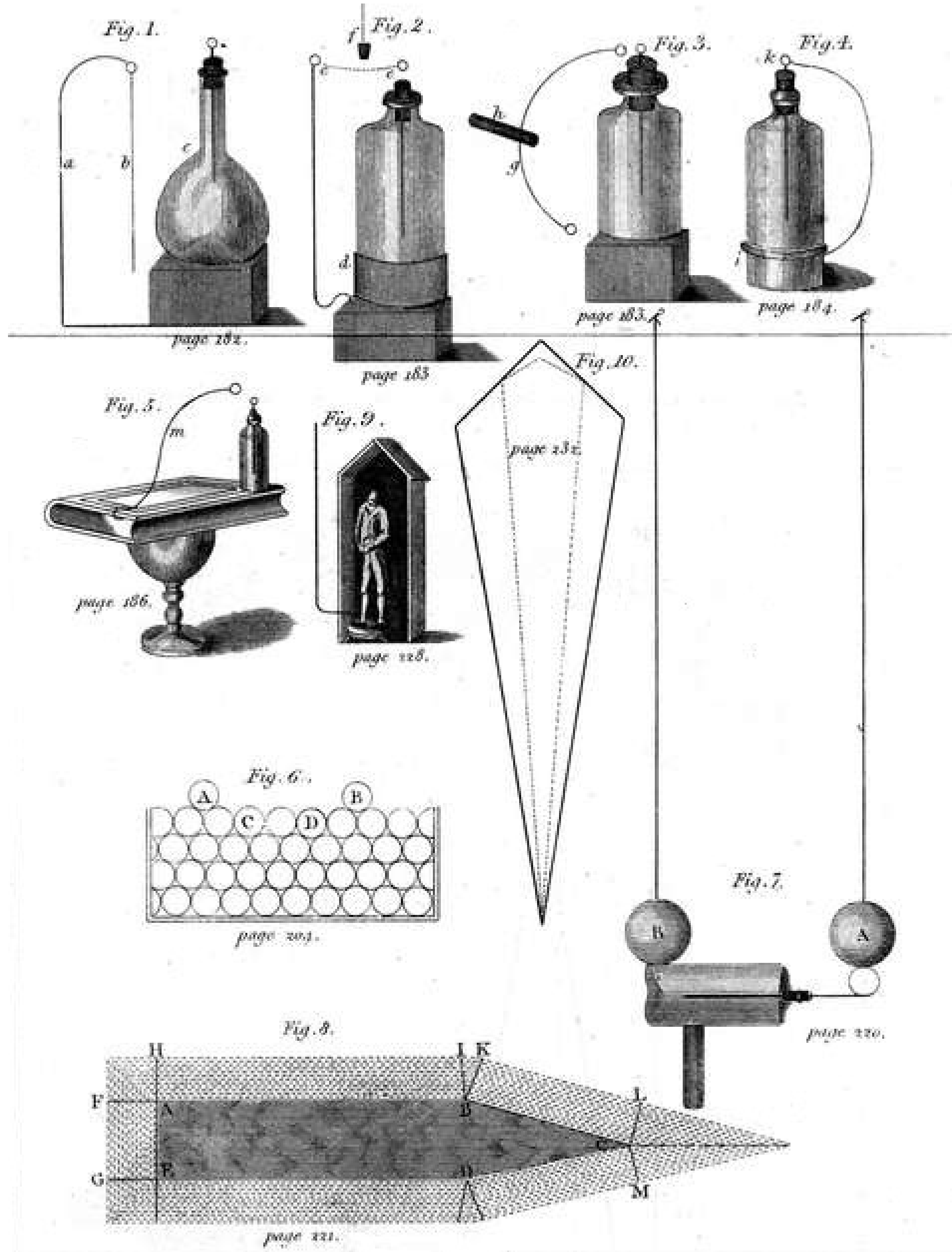
5. The shock to the nerves (or convulsion rather) is occasioned by the sudden passing of the fire through the body in its way from the top to the bottom of the bottle. The fire takes the shortest[28] course, as Mr. Watson justly observes: But it does not appear from experiment that in order for a person 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. [182]

Experiments confirming the above.

EXPERIMENT I.

Place an electrised 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.



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EXPERIMENT II.

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 electrised 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. [183]

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 electrise 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 electrised; that is, it fetches and carries fire from the top to the bottom[29] of the bottle, till the equilibrium is restored.

EXPERIMENT IV.

Fig. 3. Place an electrised 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 [184] 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 fixt cannot by any means be electrised: 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[30]. Hence a bottle cannot be electrised that is foul or 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 [185] 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 electrised *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 electrised a number of times by repeatedly touching the wire of an electrised bottle (held in the hand of one standing on the floor) he receiving the fire from the wire each time: [186] 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 electrised *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[31] of the bottle, to restore the equilibrium, is rendered strongly visible by the following pretty experiment. Take a book whose covering is filletted 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 up, but leaning towards the other end of the book. Lay the book on a glass or wax[32], and on the other end of the gold lines set the bottle electrised; then bend the springing [187] 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 filletting 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.

FOOTNOTES:

[25] 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.

[26] 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.

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

[28] Other circumstances being equal.

[29] *i. e.* from the inside to the outside.

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

[31] *i. e.* From the *inside* to the *outside*.

[32] 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.

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

Farther Experiments confirming the preceding Observations.—Leyden Bottle analysed.—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.

2. To take the charged phial safely by the hook, and not at the same time diminish its force, it must first be set down on an electric *per se*.

3. The phial will be electrified as strongly, if held by the hook, and the coating applied to the globe or tube; as when held by the coating, and the hook applied[33]. [188]

4. But the *direction* of the electrical fire being different in the charging, will also be different in the explosion. The bottle charged through the hook, will be discharged through the hook; the bottle charged through the coating, will be discharged through the coating, and not otherways; for the fire must come out the same way it went in.

5. To prove this, take two bottles that were equally charged through the hooks, one in each hand: bring their hooks near each other, and no spark or shock will follow; because each hook is disposed to give fire, and neither to receive it. Set one of the bottles down on glass, take it up by the hook, and apply its coating to the hook of the other; then there will be an explosion and shock, and both bottles will be discharged.

6. Vary the experiment, by charging two phials equally, one through the hook, the other through the coating: hold that by the coating which was charged through the hook; and that by the hook which was charged through the coating: apply the hook of the first to the coating of the other, and there will be no shock or spark. Set that down on glass which you held by the hook, take it up by the coating, and bring the two hooks together: a spark and shock will follow, and both phials be discharged.

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. [189]

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[34] 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 [190] 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 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 labour, 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 [191] 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 shewn 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; *i. e.* we may take away part of it from one of the sides, [192] 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 analyse 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 shewed 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 [193] 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 dextrously placing it again between the leaden plates, and compleating 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 [194] 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 labour 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, *Sec. 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[35]; 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[36] is made thus. Having a large metzotinto with a frame and glass, suppose of the KING (God [195] 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 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 moveable 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[37] 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 [196] 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 *Sec. 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* 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 [197] 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 [198] 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 encreases its motion till it comes to such a height as 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 [199]
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,[38] 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 shews 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 thro' 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 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 [200]
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.

27. 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 simple 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 shewed any signs of its being in connection with it[39]. 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 [201]
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[40].

28. 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 quantity, so will the cork be repelled again: And so may the experiment be repeated as long as there is any charge in the [202] bottles. Which shews 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 *Skuylkil*[41]. 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[42]. A turkey is to be killed for our dinner by the *electrical shock*, and [203] 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*[43], under the discharge of guns from the *electrical battery*.

FOOTNOTES:

[33] This was a discovery of the very ingenious Mr. Kinnersley, and by him communicated to me.

[34] 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.

[35] I have since heard that Mr. Smeaton was the first who made use of panes of glass for that purpose.

[36] Contrived by Mr. Kinnersley.

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

[38] This was afterwards done with success by Mr. Kinnersley.

[39] Probably the ground is never so dry.

[40] 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.

[41] 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.

[42] 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 a-cross 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 strait or shortest course, if sufficient, and other circumstances are equal) is struck and penetrated by it as it passes.

Observations and Suppositions, towards forming a new Hypothesis, for explaining the several Phenomena of Thunder-Gusts.[44]

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 [204]
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 vapours arising from it will be equally electrified; and floating in the air, in 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 vapours 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. VI. *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: [205]
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 shews 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 vapours, 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 rarified air they are larger. [206]

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 vapours.

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 [207]
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 vapours, whether raised from earth or sea.

25. Those vapours, which have both common and electrical fire in them, are better supported than those which have only common fire in them; for when vapours 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 vapours, 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. [208]

27. But clouds, formed by vapours 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, [209]
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 shew 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 [210]
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 ball 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 [211]
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 10,000 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 shews 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 in 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 vapours raised from the ocean between the tropics, comes to descend in the polar regions, and to be in contact with the vapours arising there, the electrical fire they brought begins to be communicated, and is seen in [212]
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 vaporised air, appears first where it is first in motion, *i. e.* 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 [213] 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 strait, 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 prominencies 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 cloaths 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 cloaths were dry, it would go through the body, because the blood and other humours, 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[45].

46. Common fire is in all bodies, more or less, as well as electrical fire. Perhaps they may be different modifications of [214] 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.[46] 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 vapours; 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 vapours, arising from the earth, are easily kindled by lightning. Besides what arise from the earth, such vapours are sent out by stacks of moist hay, corn, or other vegetables, which heat and reek. Wood, [215] rotting in old trees or buildings, does the same. Such are therefore easily and often fired.

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[47].

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 enquiry 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 Bermudas, says, there was less thunder there in that whole time than he has sometimes heard in a month at Carolina. [216]

FOOTNOTES:

[43] 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 breath on the liquor.—April 29, 1749.

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

[45] 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] 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.

[47] 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.

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

Introductory Letter to some additional Papers.

Philadelphia, July 29, 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 honour 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 shew, that the instruments put into our hands are not neglected; and that if no valuable discoveries are made by us, whatever the [217] 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 do repel each other, they are strongly attracted by all other matter[48].

5. From these three things, the extreme subtilty of the electrical matter, the mutual repulsion of its parts, and the strong [218] attraction between them and other matter, arise 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 spunge to the electrical fluid. And as a spunge would receive no water, if the parts of water were not smaller than the pores of the spunge; and even then but slowly, if there were not a mutual attraction

between those parts and the parts of the spunge; 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 spunge: 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 [219]
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 encreases; [220]
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 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 cieling. Apply the wire of a well-charged vial, 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 vial 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 [221] 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[49]. 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 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 [222] 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 attracter 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 [223] 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 [224] 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; *i. e.* 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 [225] 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 50 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 ones knuckle ach. Let a person standing on the floor present the point of a needle at 12 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 [226]

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 pack-thread from the cieling, 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 pack-thread. 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 upwards, 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 shew 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 [227] discharge its fire on the punch at two or three inches distance, an electrified cloud of perhaps 10,000 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 [228] experiment to be tried where it may be done conveniently. On the top of some high tower or steeple, place a kind of centry-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 20 or 30 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 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 we concluded that the pigeon also had been absolutely blinded by the shock. [229] 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 filletting 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 Turky-leather in which it was bound; and convinced me, that had it been painted, the paint would have been stript 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[50]. 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 [230] 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 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 [231] 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 filletting, 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 [232] 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 encreased; 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 Fig. 10, the upper corner a right angle, the two next obtuse angles, and the lowest a [233] 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 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 [234] 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 8, 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 [235]
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[51]?

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 the whole received by the bottle was again discharged from it. And yet the bottle by this means is charged[52]! 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. [236]

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 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 [237] the favour 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 every where 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 kind 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 [238] 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 favouring (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 [239] 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[53]). 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, 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, [240]
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.

34. So if a tube lined with a non-electric be rubbed[54], 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 exhausted, and the outer surface charged; [241]
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 that overplus; the equilibrium being restored through your body, which could not be restored through the glass[55]. 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 in 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 inclosed 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 [242]
same hypothesis. Yet, perhaps, it may not be a true one, and I shall be obliged to him that affords me a better.

35. 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.

36. Hence we see the impossibility of success in the experiments proposed, to draw out the effluvial virtues of a non- [243]
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, 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 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 [244]
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 electrised. 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 smelt the electric fire when drawn through gold, silver, copper, lead, iron, wood, and the human body, and could perceive no difference: the odour 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 [245]
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

70; 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, [246]

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 [247] 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.

FOOTNOTES:

[48] See the ingenious Essays on Electricity, in the Transactions, by Mr. Ellicot.

[49] See page 173.

[50] See note in page 214.

[51] See the first sixteen Sections of the former paper, called *Farther Experiments*, &c.

[52] See Sect. 10, of *Farther Experiments*, &c.

[53] 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.

[54] Gilt paper, with the gilt face next the glass, does well

[55] See *Further Experiments*, Sect. 15.

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

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, July 27, 1750.

Sir,

Mr. Watson, I believe, wrote his Observations on my last paper in haste, without having first well considered the experiments related §. 17[56], 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, [248] standing on wax, with a bason 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, the side of the bason, with the arms and body of the person on the wax, being all together but as one long wire, reaching from the internal surface of the phial to the spirits.

June 29, 1751. In Capt. 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 burnt 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 load-stone, 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 [249] 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 needles are sometimes finely blued like a watch-spring by the electric flame.—This colour 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 off hold seven or eight gallons, and are coated and lined with tin foil; each of them takes a thousand turns[57] 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. [250]

I have not heard that any of your European electricians have ever been able to fire gun-powder 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 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.

Your's, &c.

B. FRANKLIN.

FOOTNOTES:

[56] See the paper entitled, *Farther Experiments, &c.*

[57] 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 150 turns were sufficient. 1753.

TO C. C[58]. ESQ. AT NEW-YORK, COMMUNICATED TO MR. COLLINSON.

Unlimited Nature of the electric Force.

Philadelphia, 1751.

Sir,

I inclose you answers, such as my present hurry of business will permit me to make, to the principal queries contained in your's 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 is 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 expence and labour give) to the force man may raise and use in the electrical way: for bottle may be added to 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 humourously says, had only learnt to thunder and lighten a little round the head of a cabbage. [251]

I am, with sincere respect,

Your most obliged humble servant,

B. FRANKLIN.

QUERIES AND ANSWERS REFERRED TO IN THE FOREGOING LETTER. [252]

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 [253] 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[59]. This (by the way) shews 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-conductors, it is like water dropt 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 [254] it quits easily, and points operate stronger, *i. e.* 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[60] 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 whirl'd 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 add a foot to the semi-diameter 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[61] accurately made, whence we concluded that the air's elasticity was not affected thereby. [255]

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 colour of a watch spring.

A bright piece of iron will also be spotted, but not with that colour; 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.

FOOTNOTES:

[58] Cadwallader Colden, who was afterwards lieutenant-governor of New-York. *Editor.*

[59] This proposition is since found to be too general; Mr. Wilson having discovered that melted wax and rosin will also conduct.

[60] A cold dry wind of North America.

[61] 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 syphon, 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 syphon. Then a little red ink in a tea-spoon was applied to the opening of the outer leg of the syphon; 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 syphon. But no such effect followed.

TO C. C[62]. ESQ. AT NEW YORK. [256]

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, Nov. 11, 1756.

Philadelphia, April 23, 1752.

Sir,

In considering your favour 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 shewed 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 dropt as improper, and that of *conductors* and *non-conductors* assumed in its place, as I mentioned in those answers.

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 [257]
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 subtle 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 watry contents, together with that etherial 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, [258]
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 planets, 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 antient dimensions, and his attendants move in their antient orbits.

May not all the phenomena of light be more conveniently solved, by supposing universal space filled with a subtle 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 [259] 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 strait 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 colours? I think the electric fluid is always the same; yet I find that weaker and stronger sparks differ in apparent colour, 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, analagous to the seven colours, yet the medium, air, is the same.

If the Sun is not wasted by expence 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 vapour, returns to the earth in rain; and if we could collect all the particles of burning matter that go off in smoak, perhaps they might, with the ashes, weigh as much as [260] 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 chymists have analysed 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 [261] send it to you. I thought you had described it pretty fully[63].

I am, Sir, &c.

B. FRANKLIN.

FOOTNOTES:

[62] Cadwallader Colden. See note, page 250. *Editor.*

[63] 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.

"LONDON, MARCH 27, 1773.

"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 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, APRIL 23, 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.)"

Editor.

MR. E. KINNERSLEY, AT BOSTON, TO BENJAMIN FRANKLIN, ESQ. AT PHILADELPHIA.

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.

Feb. 3, 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. [262]

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, 20 turns of the wheel, for instance, will charge it; after which, so many tarns of the other wheel will discharge it; and as many more will charge it again. [263]

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 MR. E. KINNERSLEY, AT BOSTON. [264]

Probable Cause of the Different Attractions and Repulsions of the two electrified Globes mentioned in the two preceding Letters.

Philadelphia, March 2, 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.

Reasons for supposing, that the glass Globe charges positively, and the Sulphur negatively.—Hint respecting a leather Globe for Experiments when travelling.

Philadelphia, March 16, 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 [265] 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 versa*, 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 2d, 3d, and 4th 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 [266] 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[64]. I think I can conceive how it may be done; but have not time to add more than that I am, [267]

Yours, &c.

B. FRANKLIN.

FOOTNOTE:

[64] 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.

[In Mr. Collinson's edition, several papers followed here, by the Abbé Mazeas, and others, upon the subject of Dr. Franklin's experiments, which, that the letters of our author might not be too much interrupted, we have thought proper to transfer to an Appendix. A subsequent paper by Mr. David Colden, entitled Remarks on the Abbé Nollet's Letters to Benjamin Franklin, esq. on Electricity, will be found transferred in the same manner.]

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

Electrical Kite.

Philadelphia, Oct. 19, 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 [268] 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 [269] 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.

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

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 sea-coast, 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 [270] 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 vapours 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 rang 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 [271] 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 cieling, 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 my 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 [272] 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 surprize and pleasure, the cork ball play briskly between them; and was convinced that one bottle was electrised *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 electrises *positively*, I concluded that the clouds are *always* electrised *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 electrised 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 electrised *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, [273] 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: [274] *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 [275] shew 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, i. e.* 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 [276] 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 shews signs of electricity.

I have in a former paper compared common matter to a spunge, 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 spunge 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 spunge will not only resume what was lately forced out, but attract an additional quantity.

As the spunge 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 attacks and absorbs in either state, its *natural quantity*, the state being considered.

Now what the spunge 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 vapour, and forms a cloud, it is then capable of receiving and absorbing [277] 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 electrised positively, I conjecture that, in that case, such cloud, [278] 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 cieling, 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 cieling, and let it gradually sink into the can again.—From the cieling, 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 [279] 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 it, 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 vapour, as the water is in clouds. Perhaps some future experiments on vapourized 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 it wants at the instant of its leaving the surface, while it is yet near, and but just rising in vapour? 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. [280]

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, dis-united, 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. [281]

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 colour 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. Reaumur; yet it is sufficient to [282] 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 compleat 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 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 [283] 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 cloud 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 electrised 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 [284] good effect, in exciting the attention of the ingenious to the subject, and so become the occasion of more exact disquisition, and more compleat 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, ESQ. F. R. S. LONDON.

Additional Proofs of the positive and negative State of Electricity in the Clouds.—New Method of ascertaining it.

Philadelphia, April 18, 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 [285] another observation of the same kind; and last Monday afternoon, the wind blowing hard at S. E. and veering round to N. E. 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.

ELECTRICAL EXPERIMENTS, [286]

With an attempt to account for their several phænomena. 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. and F. R. S.

Dec. 6, 1753.

EXPERIMENT I.

From the cieling, 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 [287] 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 an 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.

[288]

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 [289]
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 [290]
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. [291]

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 an 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, [292] 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 which soever 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 electrised 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 [293] 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 vapours 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?

EXPERIMENTS [294]

Made in Pursuance of those made by Mr. Canton, dated December 6, 1753; with Explanations, by Mr. Benjamin Franklin.

Read at the Royal Society, Dec. 18, 1755.

Philadelphia, March 14, 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 shewn 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 shewn 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. [295]

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, crossways, 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 intire, 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 [296]
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.

[297]

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 electrised 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 electrised negatively, and therefore repel each other, by *Pr. 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 [298]
them once more electrised 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 electrised, 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 electrised, 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 [299] of a bottle, it will recede from that wire in the same manner that it did from the finger; which demonstrates the finger to be negatively electrised, 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 [300] very near fully charged. It seemed to him an 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 DR. L——[65], AT CHARLES TOWN, SOUTH CAROLINA. [301]

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, March 18, 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 these, with my explanation of them, will afford you some entertainment[66].

In answer to your several enquiries. 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 [302]
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 Charles-Town, that he had lived eight hundred miles upon electricity, it had been meat, drink, and cloathing to him. His last letter to me was, I think, from Jamaica, desiring me to send the tubes you mention, to meet him at the Havannah, 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 Havannah 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 [303]
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, *i. e.* straight through a trough of water ten feet long, and six inches square; or round [304] 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.

"Nov. 7, 1749. Electrical fluid agrees with lightning in these particulars: 1. Giving light. 2. Colour 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. [305] —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 vapour, hoping that if the vapour 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 electrised 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 electrised, 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 electrised 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 [306] 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 [307] 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 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[67]. 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 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, [308] should expect to escape it. There are every where 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 a 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. [309]

I am, &c.

B. FRANKLIN.

FOOTNOTES:

[65] Dr. Lining.—Editor.

[66] See page 286, for the paper here mentioned.

[67] Mr. F. has since thought, that, possibly, the mutual repulsion of the inner opposite sides of the electrised 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.

TO MONS. DALIBARD, AT PARIS, INCLOSED IN A LETTER TO MR. PETER COLLINSON, F. R. S.

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, Dec. 18, 1755.

Philadelphia, June 29, 1755.

Sir,

You desire my opinion of Pere Beccaria's Italian book[68]. I have read it with much pleasure, and think 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 [310]

them transcribed for your perusal[69]. It does not appear to me that Pere 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 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 considered but the probability of those rods *preventing* a stroke or explosion, which is only a *part* of the use I proposed [311]
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 shewn 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 plaistered cieling of that second floor, till it came near a plaistered 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 above-mentioned 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,) [312]
and without hurting the plaistered 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 afore-mentioned 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 plaistering, three or four inches broad, darkest in the middle, and fainter toward the edges, all along the cieling, 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. [313]

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.

FOOTNOTES:

[68] This work is written conformable to Mr. Franklin's theory, upon artificial and natural electricity, which compose the two parts of it. It was printed in Italian, at Turin, in 4to. 1753; between the two parts is a letter to the Abbé Nollet, in defence of Mr. Franklin's system. *J. Bevis.*

[69] These papers will be found in Vol II. *Editor.*

TO PETER COLLINSON, ESQ. F. R. S. LONDON.

Notice of another Packet of Letters.

Philadelphia, Nov. 23, 1753.

DEAR FRIEND.

In my last, via 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[70].

B. FRANKLIN.

FOOTNOTES:

[70] These letters and papers are a philosophical correspondence between Mr. Franklin and some of his American Friends[71]. 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. F. had at that time an intention of revising them, and pursuing some of the enquiries 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.

[71] As some of these papers are upon subjects not immediately connected with electricity, we have taken such papers from the order in which they were placed by Mr. Collinson, and transferred them to other parts of the work. *Editor.*

Extract of a Letter from a Gentleman in Boston[72]*, to Benjamin Franklin, Esq. concerning the crooked Direction, and the Source of Lightning, and the Swiftness of the electric Fire.* [314]

Boston, Dec. 21, 1751.

Sir,

The experiments Mr. K. 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, &c.

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, is a further and convincing proof that they are both the same element; [315] but, which is very unaccountable, Mr. K. tells me, it is necessary to produce this effect, that the direction of the needle and the electric 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 the north and south, the effect entirely ceases. We made at Faneuil Hall, where Mr. K——'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. K. tells me always points to the north.

The electrical fire passing through air has the same crooked direction as lightning[73]. This appearance I endeavour to account for thus: Air is an electric *per se*, therefore there must be a mutual repulsion betwixt 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 that part of the body which the spark is taken from, and 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 [316] repellency being in proportion to its density: Having acquired, by being condensed, a degree of repellency greater than its natural, it turns the spark out of its strait 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 thus 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 electric fire seems propagated instantaneously, taking up no perceptible time in going very great distances. It must then be an inconceivably [317]
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 electric 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 electric spark, if the foregoing be true, will pass through a vacuum in a right line. To try this, let a wire be fixed perpendicularly 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 a still more crooked direction. I have not had opportunity to make any experiments of this sort, not knowing of an air-pump nearer than Cambridge, but you can easily make them. If these experiments answer, I think the crooked direction of lightning will be also accounted for.

With respect to your letters on electricity, * * * * * * * * * * * * * * *. Your hypothesis in particular for explaining the [318]
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 eminencies, 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 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 salt and water would collect the electrical fire, that fire, being so extremely subtle 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 [319]
how there can be any accumulation of the electrical fire upon the surface of the sea or how the vapours arising from the sea should have a greater share of that fire than other vapours.

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, was 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 electric fire be the same as that of light, it will go through a space equal to the earth's diameter in about 2/60 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 upon 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. I understand by your son, that you had [320] writ, or was writing, a paper on the effect of the electrical fire on loadstones, needles, &c. which I would ask the favour 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, &c.

J. B.

FOOTNOTES:

[72] Mr. Badouin. *Editor.*

[73] This is most easily observed in large strong sparks taken at some inches distance.

TO J. B. AT BOSTON.

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 27, 1756.

Philadelphia, Jan. 24, 1752.

Sir,

I am glad to learn, by your favour 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 [321]
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 strait *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 [322]
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 subtle 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 subtle 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 [323]
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 vapours 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 ****, who is curious in that way, some meteorological observations and conjectures, and desire [324] 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, &c.

B. FRANKLIN.

FROM J. B. ESQ. OF BOSTON, TO BENJAMIN FRANKLIN, ESQ. AT PHILADELPHIA.

Effect of Lightning on Captain Waddel's Compass, and the Dutch Church at New York.

Read at the Royal Society, June 3, 1756.

Boston, March 2, 1752.

Sir,

I have received your favour of the 24th of January past, inclosing an extract from your letter to Mr. Collinson, and ****'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 [325] 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 binnacle (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 [326] 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.[74]

Your information about your globe's raising the electric fire in greater quantities, by means of a wire extended from the [327] 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 ****, I hope I shall have the pleasure of seeing them.

I am, &c.

J. B.

FOOTNOTE:

[74] The wire mentioned in this account was re-placed 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. 311.] 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.

Proposal of an Experiment to measure the Time taken up by an Electric Spark, in moving through any given Space. By J. A. Esq. of New-York. [75]

Read at the Royal Society, Dec 26, 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 [328] 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 discovery 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 strait lines through the water the shortest courses 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 Schuylkil, and let a wire be stretched and supported as before, from the head of the 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 further upwards the brooks are chosen, the more observable it would be.

Should this be not observable, then suppose the two brooks falling into Sasquehana and Delaware, and proceeding as [329] 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 Sasquehana, or Potomack, 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, Dec. 25, 1756.

Suppose a tube of any length open at both ends, and containing a moveable 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 [330] 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 shews the extreme facility with which the electric fluid moves in metal; it can never determine the velocity.

[331]

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 Susquehannah, or Potowmack, 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.

FOOTNOTE:

[75] James Alexander. *Editor*.

Experiments on boiling Water, and Glass heated by boiling Water.—Doctrine of Repulsion in electrised 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, March 12, 1761.

Sir,

Having lately made the following experiments, I very chearfully 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 electrised, threw my hat to an unelectrised 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 electrised sufficiently to attract the thread.

I then suspended, by silk, a broad plate of metal, and electrised some boiling water under it at about four feet distance, [332] expecting that the vapour, 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 vapours 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, electrising 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 electrised the stand negatively, expecting the needle to turn the contrary way, but was extremely disappointed, for it went [333] still the same way as before. When the stand was electrised 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 electrised 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 electrised 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, electrised negatively, separate as far as when electrised 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 electrised 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 [334]
conductor, it seems loth 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.

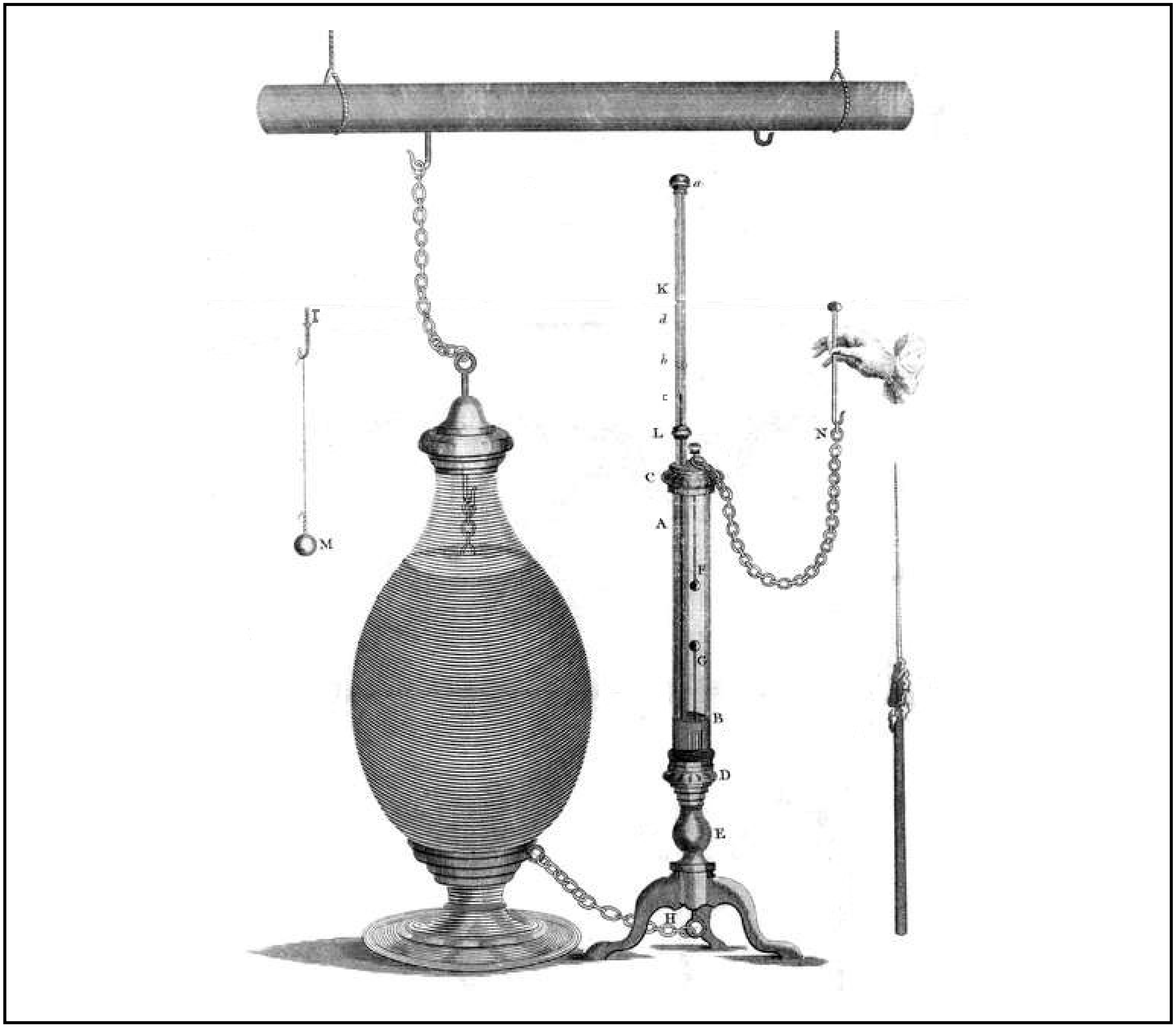
Let a person electrised negatively present the point of a needle, horizontally, to a cork ball, suspended by silk, and the ball will be attracted towards the point, till it has parted with so much of its natural quantity of electricity as to be in the negative state in the same degree with the person 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 electrised positively. The kite had three metalline points fixed to it: one on the top, and one on each side. That the [335]
twine was electrised, 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 electrised 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 enquiry.

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 electrised 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 draught, and the following description, [336] 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, coloured with cochineal, at the bottom of the tube A B. (I used, at first, coloured 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 strait 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 coloured water in the tube K, up to *c*, or thereabouts; and then, the gage-wire *b*, being slipt down to the top of the column, the thermometer is ready for use.


a
K
d
b
c
L
C
A
F
G
B
D
E
H
I
M
N

I set the thermometer on an electric stand, with the chain N fixed to the prime conductor, and kept it well electrised a considerable time; but this produced no sensible effect; which shews, that the electric fire, when in a state of rest, has no more heat than the air, and other matter wherein it resides. [337]

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 the tube K, up to *d*, or thereabouts; and the charge of the above-mentioned 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 above-mentioned glass jar, passing through each of these, especially the last, produced heat enough to rarefy the air very perceptibly. [338]

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 gun-powder; 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 [339] 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 [340] 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 enquire 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 [341] 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 drove about four or five feet into the ground.

The above-mentioned 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 [342] 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 shewing 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 shew 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 [343] 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 MR. 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, Feb. 20, 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 vapour ascending from electrised 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 [344] a fine thread from the cieling, hung opposite to, and within an inch of the bullet. I then sprinkled the heated plate with water, which arose fast from it in vapour. If vapour 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 electrised. 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 vapour. 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 65, the state of warmth in the common air, to 7, which is 22 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 [345] 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 subtle 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 [346] 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 Oct. 31, 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 [347] 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 [348] 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 sieve 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 210, 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 400 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 600, 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 400."

Plate III.

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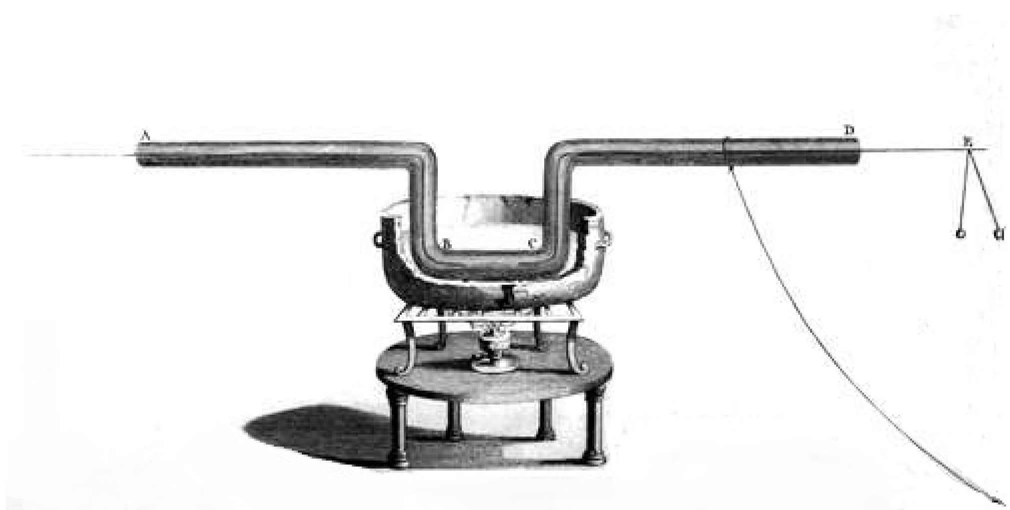


It were to be wished, that this noble philosopher would communicate more of his experiments to the world, as he makes [349]
many, and with great accuracy.

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, *i. e.* 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 [350]
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, *i. e.* the natural state, it does

not seem to me easy to suppose, that an attraction should suddenly 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 subtle moveable fluid in many respects analagous 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. [351]
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 electrised positively, repels the points; when negatively, the air opposite the points being also, by their means, electrised 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, [352]
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 any body. 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 encreased, and its principles become better [353] 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 electrised 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 electrised the air negatively. The difference was easily discovered by his cork balls, as he passed out of one room into another.—Pere Beccaria, too, has a pretty experiment, which shows that air may be electrised. Suspending a pair of small light balls, by flaxen threads, to the end of his prime conductor, he turns his globe some time, electrising 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 wide 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 electrised as the conductor at that time; and more than the conductor, when [354] that was reduced to its natural state. For the balls, though in the natural state, will diverge, when the air that surrounds them is electrised *plus* or *minus*, as well as when that is in its natural state and they are electrised *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 enquiry 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 electrising 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 electrised 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 syphon, 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 [355] electric explosion. The continuance of its rarefaction, for some time after the discharge of your glass jar and of your case of bottles, seem 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 vapour, by the electric fluid passing through it, might occasion some expansion which would be gradually reduced by the condensation of such vapour. 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 [356] 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 colour, 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 an 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 [357] 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 [358] 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 vapour, whereby a force is generated, that may damage the foundation. Water reduced to vapour, is said to occupy 14,000 times its former space. I have sent a charge through a small [359]
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 vapour; 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 watry fluid, which, when reduced to vapour, rends every tube lengthways. 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 putrify. 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 [360]
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 electrised cloud, knobs draw them nearer. An experiment, which I believe I have shewn you, of cotton fleece hanging from an electrised 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 expence 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 [361] 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.

Charlestown, Nov. 1, 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, [362] all down till it came opposite to the top of the gun-barrel, was destroyed[76]. There the lightning made a hole through the wall or back of the chimney, to get to the gun-barrel[77], 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."——

FOOTNOTES:

[76] 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.

[77] A more substantial conductor.

Mr. William Maine's Account of the Effects of the Lightning on his Rod, dated at Indian Land, in South Carolina, Aug. 28, 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 rivetted 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 above 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 [363] 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 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 beaufet (*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 [364] 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 logger-head, 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 90 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 [365]
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* 283, 310.) 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 electrised 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. [366]

(*b*) *Nothing of the points, &c. could be found.* This is a common effect. (*See page* 312.) 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 [367]
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* 358.) 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 [368] brought something more than soot with it; it would probably have ripped off the pargetting, 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 it 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 [369] 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 beaufet*, may nevertheless seem to indicate that the lightning was there: but as there is no mention of its having hurt any part of the beaufet, 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 DR. H[78]. AT LONDON.

On the Electricity of the Tourmalin.

Craven-street, June 7, 1759.

Sir,

I now return the smallest of your two tourmalins, with hearty thanks for your kind present of the other, which, though I [370] value highly for its rare and wonderful properties, I shall ever esteem it more for the friendship I am honoured with by the giver.

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 favour 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 [371] 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 side 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 a-fresh 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. [372]

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 [373] through the metal.

I am, &c.

B. FRANKLIN.

FOOTNOTE:

[78] Dr. Heberden. *Editor*.

FROM PROFESSOR WINTHROP, TO B. FRANKLIN.

New Observation relating to Electricity in the Atmosphere.

Cambridge, N. E. Sept. 29, 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 about by a high wind at W. or N. W. the bells rung for several hours (though with little intermissions) as briskly as ever I knew them, and I drew considerable sparks from [374] 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.

FROM MR. A. S[79]. TO B. F.

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 strait 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 zig-zag lightning motion. I instantly told a person sitting with me, that some place must be struck at that instant. I was so much surprized 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. Clements'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 [375] 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

Your's, A. S.

FOOTNOTE:

[79] Mr. Alexander Small. *Editor.*

TO MR. P. F[80]. NEWPORT.

Best Method of securing a Powder Magazine from Lightning.

----You may acquaint the gentleman that desired you to enquire 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 expence 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 [376] cases of bottles well corked; or in large tin canisters, with small covers shutting close by means of oiled paper between, or 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 tin-foil, 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 tin-foil should be plyed 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 tin-foil is but about eighteen pence sterling a pound, and is so [377] extremely thin, that I imagine a pound of it would line three or four powder-barrels.

I am, &c.

B. FRANKLIN.

FOOTNOTE:

[80] Peter Franklin. *Editor.*

Of Lightning, and the Methods (now used in America) of securing Buildings and Persons from its mischievous Effects.

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*. [378]

If the communication of this fluid is by a conductor, it may be without either light or sound, the subtle 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 subtle 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 [379]
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 strait, or crooked line [380]
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 strait 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, [381]
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 mattrasses 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 chuse an [382] interrupted course through the air of the room and the bedding, when it can go through a continued better conductor, the wall. 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 cieling 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.

Paris, Sept. 1767.

FROM J. W.[81] ESQ. PROFESSOR OF NATURAL PHILOSOPHY AT CAMBRIDGE, IN NEW ENGLAND, JAN. 6, 1768.

St. Bride's Steeple.—Utility of Electrical Conductors to Steeples.—Singular kind of Glass tube.

"**** 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 enquiry!"

ANSWER TO THE ABOVE.

**** It is perhaps not so extraordinary that unlearned men, such as commonly compose our church vestries, should not [383] 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 objects to the providing metalline conductors *without* the building, as useless or dangerous.[82] He cautions people not to ring the church bells during a thunder-storm, lest the lightning, in its way to the [384] earth, should be conducted down to them by the bell ropes,[83] 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 chuse to pass in, rather than in dry hemp. And though for a thousand years past bells have been solemnly consecrated by the Romish church[84], in expectation 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 [385] to strike steeples of choice, and that at the very time the bells are ringing[85]; 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 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 [386] 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 subtle invisible vapour 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; [387]
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 vapour 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 dipt 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 vapour 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 vapour 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 vapour so much rarefied from water is capable of being itself still farther rarefied to a boundless [388]
degree by the application of heat to the vessels or parts of vessels containing the vapour (as at first it is applied to those containing the water) perhaps a much greater power may be obtained, with little additional expence. Possibly too, the power of easily moving water from one end to the other of a moveable beam (suspended in the middle like a scale-beam) by a small degree of heat, may be applied advantageously to some other mechanical purposes. ****

I am, &c.

B. FRANKLIN.

FOOTNOTES:

[81] John Winthrop. *Editor.*

[82] Notre curiosité pourroit peut-être s'applandir des recherches qu'elle nous a fait faire sur la nature du tonnerre, & 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 tronver 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 & 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, and 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;——& je

persiste â dire que le projet d'épuiser une nuée orageuse du feu dont elle est chargée, n'est pas celui d'un physicien,——. *Memoire sur les Effets du Tonnerre.*

[83] Les cloches, en vertu de leur bénédiction, doivent écarter les orages & nous preserver 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, & de causer l'épanchement de son feu vers les objets terrestres, mais il est certain & prouvé par l'expérience, que la tonnerre peut tomber sur un clocher, soit que l'on y sonne ou que l'on n'y sonne point; & 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 jusq'à eux: il est donc plus sage de laisser les cloches en repos quand l'orage est arrivé au-dessus de l'église. Ibid.

[84] Suivant le rituel de Paris, lorsqu'on benit des cloches, on recite les oraisons suivantes:

Benedic, Domine ... quotiescumque sonuerit, procul recedat virtus insidiantium, umbra phantasmatis, incursio turbinum, percussio fulminum, læsio tonitruum, calamitas tempestatum, omnisque spiritus procellarum, &c.

Deus, qui per beatum Moïsen, &c. ... procul pellentur insidiæ 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.

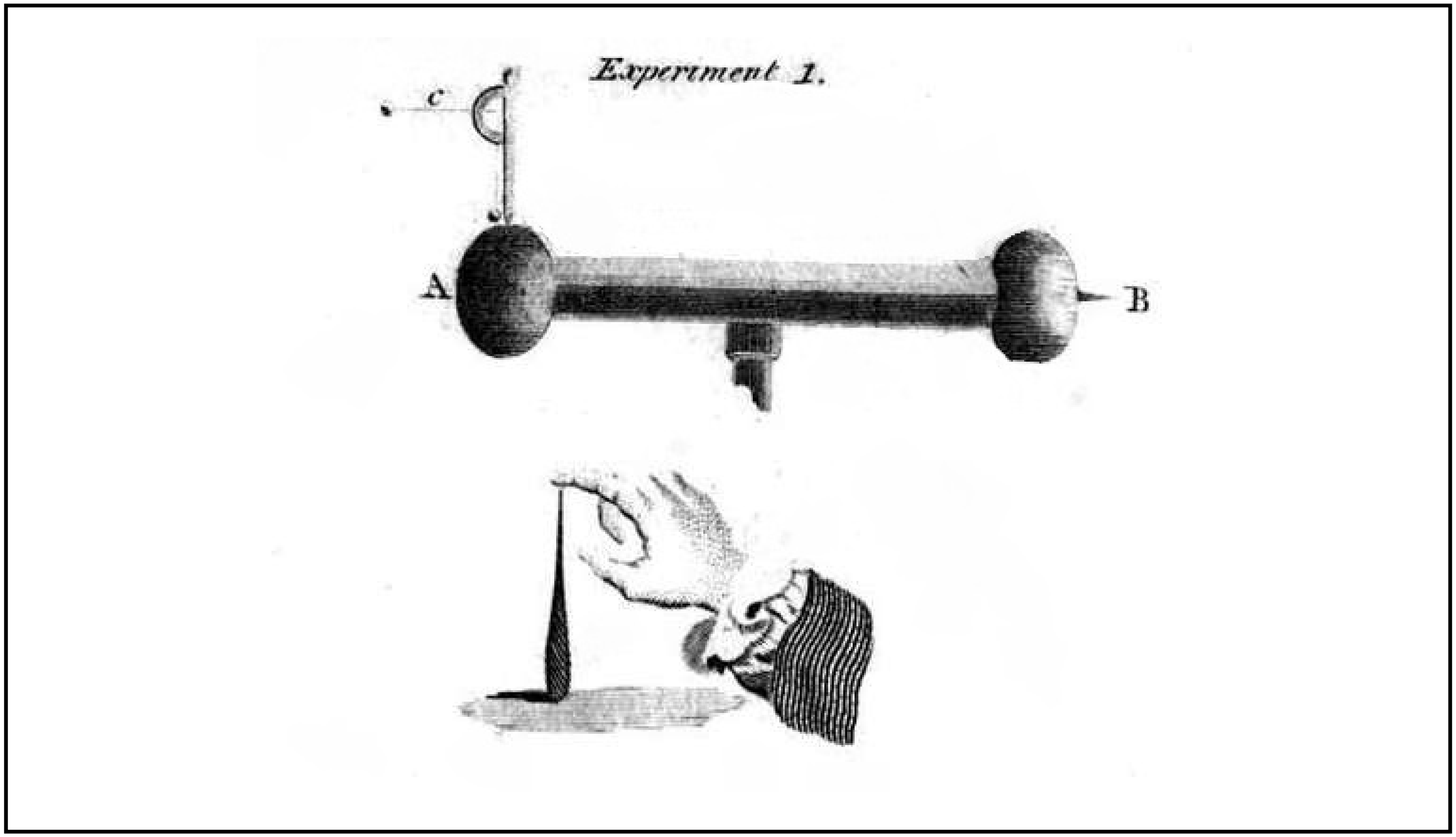
[85] En 1718. M. Deslandes fit savoir à l'Academie Royale des sciences, que la nuit du 14 ou 15 d'Avril de la mème année, le tonnerre étoit tombé sur vingtquatre églises, dequis Landernau jusqu'à Saint-Pol-de-Léon en Bretagne; que ces églises étoient précisément celles où l'on sonnoit, & que la foudre avoit épargné celles ou l'on ne sonnoit pas: que dans celle de Gouisnon, qui fut entièrement ruinée, le tonnerre tua deux personnes de quatre qui sonnoient, &c. *Hist. du l'Ac. R. des Sci. 1719.*

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 Conductors to secure the Magazines at Purfleet, Aug. 27, 1772.

EXPERIMENT I.

The prime conductor of an electric machine, A. B. (*See Plate* IV.) being supported about 10 inches and a half above the table by a wax-stand, and under it erected a *pointed wire* 7 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 c[86], will rise to the height indicating a full charge: but the moment the point is *uncovered*, the ball of the electrometer drops, showing the prime conductor to be instantly discharged [389] 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.


Experiment 1.
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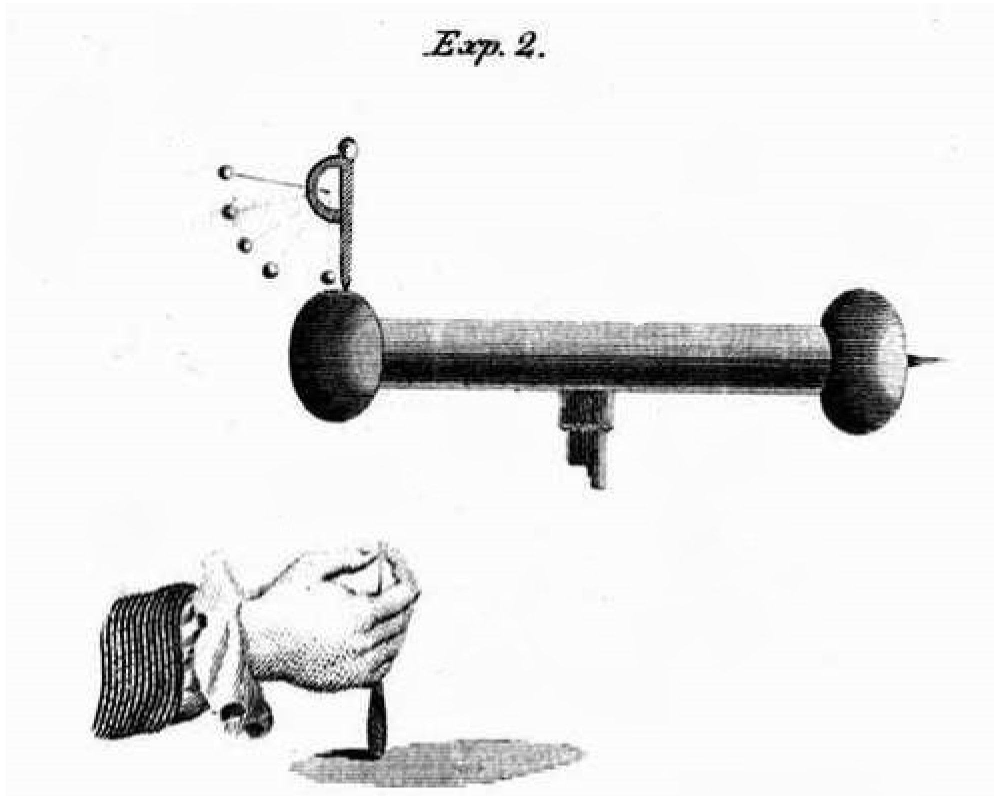
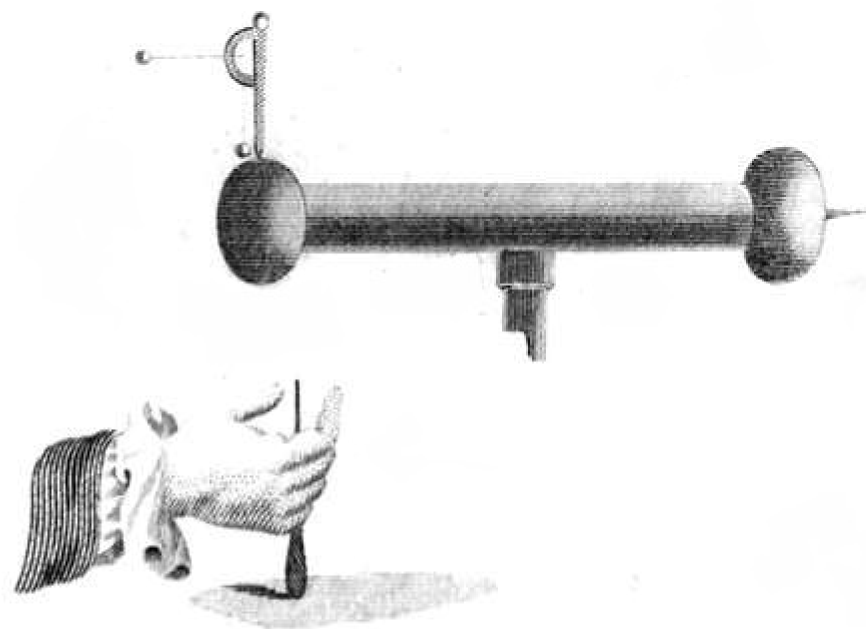

Exp. 2.

Exp. 3.



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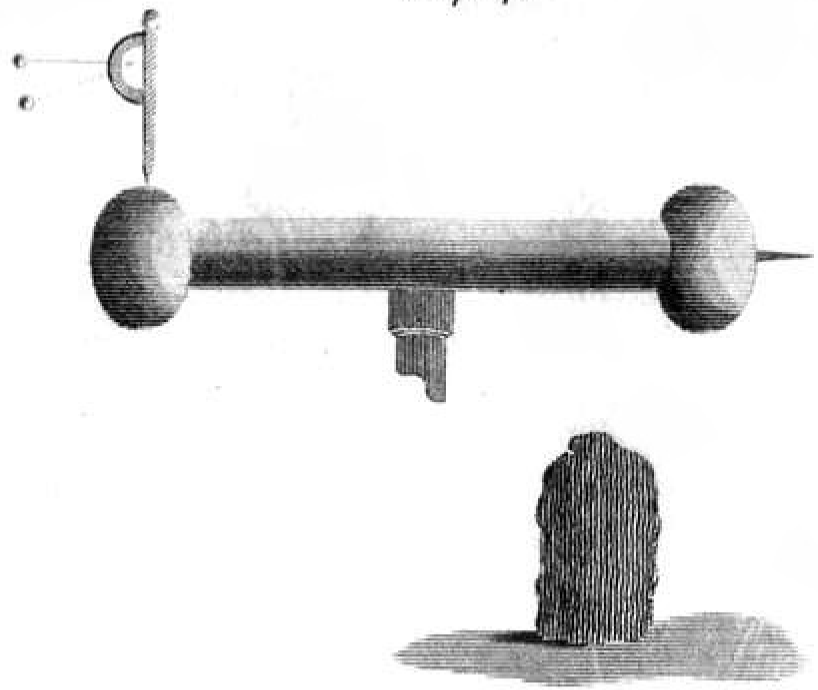

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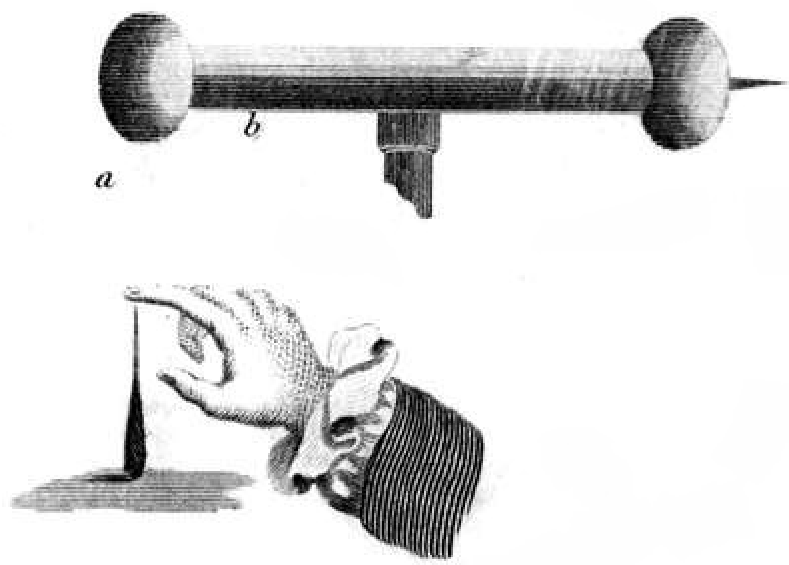

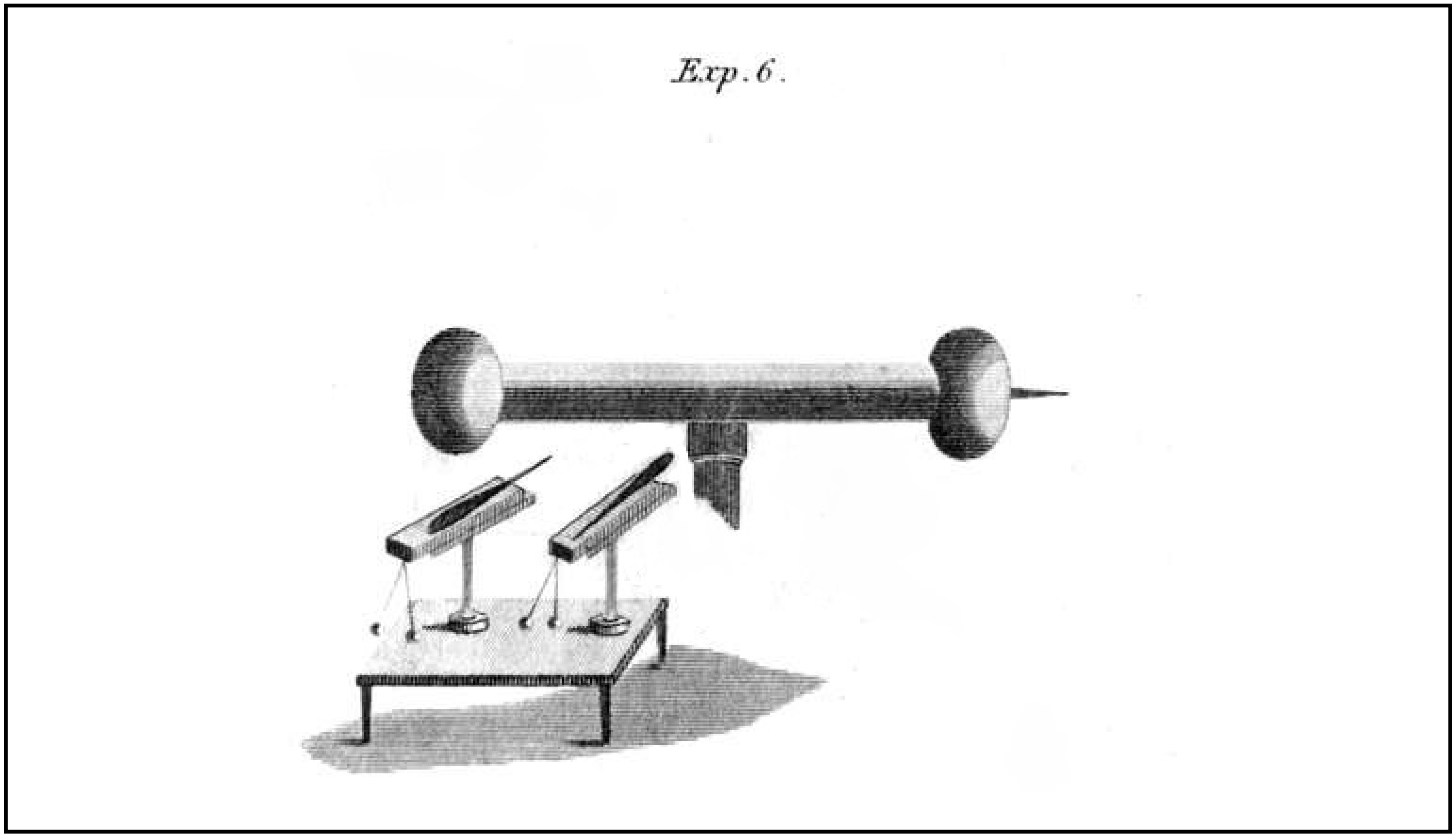

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OBSERVATION.

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 have 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 stair-case; the lower end connected with the iron spear of a pump. On the stair-case 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 waked by loud cracks on the stair-case. 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 [390]
whole stair-case was enlightened as with sunshine, so that one might see to pick up a pin[87]. And from the apparent

quantity thus discharged, I cannot but conceive that a *number*[88] 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. [391]

OBSERVATION.

From this experiment it seems that a greater effect in drawing off the lightning from the clouds may be 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 [392] 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 chimnies*, 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 [393]
conductor moveable 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 underside 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 connection 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 [394]
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 [395] *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 [396] earth, this objection might then have weight; but when such compleat 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 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 surprizingly 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 [397] 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, viz. 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 *compleat* conductor to the moist earth *has* been insufficient, if half an inch 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 [398] 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 20 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 or 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 [399] distance: But there is a circumstance which by occasionally lessening the distance, lessens the discharge; to wit, the moveableness 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 acquainted with is scarce to be expected[89].

B. F.

Aug. 27, 1772.

FOOTNOTES:

[86] Mr. Henley's.

[87] Mr. 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*, pages 134-6, *first edition*.

[88] Twelve were proposed on and near the magazines at Purfleet.

[89] 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, 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.[90]

[90] Wherever this signature occurs, the note is taken from a volume of Dr. Franklin's writings, entitled Political, Miscellaneous, and Philosophical Pieces, printed for Johnson, 1779. The editor of that volume, though a young man at the time, had already evinced extraordinary talents, and was the friend and correspondent of our author. As he has chosen to withhold his name, we conceive ourselves not entitled to disclose it: but we shall take the freedom of an acquaintance to use the notes occasionally, deeming them in many instances valuable historical records. *Editor.*

TO PROFESSOR LANDRIANI, OF ITALY. [400]

On the Utility of Electrical Conductors.

Philadelphia, Oct. 14, 1787.

Sir,

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 connection 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. [401] 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 come common in this city.

B. FRANKLIN.

TO JOHN PRINGLE, M. D. AND F. R. S.

On the Effects of Electricity in paralytic Cases.

Craven-street, Dec. 21, 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 news-papers 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 Pensylvania, and the neighbouring provinces, to be electrised, 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 sensible warmth in the lame limbs that had received the stroke than in the others; and the next morning [402] 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 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 [403]
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.

Electrical Experiments on Amber.

Saturday, July 3, 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 [404]
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 in 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.

TO THOMAS RONAYNE, ESQ. AT CORKE[91]. [405]

On the Electricity of the Fogs in Ireland.

London, April 20, 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 [406] remained after the passing of the clouds, diffusing itself uniformly 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 brought within a certain distance, the balls will at first [407] 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 these 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 [408] 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.

FOOTNOTE:

[91] This letter is translated from the French edition of Dr. Franklin's works, as are also all that follow, to the Appendix, the one to Miss Stephenson excepted. *Editor.*

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 [409] 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, *12th 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 [410] 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.

TO M. DUBOURG.

On the Analogy between Magnetism and Electricity.

London, March 10, 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 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 [411] 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 magnetised, 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 electric 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 [412] 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 Petersburgh, 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 [413] 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.

TO MESSRS. DUBOURG AND D'ALIBARD[92].

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.

It has been observed, that lightning, by rarefying and reducing into vapour the moisture contained in solid wood, in an [414] 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 putrify 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 [415] 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 20 to 24 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 [416] 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.

FOOTNOTE:

[92] This letter has no date, but the one to which it is an answer is dated May 1, 1773. *Editor.*

In Answer to some Queries concerning the Choice of Glass for the Leyden Experiment.

London, June 1, 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 [417] 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, [418] 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 inclosed, 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 MISS STEPHENSON.

Concerning the Leyden Bottle.

London, March 22, 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. [419]

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.

APPENDIX.

No. 1 [93].

The early Letters *of Dr. Franklin on Electricity having been translated into French, and printed at Paris; the Abbé Mazeas, in a Letter to Dr. Stephen Hales, dated St. Germain, May 20, 1752, gives the following Account (printed in the Philosophical Transactions) of the Experiment made at Marly, in Pursuance of that proposed by Mr. Franklin, Pages 227, 228.*

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 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, D'Alibard, and de Lor, a desire of verifying the conjectures of Mr. Franklin, upon the analogy of thunder and electricity, they prepared [421] themselves for making the experiment.

M. D'Alibard 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. MAZEAS.

FOOTNOTE:

[93] See the paragraph between brackets, page 267.

A more particular 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. D'Alibard, viz. [422]

EXTRAIT D'UN MEMOIRE

DE M. D'ALIBARD,

Lû 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 & 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 diametre, longue de 40 pieds, & fort pointue par son extrémité supérieure; pour lui ménager une pointe plus fine, je l'ai fait armer d'acier trempé & 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, & le second est en sens contraire à trois pieds du premier.

"2°. J'ai fait planter dans un jardin trois grosses perches de 28 à 29 pieds, disposées en triangle, & éloignées les unes des autres d'environ huit pieds; deux de ces perches sont contre un mur, & la troisieme est au-dedans du jardin. Pour les [423] affermir toutes ensemble, l'on à cloué sur chacune des entretoises à vingt pieds de hauteur; & comme le grand vent agitoit encore cette espéce 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 20 pieds des perches.

"3°. J'ai fait construire entres les deux perches voisines du mur, & adosser contre ce mur une petite guerite de bois capable de contenir un homme & une table.

"4°. J'ai fait placer au milieu de la guérite une petite table d'environ un demi-pied de hauteur; & sur cette table j'ai fait dresser & affermir un tabouret electrique. Ce tabouret n'est autre chose qu'une petite planche quarrée, portée sur trois bouteilles à vin; il n'est fait de cette matiere que pour suppléer au defaut d'un gâteau de résine qui me manquoit.

"5°. Tout étant ainsi préparé, j'ai fait elever perpendiculairement la verge de fer au milieu des trois perches, & 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 electrique, où j'ai fait creuser un trou propre à le recevoir.

"6º. Comme il étoit important de garantir de la pluie te tabouret & les cordons de soie, parce qu'ils laisseroient passer la matiére électrique s'ils etoient mouillés, j'ai pris les précautions necessaires pour en empêcher. C'est dans cette vue que j'ai [424]
mis mon tabouret sous la guérite, & 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 & au milieu de mes perches, à trois pouces au-dessus des cordons de soie, des especes de boîtes formées de trois petites planches d'environ 15 pouces de long, qui couvrent par-dessus & par les côtes 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; & 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 & 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, & en entend le pétillement; il tire une seconde étincelle plus fort que la premiere & avec plus de bruit! il appelle ses voisins, & envoie chercher M. le Prieur. Celui-ci accourt de toutes ses forces; les paroissiens voyant la précipitation de leur curé, s'imaginent [425]
que le pauvre Coiffier a été tué du tonnerre; l'allarme se répand dans le village: la grêle qui survient n'empêche point le troupeau du suivre son pasteur. Cet honnête ecclésiastique arrive près de la machine, & voyant qu'il n'y avoit point de danger, met lui-même la main â l'œuvre & tire de fortes étincelles. La nuée d'orage & de grêle ne fut pas plus d'un quart-d'heure à passer au zénith de notre machine, & l'on n'entendit que ce seul coup de tonnerre. Sitôt que le nuage fut passé, & 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'ecrivit à la hâte."

Je vous annonce, Monsieur, ce que veus attendez: l'expérience est complette. Aujourd'hui à deux heures 20 minutes après midi, le tonnerre a grondé directement sur Marly; le coup a été assez fort. L'envie de vous obliger, & la curiosité m'ont tiré de mon fauteüil, où j'étois occupé à lire: je suis allé chez Coiffier, qui déja m'avoit dépêché un enfant que j'ai rencontré en chemin, pour me prier de veenir; 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 evançant successivement vers la tringle, à un pouce & demi, ou environ; il est sorti de la tringle une petite colonne de fer bleuâtre sentant le soufre, qui venoit frapper avec une extrême vivacité le tenon du fil d'archal, & occasionnoit un bruit semblable à celui qu'on feroit en frappant sur la tringle avec une clef. J'ai répeté l'expérience au moins six fois dans l'espace d'environ quatre minutes, en présence de plusieurs personnes, & chaque expérience que j'ai faite a duré l'espace d'un pater & d'un ave. *J'ai voulu continuer; l'action du feu s'est* [426]
ralentie peu à peu; j'ai approché plus près, & n'ai plus tiré que quelques étincelles, & enfin rien n'ai 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 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, & nous avons apperçu une meurtrissure tournante autour du brass, 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 recontré 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 frappait davantage à mesure qu'ils s'approichient de moi: j'ai porté chez moi la même odeur, & mes domestiques s'en sont apperçus sans que je leur aye rien dit.*

Voilà, Monsieur, un récit fait à la hâte, mais naif & vrai que j'atteste, & 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 & 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 & 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 [427] 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 & plus bruyantes que celles dont il est parlé dans la lettre. Ces premieres personnes arrivant successivement, n'osient approcher qu'à 10 ou 12 pas de la machine; & à cette distance, malgré le plein soleil, ils voyoient les étincelles & entendoient le bruit....

"Il résulte de toutes les expériences & observations que j'ai rapportées dans ce mémoire, & surtout de la dernière expérience faite à Marly-la-ville, que la matiere 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, & 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."

Letter of Mr. W. Watson, F. R. S. to the Royal Society, concerning the electrical Experiments in England upon Thunder-Clouds.

Read Dec. 1752. Trans. Vol. XLVII.

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 [428] extraordinary, that no accounts have been yet laid before you, of our success here from the same experiments. That no want of attention, therefore, may be attributed to those here, who have been hitherto conversant in these enquiries, I thought proper to apprise 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; viz. on July 20; 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 21, 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 chimnies 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 [429] 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 12, 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, [430] 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.

No. 2.

Remarks on the Abbé Nollet's Letters to Benjamin Franklin, Esq. of Philadelphia, on Electricity: by Mr. David Colden, of New York.

Coldenham, in New York, Dec. 4, 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 to me thereon, by experimental proof. Wherefore, the first point wherein I can dare to give my opinion, is in the Abbé's 4th 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 [431]
writes thus of it. "When you electrise a pane of glass coated on both sides with metal, it is 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), I pray you, how much time is necessary for this pretended discharge? I can assure you, that after having maintained the electrisation 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 electrised thereby, and more proper to produce all the effects of an actual electric body." *P.* 68.

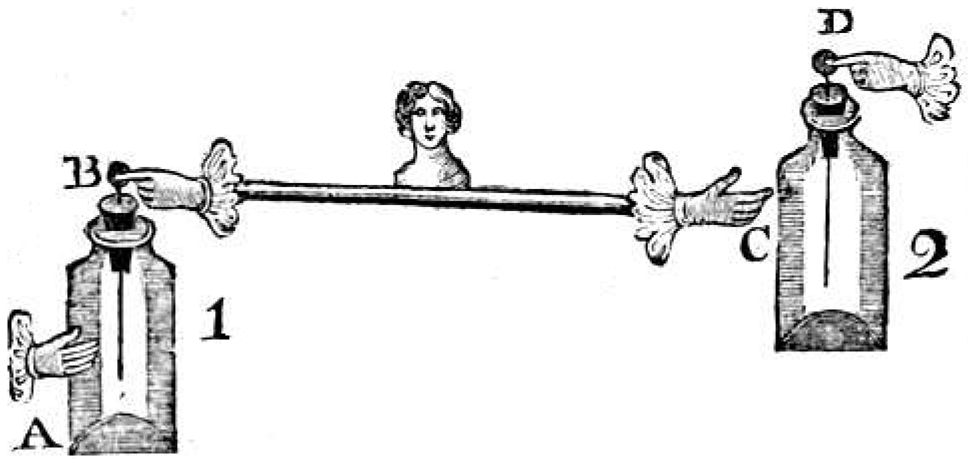
The Abbé does not tell us what those effects were, all the effects I could never observe, and those that are to be observed can easily be accounted for, by supposing that side to be entirely destitute of electric matter. The most sensible effect of a body charged with electricity is, that when you present 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 [432]
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 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 electrise it; then bring this [433]

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 electrise 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 electrised. 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 [434] 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 [435] 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, run 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 [436] 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. 179, 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 [437] 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 any body 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 shews evident signs of being electrised; 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 shew the least sign of being electrised 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 [438] 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 bason, 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 shew that the conductor is electrised. It receives this electrisation 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 electrises 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 [439] 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 electrised, 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. [440]

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 is 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.

END OF VOLUME THE FIRST.

J. CUNDEE, PRINTER,
IVY-LANE.

[1i]

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TRANSCRIBER'S NOTE

Obvious typographical errors and punctuation errors have been corrected after careful comparison with other occurrences within the text and consultation of external sources.

For consistency and clarity, the pound abbreviation 'l.' has been italicized, so for example '123,321l.' has been replaced by '123,321*l.*' in the etext.

For consistency, the date and salutation at the beginning of each letter, and the closing and name at the end of each letter, have been put on separate lines (they were sometimes placed on the same line in the original printed text).

A 'List of the Plates' has been created and added in front of the Errata.

For consistency, all occurrences of 'Abbe' have been replaced by 'Abbé'.

Text omitted by the editor may be indicated by '***', '****' or '----'.

All the changes noted in the Errata (pg xiv) have been applied to the text.

Except for those changes noted below, misspelling in the text, and inconsistent or archaic usage, have been retained. For example, compleat; cieling; inclose; watry; spunge; negociate; Pensylvania; Massachussets; newspaper, news-paper; farther, further.

In addition:
Pg v. 'works af' replaced by 'works of'.
Pg vi. 'side the' replaced by 'side of the'.
Pg xiv. 'anology' replaced by 'analogy'.
Pg xiv. Errata: '12 1:' replaced by '20 1:'.
Pg xiv. Errata: '29 3:' replaced by '28 3:'.
Pg xiv. Errata: '40 19:' replaced by '50 19:'.
Pg 5. 'frandfather' replaced by 'grandfather'.
Pg 48. 'oponent' replaced by 'opponent'.
Pg 74. 'tolera-manner' replaced by 'tolerable manner'.
Pg 102. 'over the the lives' replaced by 'over the lives'.
Pg 110. 'Mary-la-ville' replaced by 'Marly-la-ville'.
Pg 110. 'with a whom' replaced by 'with whom'.
Pg 131. 'a juncion with' replaced by 'a junction with'.
Pg 132. 'of governtment' replaced by 'of government'.
Pg 133. 'was appehensive' replaced by 'was apprehensive'.
Pg 139. 'in the goal' replaced by 'in the gaol'.
Pg 140. 'A num-of' replaced by 'A number of'.
Pg 142. 'be learned' replaced by 'he learned'.
Pg 144. 'stampt-act' replaced by 'stamp-act'.
Pg 170. 'in crouds' replaced by 'in crowds'.
Pg 173. 'o bright' replaced by 'of a bright'.
Pg 222. 'with mose ease' replaced by 'with more ease'.
Pg 242. 'yerhaps' replaced by 'perhaps'.
Pg 244. 'does nor burn' replaced by 'does not burn'.
Pg 263. 'powdered sulpur' replaced by 'powdered sulphur'.
Pg 305. 'satisfation' replaced by 'satisfaction'.
Pg 310. 'appear to to me' replaced by 'appear to me'.
Pg 318. The * * * asterisks denote text omitted by the Editor.
Pg 356. 'and by electricty' replaced by 'and by electricity'.
Pg 358. 'above a a quarter' replaced by 'above a quarter'.
Pg 404. 'most of of the' replaced by 'most of the'.
Pg 406. 'silk handkercheif' replaced by 'silk handkerchief'.

Pg 418. 'and bottless' replaced by 'and bottles'.
Pg 424. 'è celle que' replaced by 'à celle que'.
Pg 424. 'piquûres' replaced by 'piqûres'.
Pg 426. 'évenénement' replaced by 'événement'.
Pg 440. 'and so dicharge' replaced by 'and so discharge'.
Index Pg 4i. 'Animalcnles' replaced by 'Animalcules'.
Index Pg 29i. 'relation batween' replaced by 'relation between'.

The Index covers all three volumes and was originally printed at the end of Volume 1 only. It has been copied to the end of Volume 2 and 3 as a convenience for the reader.

The Index had no page numbers in the original text; page numbers from 1i to 36i have been added for completeness. For clarity, some volume identifiers (i. or ii. or iii.) have been added, or removed, in the index. Only references within this volume have been hyperlinked.

The Index has some references to page numbers with a *, eg 551*. These are valid references; the book printer inserted pages 543*-556* between pages 542 and 543 in Vol iii.

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