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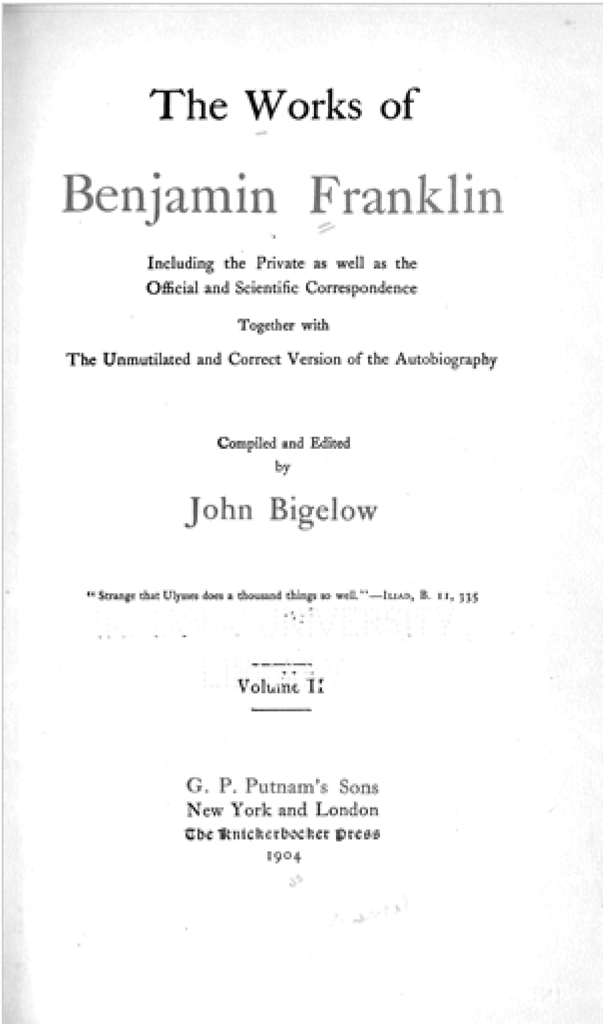

The Works of

Benjamin Franklin

Including the Private as well as the
Official and Scientific Correspondence

Together with

The Unmutilated and Correct Version of the Autobiography

Compiled and Edited
by

John Bigelow

"Strange that Ulysses does a thousand things so well."—Iliad, B. ii, 335

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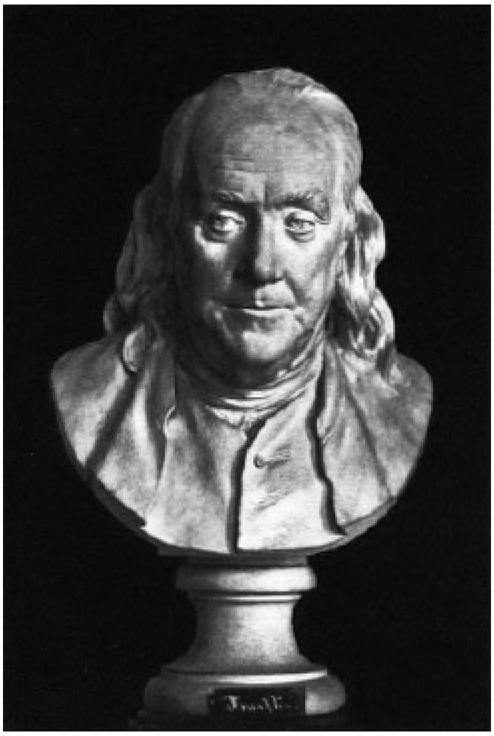

Benjamin Franklin

From the Bust by Giuseppe Ceracchi

The Works of Benjamin Franklin in Twelve Volumes

Federal Edition

The Knickerbocker Press, New York

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The Works Of Benjamin Franklin, Volume II

CORRESPONDENCE AND MISCELLANEOUS WRITINGS

XVI

ON THE USEFULNESS OF THE MATHEMATICS[1]

MATHEMATICS originally signified any kind of discipline or learning, but now it is taken for that science which teaches or contemplates whatever is capable of being numbered or measured. That part of the mathematics which relates to numbers only is called *arithmetic;* and that which is concerned about measure in general, whether length, breadth, motion, force, &c., is called *geometry.*

As to the usefulness of arithmetic, it is well known that no business, commerce, trade, or employment whatsoever, even from the merchant to the shopkeeper, &c., can be managed and carried on without the assistance of numbers; for by these the trader computes the value of all sorts of goods that he dealeth in, does his business with ease and certainty, and informs himself how matters stand at any time with respect to men, money, or merchandise, to profit and loss, whether he goes forward or backward, grows richer or poorer. Neither is this science only useful to the merchant, but is reckoned the *primum mobile* (or first mover) of all mundane affairs in general, and is useful for all sorts and degrees of men, from the highest to the lowest.

As to the usefulness of geometry, it is as certain that no curious art or mechanic work can either be invented, improved, or performed without its assisting principles.

It is owing to this that astronomers are put into a way of making their observations, coming at the knowledge of the extent of the heavens, the duration of time, the motions, magnitudes, and distances of the heavenly bodies, their situations, positions, risings, settings, aspects, and eclipses; also the measure of seasons, of years, and of ages.

It is by the assistance of this science that geographers present to our view at once the magnitude and form of the whole earth, the vast extent of the seas, the divisions of empires, kingdoms, and provinces.

It is by the help of geometry the ingenious mariner is instructed how to guide a ship through the vast ocean, from one part of the earth to another, the nearest and safest way and in the shortest time.

By help of this science the architects take their just measures for the structure of buildings, as private houses, churches, palaces, ships, fortifications, &c.

By its help engineers conduct all their works, take the situation and plan of towns, forts, and castles, measure their distances from one another, and carry their measures into places that are only accessible of the eye.

From hence also is deduced that admirable art of drawing sun-dials on any plane howsoever situate, and for any part of the world, to point out the exact time of the day, sun’s declination, altitude, amplitude, azimuth, and other astronomical matters.

By geometry the surveyor is directed how to draw a map of any country, to divide his lands, and to lay down and plot any piece of ground, and thereby discover the area in acres, rods, and perches; the gauger is instructed how to find the capacities or solid contents of all kinds of vessels, in barrels, gallons, bushels &c.; and the measurer is furnished with rules for finding the areas and contents of superficies and solids, and casting up all manner of workmanship. All these and many more useful arts too many to be enumerated here, wholly depend upon the aforesaid sciences—viz., arithmetic and geometry.

This science is descended from the infancy of the world, the inventors of which were the first propagators of human kind, as Adam, Noah, Abraham, Moses, and divers others.

There has not been any science so much esteemed and honored as this of the mathematics, nor with so much industry and vigilance become the care of great men, and labored in by the potentates of the world,—viz., emperors, kings, princes, &c.

Mathematical demonstrations are a logic of as much or more use than that commonly learned at schools, serving to a just formation of the mind, enlarging its capacity, and strengthening it so as to render the same capable of exact reasoning, and discerning truth from falsehood in all occurrences, even subjects not mathematical. For which reason, it is said, the Egyptians, Persians, and

Lacedæmonians seldom elected any new kings but such as had some knowledge in the mathematics, imagining those who had not, men of imperfect judgments and unfit to rule and govern.

Though Plato's censure, that those who did not understand the 117th proposition of the 13th book of Euclid's *Elements* ought not to be ranked amongst rational creatures, was unreasonable and unjust; yet to give a man the character of universal learning, who is destitute of a competent knowledge in the mathematics, is no less so.

The usefulness of some particular parts of the mathematics in the common affairs of human life has rendered some knowledge of them very necessary to a great part of mankind, and very convenient to all the rest that are any way conversant beyond the limits of their own particular callings.

Those whom necessity has obliged to get their bread by manual industry, where some degree of art is required to go along with it, and who have had some insight into these studies, have very often found advantages from them sufficient to reward the pains they were at in acquiring them. And whatever may have been imputed to some other studies, under the notion of insignificancy and loss of time, yet these, I believe, never caused repentance in any, except it was for their remissness in the prosecution of them.

Philosophers do generally affirm that human knowledge to be most excellent which is conversant amongst the most excellent things. What science then can there be more noble, more excellent, more useful for men, more admirably high and demonstrative, than this of the mathematics?

I shall conclude with what Plato says in the seventh book of his *Republic* with regard to the excellence and usefulness of geometry, being to this purpose;

"Dear friend; you see then that mathematics are necessary, because by the exactness of the method we get a habit of using our minds to the best advantage. And it is remarkable that all men being capable by nature to reason and understand the sciences, the less acute, by studying this, though useless to them in every other respect, will gain this advantage—that their minds will be improved in reasoning aright; for no study employs it more, nor makes it susceptible of attention so much; and those who we find have a mind worth cultivating ought to apply themselves to this study."

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XVII

ON TRUE HAPPINESS[1]

The desire of happiness in general is so natural to us that all the world are in pursuit of it; all have this one end in view, though they take such different methods to attain it, and are so much divided in their notions of it.

Evil, as evil, can never be chosen; and though evil is often the effect of our own choice, yet we never desire it but under the appearance of an imaginary good.

Many things we indulge ourselves in may be considered by us as evils, and yet be desirable; but then they are only considered as evils in their effects and consequences, not as evils at present and attended with immediate misery.

Reason represents things to us not only as they are at present, but as they are in their whole nature and tendency; passion only regards them in their former light. When this governs us we are regardless of the future, and are only affected with the present. It is impossible ever to enjoy ourselves rightly if our conduct be not such as to preserve the harmony and order of our faculties and the original frame and constitution of our minds; all true happiness, as all that is truly beautiful, can only result from order.

Whilst there is a conflict betwixt the two principles of passion and reason, we must be miserable in proportion to the struggle, and when the victory is gained and reason so far subdued as seldom to trouble us with its remonstrances, the happiness we have then is not the happiness of our rational nature, but the happiness only of the inferior and sensual part of us, and consequently a very low and imperfect happiness to what the other would have afforded us.

If we reflect upon any one passion and disposition of mind abstract from virtue, we shall soon see the disconnexion between that and true, solid happiness. It is of the very essence, for instance, of envy to be uneasy and disquieted. Pride meets with provocations and disturbances upon almost every occasion. Covetousness is ever attended with solicitude and anxiety. Ambition has its disappointments to sour us, but never the good fortune to satisfy us; its appetite grows the keener by indulgence, and all we can gratify it with at present serves but the more to inflame its insatiable desires.

The passions, by being too much conversant with earthly objects, can never fix in us a proper composure and acquiescence of mind. Nothing but an indifference to the things of this world, an entire submission to the will of Providence here, and a well-grounded expectation of happiness hereafter, can give us a true satisfactory enjoyment of ourselves. Virtue is the best guard against the many unavoidable evils incident to us; nothing better alleviates the weight of the afflictions or gives a truer relish of the blessings of human life.

What is without us has not the least connexion with happiness only so far as the preservation of our lives and health depends upon it. Health of body, though so far necessary that we cannot be perfectly happy without it, is not sufficient to make us happy of itself. Happiness springs immediately from the mind; health is but to be considered as a condition or circumstance, without which this happiness cannot be tasted pure and unabated.

Virtue is the best preservative of health, as it prescribes temperance and such a regulation of our passions as is most conducive to the well-being of the animal economy, so that it is at the same time the only true happiness of the mind and the best means of preserving the health of the body.

If our desires are to the things of this world, they are never to be satisfied. If our great view is upon those of the next, the expectation of them is an infinitely higher satisfaction than the enjoyment of those of the present.

There is no happiness then but in a virtuous and self-approving conduct. Unless our actions will bear the test of our sober judgments and reflections upon them, they are not the actions and consequently not the happiness of a rational being.

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XVIII

ON GOVERNMENT.—NO. I1

Government is aptly compared to architecture; if the superstructure is too heavy for the foundation the building totters, though assisted by outward props of art. But leaving it to everybody to mould the similitude according to his particular fancy, I shall only observe that the people have made the most considerable part of the legislature in every free state; which has been more or less so in proportion to the share they have had in the administration of affairs. The English constitution is fixed on the strongest basis; we choose whomsoever we please for our representatives, and thus we have all the advantages of a democracy without any of its inconveniences.

Popular governments have not been framed without the wisest reasons. It seemed highly fitting that the conduct of magistrates, created by and for the good of the whole, should be made *liable to the inspection and animadversion* of the whole. Besides, there could not be a more potent counterpoise to the designs of ambitious men than a multitude that hated and feared ambition. Moreover, the power they possessed, though great collectively, yet, being distributed among a vast number, the share of each individual was too inconsiderable to lay him under any temptations of turning it to a wrong use. Again, a body of people thus circumstanced cannot be supposed to judge amiss on any essential points; for if they decide in favor of themselves, which is extremely natural, their decision is just, inasmuch as whatever contributes to their benefit is a general benefit and advances the real public good. Hence we have an easy solution of the *sophism,* so often proposed by the abettors of tyranny, who tell us that when *differences arise between a prince and his subjects the latter are incapable of being judges of the controversy, for that would be setting up judge and party in the same person.*

Some foreigners have had a truer idea of our constitution. We read in the Memoirs of the late Archbishop of Cambray, Fenelon, the celebrated author of *Telemachus,* a conversation which he had with the Pretender (son of James the Second, of England): “If ever you come to the crown of England,” says the bishop, “you will be a happy prince; with an unlimited power to do good and only restrained from doing evil.” A blunt Briton, perhaps, would have said in plain English: “You ’ll be at liberty to do as much good as you please, but, by G—, you shall do us no hurt.” The bishop sweetened the pill; for such it would appear in its simple form to a mind fraught with notions of arbitrary power and educated among a people who, with the utmost simplicity, boast of their slavery.

What can be more ridiculous than to hear them frequently object to the English gentlemen that travel in their country, “What is your king? Commend me to our grand monarch, who can do whatever he pleases.”[1] But begging pardon of these facetious gentlemen, whom it is not my intention to disturb in their many notions of government, I shall go on to examine what were the sentiments of the ancient Romans on this head.

We find that their dictator, a magistrate never created but in cases of great extremity, vested with power as absolute during his office (which never exceeded six months) as the greatest kings were never possessed of,—this great ruler was liable to be called to an account by any of the tribunes of the people,[2] whose persons were at the same time rendered sacred by the most solemn laws.

This is evident proof that the Romans were of opinion that the *people could not in any sense divest themselves of the supreme authority* by conferring the most extensive power they possibly could imagine, on one or more persons acting as magistrates.

This appears still more evident in remarking that the people sat as umpire of the differences which had arisen between the dictator and senate in the case of young Fabius.[1]

The great deference which Cicero paid to the judgment of the Roman people appears by those inimitable orations of which they were the sole judges and auditors. That great orator had a just opinion of their understanding. Nothing gave him a more sensible pleasure than their approbation. But the Roman populace were more learned than ours, more *virtuous* perhaps, but their sense of discernment was not better than ours. However, the judgment of a whole people, especially of a *free people,* is looked upon to be infallible, so that it has become a common proverb that the voice of God is the voice of the people, *Vox Dei est populi vox.* And this is universally true while they remain in their proper sphere, unbiased by faction, undeluded by the tricks of designing men.

Thank God! we are in the full enjoyment of all these privileges. But can we be taught to prize them too much? or how can we prize them equal to their value if we do not know their intrinsic worth, and that they are not a gift bestowed upon us by other men, but *a right that belongs to us by the laws of God and nature?*

Since they are our right, let us be vigilant to preserve them uninfringed and free from encroachments. If animosities arise and we should be obliged to resort to party, let each of us range himself on the side which unfurls the ensigns of *public good.* Faction will then vanish, which, if not timely suppressed, may overturn the balance, the palladium of liberty, and crush us under its ruins.

The design of this paper is to assert the *common rights of mankind* by endeavouring to illustrate eternal truths that cannot be shaken even with the foundations of the world.

I may take another opportunity to show how a government founded on these principles rises into the most beautiful structure, with all the graces of symmetry and proportion, as much different from that raised on arbitrary power as Roman architecture from a Gothic building.

ON GOVERNMENT.—NO. II[1]

An ancient sage of the law[2] says: "The King can do no wrong, for, if he doeth wrong, he is not the King."[3] And in another place: "When the King doth justice, he is God's vicar; but when he doth unjustly, he is the agent of the Devil."[1] The politeness of the later times has given a softer turn to the expression. It is now said: *The King can do no wrong, but his ministers may.* In allusion to this the Parliament of 1641 declared they made war against the King for the King's service. But his Majesty affirmed that such a distinction was absurd; though, by the way, his own creed contained a greater absurdity, for he believed he had an authority from God to oppress the subjects whom by the same authority he was obliged to cherish and defend. Aristotle calls all princes *tyrants,* from the moment they set up an interest different from that of their subjects; and this is the only definition he gives us of tyranny. Our own countryman before cited and the sagacious Greek both agree on this point, that a governor who acts contrary to the ends of government loses the title bestowed on him at his institution. It would be highly improper to give the same name to things of different qualities or that produce different effects. Matter, while it communicates heat, is generally called *fire,* but when the flames are extinguished the appellation is changed. Sometimes indeed the same sound serves to express things of a contrary nature, but that only denotes a defect or poverty in the language.

A wicked prince imagines that the crown receives a new lustre from absolute power, whereas every step he takes to obtain it is a forfeiture of the crown.

His conduct is as foolish as it is detestable; he aims at glory and power, and treads the path that leads to dishonor and contempt; he is a plague to his country, and deceives himself.

During the inglorious reigns of the Stuarts (except a part of Queen Anne's), it was a perpetual struggle between them and the people: those endeavouring to subvert, and these bravely opposing the subverters of liberty. What were the consequences? One lost his life on the scaffold, another was banished. The memory of all of them stinks in the nostrils of every true lover of his country; and their history stains with indelible blots the English annals.

The reign of Queen Elizabeth furnishes a beautiful contrast. All her views centred in one object, which was the public good. She made it her study to gain the love of her subjects, not by flattery or little soothing arts, but by rendering them substantial favors. It was far from her policy to encroach on their privileges; she augmented and secured them.

And it is remarked to her eternal honor, that the acts presented to her for her royal approbation (forty or fifty of a session of Parliament) were signed without examining any farther than the titles. This wise and good Queen only reigned for her people, and knew that it was absurd to imagine they would promote any thing contrary to their own interests, which she so studiously endeavoured to advance. On the other hand, when this Queen asked money of the Parliament they frequently gave her more than she demanded, and never inquired how it was disposed of, except for form's sake, being fully convinced she would not employ it but for the general welfare. Happy princes, happy people! What harmony, what mutual confidence! Seconded by the hearts and purses of her subjects, she crushed the exorbitant power of Spain, which threatened destruction to England and chains to all Europe. That monarchy has ever since pined under the stroke, so that now, when we send a man-of-war or two to the West Indies, it puts her into such a panic fright that if the galleons can steal home she sings *Te Deum* as for a victory.

This is a true picture of government; its reverse is *tyranny.*

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XIX

ON DISCOVERIES[1]

The world but a few ages since was in a very poor condition as to trade and navigation; nor indeed were they much better in other matters of useful knowledge. It was a green-headed time; every useful improvement was hid from them; they had neither looked into heaven nor earth, into the sea nor land, as has been done since. They had philosophy without experiments, mathematics without instruments, geometry without scale, astronomy without demonstration.

They made war without powder, shot, cannon, or mortars; nay, the mob made their bonfires without squibs or crackers. They went to sea without compass, and sailed without the needle. They viewed the stars without telescopes, and measured latitudes without observation. Learning had no printing-press, writing no paper, and paper no ink. The lover was forced to send his mistress a deal board for a love-letter, and a billet-doux might be about the size of an ordinary trencher. They were clothed without manufacture, and their richest robes were the skins of the most formidable monsters. They carried on trade without books, and correspondence without posts; their merchants kept no accounts, their shopkeepers no cash-books; they had surgery without anatomy, and physicians without the *materia medica;* they gave emetics without ipecacuanha, drew blisters without cantharides, and cured agues without the bark.

As for geographical discoveries, they had neither seen the North Cape, nor the Cape of Good Hope south. All the discovered inhabited world which they knew and conversed with was circumscribed within very narrow limits, viz., France, Britain, Spain, Italy, Germany, and Greece; the lesser Asia, the west part of Persia, Arabia, the north parts of Africa, and the islands of the Mediterranean sea, and this was the whole world to them; not that even these countries were fully known either, and several parts of them not inquired into at all. Germany was known little further than the banks of the Elbe; Poland as little beyond the Vistula, or Hungary as little beyond the Danube; Muscovy or Russia perfectly unknown, as much as China beyond it; and India only by a little commerce upon the coast about Surat and Malabar. Africa had been more unknown, but by the ruin of the Carthaginians; all the western coast of it was sunk out of knowledge again and forgotten; the northern coast of Africa, in the Mediterranean, remained known, and that was all; for the Saracens overrunning the nations which were planted there ruined commerce as well as religion. The Baltic sea was not discovered, nor even the navigation of it known; for the Teutonic knights came not thither till the thirteenth century.

America was not heard of, nor so much as a suggestion in the minds of men that any part of the world lay that way. The coasts of Greenland, or Spitsbergen, and the whale-fishing not known; the best navigators in the world, at that time, would have fled from a whale with much more fright and horror than from the Devil in the most terrible shapes they had been told he appeared in.

The coasts of Angola, Congo, the Gold and the Grain coasts, on the west side of Africa, whence, since that time, such immense wealth has been drawn, not discovered, nor the least inquiry made after them. All the East India and China trade, not only undiscovered, but out of the reach of expectation! Coffee and tea (those modern blessings of mankind) had never been heard of. All the unbounded ocean we now call the South Sea was hid and unknown. All the Atlantic ocean beyond the mouth of the Straits was frightful and terrible in the distant prospect, nor durst any one peep into it, otherwise than as they might creep along the coast of Africa, towards Sallee or Santa Cruz. The North Sea was hid in a veil of impenetrable darkness. The White Sea, or Archangel, was a very modern discovery; not found out till Sir Hugh Willoughby doubled the North Cape, and paid dear for the adventure, being frozen to death with all his crew, on the coast of Lapland; while his companions' ship, with the famous Mr. Chancellor, went on to the gulf of Russia, called the White Sea, where no Christian strangers had ever been before him.

In these narrow circumstances stood the world's knowledge at the beginning of the fifteenth century, when men of genius began to look abroad and about them. Now, as it was wonderful to see a world so full of people, and people so capable of improving, yet so stupid and so blind, so ignorant and so perfectly unimproved; it was wonderful to see with what a general alacrity they took the alarm, almost all together, preparing themselves as it were on a sudden, by a general inspiration, to spread knowledge through the earth and to search into every thing that it was possible to uncover.

How surprising is it to look back so little a way behind us and see that even in less than two hundred years all this (now so self-wise) part of the world did not so much as know whether there was any such place as a Russia, a China, a Guinea, a Greenland, or a North Cape! That as to America, it was never supposed there was any such place; neither had the world, though they stood upon the shoulders of four thousand years' experience, the least thought so much as that there was any land that way![1]

As they were ignorant of places, so of things also; so vast are the improvements of science that all our knowledge of mathematics, of nature, of the brightest part of human wisdom, had their admission among us within these two last centuries.

What was the world, then, before? And to what were the heads and hands of mankind applied? The rich had no commerce, the poor no employment; war and the sword was the great field of honor, the stage of preferment; and you have scarce a man eminent in the world for any thing before that time but for a furious, outrageous falling upon his fellow-creatures, like Nimrod and his successors of modern memory.

The world is now daily increasing in experimental knowledge; and let no man flatter the age with pretending we have arrived at a perfection of discoveries.

> What 's now discovered only serves to show,
> That nothing 's known to what is yet to know.

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XX

THE WASTE OF LIFE[1]

Anergus was a gentleman of a good estate; he was bred to no business and could not contrive how to waste his hours agreeably; he had no relish for any of the proper works of life, nor any taste at all for the improvements of the mind; he spent generally ten hours of the four-and-twenty in his bed; he dozed away two or three more on his couch, and as many were dissolved in good liquor every evening if he met with company of his own humor. Five or six of the rest he sauntered away with much indolence; the chief business of them was to contrive his meals, and to feed his fancy beforehand with the promise of a dinner and supper; not that he was so absolute a glutton, or so entirely devoted to appetite, but chiefly because he knew not how to employ his thoughts better he let them rove about the sustenance of his body. Thus he had made a shift to wear off ten years since the paternal estate fell into his hands; and yet, according to the abuse of words in our day, he was called a man of virtue, because he was scarce ever known to be quite drunk, nor was his nature much inclined to lewdness.

One evening as he was musing alone, his thoughts happened to take a most unusual turn, for they cast a glance backward and began to reflect on his manner of life. He bethought himself what a number of living beings had been made a sacrifice to support his carcass, and how much corn and wine had been mingled with those offerings. He had not quite lost all the arithmetic that he had learned when he was a boy, and he set himself to compute what he had devoured since he came to the age of man.

“About a dozen of feathered creatures, small and great, have, one week with another,” said he, “given up their lives to prolong mine, which in ten years amounts to at least six thousand.

Fifty sheep have been sacrificed in a year, with half a hecatomb of black cattle, that I might have the choicest part offered weekly upon my table. Thus a thousand beasts out of the flock and the herd have been slain in ten years’ time to feed me, besides what the forest has supplied me with. Many hundreds of fishes have, in all their varieties, been robbed of life for my repast, and of the smaller fry as many thousands.

A measure of corn would hardly afford me fine flour enough for a month’s provision, and this arises to above six score bushels; and many hogsheads of ale and wine and other liquors have passed through this body of mine, this wretched strainer of meat and drink.

And what have I done all this time for God or man? What a vast profusion of good things upon a useless life and a worthless liver! There is not the meanest creature among all these which I have devoured but hath answered the end of its creation better than I. It was made to support human nature, and it hath done so. Every crab and oyster I have eat, and every grain of corn I have devoured, hath filled up its place in the rank of beings with more propriety and honor than I have done. O shameful waste of life and time!"

In short, he carried on his moral reflections with so just and severe a force of reason as constrained him to change his whole course of life, to break off his follies at once and to apply himself to gain some useful knowledge when he was more than thirty years of age. He lived many following years with the character of a worthy man and an excellent Christian; he performed the kind offices of a good neighbour at home, and made a shining figure as a patriot in the senate-house; he died with a peaceful conscience, and the tears of his country were dropped upon his tomb.

The world that knew the whole series of his life stood amazed at the mighty change. They beheld him as a wonder of reformation, while he himself confessed and adored the Divine power and mercy which had transformed him from a brute to a man.

But this was a single instance; and we may almost venture to write miracle upon it. Are there not numbers of both sexes among our young gentry in this degenerate age, whose lives thus run to utter waste, without the least tendency to usefulness?

When I meet with persons of such a worthless character as this it brings to my mind some scraps of Horace:

> Nos numerus sumus, et fruges consumere nati,
> . . . . Alcinoique
> . . . . juventus,
> Cui pulchrum fuit in medios dormire dies, &c.

PARAPHRASE

> There are a number of us creep
> Into this world, to eat and sleep;
> And know no reason why they 're born,
> But merely to consume the corn,

Devour the cattle, fowl, and fish,
And leave behind an empty dish.
Though crows and Ravens do the same,
Unlucky birds of hateful name,
Ravens or crows might fill their places,
And swallow corn and eat carcáses.
Then, if their tomb-stone, when they die,
Be n't taught to flatter and to lie,
There 's nothing better will be said,
Than that *they 've eat up all their bread,*
Drunk all their drink, and gone to bed.

There are other fragments of that heathen poet which occur on such occasions; one in the first of his *Satires,* the other in the last of his *Epistles,* which seem to represent life only as a season of luxury:

. . . Exacto contentus tempore vitæ
Cedat, uti conviva satur
Lusisti satis, edisti satis, atque bibisti;
Tempus abire tibi est.

Which may be thus put into English:

Life 's but a feast; and when we die,
Horace would say, if he were by:
"Friend, thou hast eat and drunk enough,
'T is time now to be marching off;
Then like a well-fed guest depart,
With cheerful looks, and ease at heart;
Bid all your friends good night, and say,
You 've done the business of the day."

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XXI

NECESSARY HINTS TO THOSE THAT WOULD BE RICH

The use of money is all the advantage there is in having money.

For six pounds a year you may have the use of one hundred pounds, provided you are a man of known prudence and honesty.

He that spends a groat a day idly spends idly above six pounds a year, which is the price for the use of one hundred pounds.

He that wastes idly a groat's worth of his time per day, one day with another, wastes the privilege of using one hundred pounds each day.

He that idly loses five shillings' worth of time loses five shillings, and might as prudently throw five shillings into the sea.

He that loses five shillings, not only loses that sum, but all the advantage that might be made by turning it in dealing, which, by the time that a young man becomes old, will amount to a considerable sum of money.

Again, he that sells upon credit asks a price for what he sells equivalent to the principal and interest of his money for the time he is to be kept out of it; therefore he that buys upon credit pays interest for what he buys, and he that pays ready money might let that money out to use; so that he that possesses any thing he has bought, pays interest for the use of it.

Yet, in buying goods, it is best to pay ready money, because he that sells upon credit expects to lose five per cent by bad debts; therefore he charges, on all he sells upon credit, an advance that shall make up that deficiency.

Those who pay for what they buy upon credit pay their share of this advance.

He that pays ready money escapes, or may escape, that charge.

> A penny saved is two pence clear,
> A pin a day 's a groat a year.

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XXII

THE WAY TO WEALTH

as clearly shown in the preface of an old almanac entitled “poor richard improved”1

Courteous Reader:

I have heard that nothing gives an author so great pleasure as to find his works respectfully quoted by others. Judge, then, how much I must have been gratified by an incident I am going to relate to you. I stopped my horse lately where a great number of people were collected at an auction of merchants’ goods. The hour of the sale not being come, they were conversing on the badness of the times; and one of the company called to a plain, clean, old man, with white locks: “Pray, Father Abraham, what think you of the times? Will not these heavy taxes quite ruin the country? How shall we ever be able to pay them? What would you advise us to do?” Father Abraham stood up and replied: “If you would have my advice, I will give it you in short; for *A word to the wise is enough,* as Poor Richard says.” They joined in desiring him to speak his mind, and gathering round him he proceeded as follows:

“Friends,” said he, “the taxes are indeed very heavy, and if those laid on by the government were the only ones we had to pay, we might more easily discharge them, but we have many others and much more grievous to some of us. We are taxed twice as much by our idleness, three times as much by our pride, and four times as much by our folly, and from these taxes the commissioners cannot ease or deliver us by allowing an abatement. However, let us hearken to good advice and something may be done for us; *God helps them that help themselves,* as Poor Richard says.

I. It would be thought a hard government that should tax its people one-tenth part of their time, to be employed in its service, but idleness taxes many of us much more; sloth by bringing on diseases, absolutely shortens life. *Sloth, like rust, consumes faster than labor wears, while the used key is always bright,* as Poor Richard says. *But dost thou love life,then do not squander time, for that is the stuff life is made of,* as Poor Richard says. How much more than is necessary do we spend in sleep, forgetting that *The sleeping fox catches no poultry,* and that *There will be sleeping enough in the grave,* as Poor Richard says.

"*If time be of all things the most precious, wasting time must be,* as Poor Richard says, *the greatest prodigality,* since, as he elsewhere tells us, *Lost time is never found again, and what we call time enough always proves little enough.* Let us then up and be doing, and doing to the purpose; so by diligence shall we do more with less perplexity. *Sloth makes all things difficult, but industry all things easy;* and *He that riseth late must trot all day, and shall scarce overtake his business at night;* while *Laziness travels so slowly that Poverty soon overtakes him. Drive thy business, let not that drive thee;* and *Early to bed and early to rise, makes a man healthy, wealthy, and wise,* as Poor Richard says.

"So what signifies wishing and hoping for better times? We may make these times better if we bestir ourselves. *Industry need not wish, and he that lives upon hopes will die fasting. There are no gains without pains; then help, hands, for I have no lands;* or if I have they are smartly taxed. *He that hath a trade hath an estate, and he that hath a calling hath an office of profit and honor,* as Poor Richard says; but then the trade must be worked at and the calling followed, or neither the estate nor the office will enable us to pay our taxes. If we are industrious we shall never starve, for *At the working man's househunger looks in but dares not enter.* Nor will the bailiff nor the constable enter, for *Industry pays debts, while despair increaseth them.* What though you have found no treasure, nor has any rich relation left you a legacy, *Diligence is the mother of good luck, and God gives all things to industry. Then plough deep while sluggards sleep, and you shall have corn to sell and to keep.* Work while it is called to-day, for you know not how much you may be hindered to-morrow. *One to-day is worth two to-morrows,* as Poor Richard says; and further, *Never leave that till to-morrow which you can do to-day.* If you were a servant would not you be ashamed that a good master should catch you idle? Are you then your own master? Be ashamed to catch yourself idle when there is so much to be done for yourself, your family, your country, and your king. Handle your tools without mittens; remember that *The cat in gloves catches no mice,* as Poor Richard says. It is true there is much to be done, and perhaps you are weak-handed, but stick to it steadily and you will see great effects; for *Constant dropping wears away stones;* and *By diligence and patience the mouse ate in two the cable;* and *Little strokes fell great oaks.*

"Methinks I hear some of you say, 'Must a man afford himself no leisure?' I will tell thee, my friend, what Poor Richard says: *Employ thy time well, if thou meanest to gain leisure; and, since thou art not sure of a minute, throw not away an hour.* Leisure is time for doing something useful; this leisure the diligent man will obtain, but the lazy man never; for *A life of leisure and a life of lazinessare two things. Many, without labor, would live by their wits only, but* *they break for want of stock;* whereas industry gives comfort and plenty and respect. *Fly pleasures, and they will follow you. The diligent spinner has a large shift; and now I have a sheep and a cow, everybody bids me good morrow.*

“II. But with our industry we must likewise be steady, settled, and careful, and oversee our own affairs with our own eyes, and not trust too much to others; for, as Poor Richard says:

> *I never saw an oft removed tree,*
> *Nor yet an oft-removed family,*
> *That throve so well as those that settled be.*

And again, *Three removes are as bad as a fire;* and again, *Keep thy shop, and thy shop will keep thee;* and again: *If you would have your business done, go; if not, send.* And again:

> *He that by the plough would thrive,*
> *Himself must either hold or drive.*

And again, *The eye of a master will do more work than both his hands;* and again, *Want of care does us more damage than want of knowledge;* and again, *Not to oversee workmen is to leave them your purse open.* Trusting too much to others’ care is the ruin of many; for, *In the affairs of this world men are saved, not by faith, but by the want of it;* but a man’s own care is profitable; for, *If you would have a faithful servant, and one that you like, serve yourself. A little neglect may breed great mischief; for want of a nail the shoe was lost; for want of a shoe the horse was lost;and for want of a horse the rider was lost, being overtaken and slain by the enemy; all for want of a little care about a horse-shoe nail.*

“III. So much for industry, my friends, and attention to one’s own business; but to these we must add frugality, if we would make our industry more certainly successful. A man may, if he knows not how to save as he gets, keep his nose all his life to the grindstone and die not worth a groat at last. *A fat kitchen makes a lean will;* and

> *Many estates are spent in the getting,*
> *Since women for tea forsook spinning and knitting,*
> *And men for punch forsook hewing and splitting.*

If you would be wealthy, think of saving as well as of getting. The Indies have not made Spain rich, because her outgoes are greater than her incomes.

“Away then with your expensive follies, and you will not then have so much cause to complain of hard times, heavy taxes, and chargeable families; for

Women and wine, game and deceit,
Make the wealth small and the want great.

And further, *What maintains one vice would bring up two children.* You may think, perhaps, that a little tea, or a little punch now and then, diet a little more costly, clothes a little finer, and a little entertainment now and then, can be no great matter; but remember, *Many a little makes a mickle.* Beware of little expenses: *A small leak will sink a great ship,* as Poor Richard says; and again, *Who dainties love,shall beggars prove;* and moreover, *Fools make feasts, and wise men eat them.*

"Here you are all got together at this sale of fineries and knick-knacks. You call them *goods;* but if you do not take care they will prove *evils* to some of you. You expect they will be sold cheap, and perhaps they may for less than they cost; but if you have no occasion for them they must be dear to you. Remember what Poor Richard says: *Buy what thou hast no need of, and ere long thou shalt sell thy necessaries.* And again, *At a great pennyworth pause a while.* He means, that perhaps the cheapness is apparent only, and not real; or the bargain, by straitening thee in thy business, may do thee more harm than good. For in another place he says, *Many have been ruined by buying good pennyworths.* Again, *It is foolish to lay out money in a purchase of repentance;* and yet this folly is practised every day at auctions for want of minding the Almanac. Many a one, for the sake of finery on the back, have gone with a hungry belly and half-starved their families. *Silks and satins, scarlet and velvets, put out the kitchen fire,* as Poor Richard says.

"These are not the necessaries of life; they can scarcely be called the conveniences; and yet, only because they look pretty, how many want to have them! By these and other extravagances the genteel are reduced to poverty and forced to borrow of those whom they formerly despised, but who, through industry and frugality, have maintained their standing; in which case it appears plainly that *A ploughman on his legs is higher than a gentleman onhis knees,* as Poor Richard says. Perhaps they have had a small estate left them, which they knew not the getting of: they think, *It is day, and will never be night;* that a little to be spent out of so much is not worth minding; but *Always taking out of the meal-tub, and never putting in, soon comes to the bottom,* as Poor Richard says; and then, *When the well is dry, they know the worth of water.* But this they might have known before, if they had taken his advice. *If you would know the value of money, go and try to borrow some; for he that goes a borrowing goes a sorrowing,* as Poor Richard says; and indeed so does he that lends to such people, when he goes to get it again. Poor Dick further advises and says,

Fond pride of dress is sure a very curse;
Ere fancy you consult, consult your purse.

And again, *Pride is as loud a beggar as Want, and a great deal more saucy.* When you have bought one fine thing you must buy ten more, that your appearance may be all of a piece; but Poor Dick says, *It is easier to suppress the first desire than to satisfy all that follow it.* And it is as truly folly for the poor to ape the rich, as for the frog to swell in order to equal the ox.

Vessels large may venture more,
But little boats should keep near shore.

It is, however, a folly soon punished; for, as Poor Richard says, *Pride that dines on vanity sups on contempt. Pride breakfasted with Plenty, dined with Poverty, and supped with Infamy.* And after all, of what use is this pride of appearance, for which so much is risked, so much is suffered? It cannot promote health, nor ease pain; it makes no increase of merit in the person; it creates envy; it hastens misfortune.

“But what madness must it be to *run in debt* for these superfluities! We are offered by the terms of this sale six months’ credit; and that, perhaps, has induced some of us to attend it, because we cannot spare the ready money, and hope now to be fine without it. But ah! think what you do when you run in debt; you give to another power over your liberty. If you cannot pay at the time, you will be ashamed to see your creditor; you will be in fear when you speak to him; you will make poor, pitiful, sneaking excuses, and by degrees come to lose your veracity, and sink into base, downright lying; for, *The second vice is lying, the first is running in debt,* as Poor Richard says; and again, to the same purpose, *Lying rides upon Debt’s back;* whereas a free-born Englishman ought not to be ashamed nor afraid to see or speak to any man living. But poverty often deprives a man of all spirit and virtue. *It is hard for an empty bag to stand upright.*

“What would you think of that prince or of that government who should issue an edict forbidding you to dress like a gentleman or gentlewoman, on pain of imprisonment or servitude? Would you not say that you were free, have a right to dress as you please, and that such an edict would be a breach of your privileges, and such a government tyrannical? And yet you are about to put yourself under such tyranny when you run in debt for such dress! Your creditor has authority, at his pleasure, to deprive you of your liberty by confining you in gaol till you shall be able to pay him. When you have got your bargain you may perhaps think little of payment, but, as Poor Richard says, *Creditors have better memories than debtors;*

creditors are a superstitious sect, great observers of set days and times. The day comes round before you are aware, and the demand is made before you are prepared to satisfy it; or, if you bear your debt in mind, the term, which at first seemed so long, will, as it lessens, appear extremely short. Time will seem to have added wings to his heels as well as his shoulders. *Those have a short Lent who owe money to be paid at Easter.* At present, perhaps, you may think yourselves in thriving circumstances, and that you can bear a little extravagance without injury, but—

For age and want save while you may;
No morning sun lasts a whole day.

Gain may be temporary and uncertain, but ever, while you live, expense is constant and certain; and *It is easier to build two chimneys than to keep one in fuel,* as Poor Richard says; so, *Rather go to bed supperless than rise in debt.*

Get what you can, and what you get hold;
'T is the stone that will turn all your lead into gold.

And, when you have got the Philosopher's stone, sure you will no longer complain of bad times or the difficulty of paying taxes.

"IV. This doctrine, my friends, is reason and wisdom; but, after all, do not depend too much upon your own industry and frugality and prudence, though excellent things, for they may all be blasted, without the blessing of Heaven; and therefore ask that blessing humbly, and be not uncharitable to those that at present seem to want it, but comfort and help them. Remember Job suffered and was afterwards prosperous.

"And now, to conclude, *Experience keeps a dear school, but fools will learn in no other,* as Poor Richard says, and scarce in that, for it is true *We may give advice, but we cannot give conduct.* However, remember this, *They that will not be counselled cannot be helped;* and further, that *If you will not hear Reason, she will surely rap your knuckles,* as Poor Richard says."

Thus the old gentleman ended his harangue. The people heard it and approved the doctrine, and immediately practised the contrary, just as if it had been a common sermon; for the auction opened, and they began to buy extravagantly. I found the good man had thoroughly studied my Almanacs, and digested all I had dropped on these topics during the course of twenty-five years. The frequent mention he made of me must have tired any one else, but my vanity was wonderfully delighted with it, though I was conscious that not a tenth part of the wisdom was my own which he ascribed to me, but rather the gleanings that I had made of the sense of all ages and nations. However, I resolved to be the better for the echo of it, and though I had at first determined to buy stuff for a new coat, I went away resolved to wear my old one a little longer. Reader, if thou wilt do the same thy profit will be as great as mine. I am, as ever, thine to serve thee,

Richard Saunders.

Speaking of the prefaces to *Poor Richard's Almanacs* Mr. Parton says[1] :

"Year after year they play upon Titan Leeds, in whose name a rival almanac, once published by Keimer, annually appeared. Mr. Richard Saunders (Poor Richard) begins his first preface by avowing that his motive in publishing an almanac is not at all a disinterested one. 'The plain truth of the matter is,' said Richard, 'I am excessive poor, and my wife, good woman, is, I tell her, excessive proud; she cannot bear, she says, to sit spinning in her shift of tow, while I do nothing but gaze at the stars; and has threatened more than once to burn all my books and rattling-traps (as she calls my instruments) if I do not make some profitable use of them for the good of my family. The printer has offer'd me some considerable share of the profits, and I have thus began to comply with my dame's desire.' Long ago, he continues, he would have given the world an almanac, but for the fear of injuring his friend and fellow-student, Titan Leeds. 'But this obstacle (I am far from speaking it with pleasure) is soon to be removed, since inexorable death, who was never known to respect merit, has already prepared the mortal dart, the fatal sister has already extended her destroying shears, and that ingenious man must soon be taken from us. He dies, by my calculation, made at his request, on October 17, 1733, 3 ho., 29 m., P.M., at the very instant of the ♂ of ? and ☿. By his own calculation he will survive till the 26th of the same month. This small difference between us we have disputed whenever we have met these nine years past; but at length he is inclined to agree with my judgment. Which of us is most exact a little time will now determine. As, therefore, these Provinces may not longer expect to see any of his performances after this year, I think myself free to take up the task.'

The next year he joyfully acknowledged the success of his almanac, through which his wife had been able to buy a pot of her own instead of being obliged to borrow one; and they had got something to put into it. 'She has also got a pair of shoes, two new shifts, and a new warm petticoat; and for my part I have bought a second-hand coat, so good that I am not now ashamed to go to town or be seen there. These things have render'd her temper so much more pacifick than it us'd to be, that I may say I have slept more, and more quietly, within this last year than in the three foregoing years put together.' Returning to Titan Leeds, he says he cannot positively say whether he is dead or alive, since he was unable to be present at the closing scene. 'The stars,' he observes, 'only show to the skilful what will happen in the natural and universal chain of causes and effects; but 't is well known that the events which would otherwise certainly happen at certain times in the course of nature, are sometimes set aside or postpon'd, for wise and good reasons, by the immediate particular dispositions of Providence; which particular dispositions the stars can by no means discover or foreshow. There is, however (and I cannot speak it without sorrow), there is the strongest probability that my dear friend is no more; for there appears in his name, as I am assured, an Almanack for the year 1734, in which I am treated in a very gross and unhandsome manner; in which I am called a false predicter, an ignorant, a conceited scribbler, a fool, and a lyar. Mr. Leeds was too well bred to use any man so indecently and so scurrilously, and, moreover, his esteem and affection for me was extraordinary; so that it is to be feared that pamphlet may be only a contrivance of somebody or other who hopes, perhaps, to sell two or three years' Almanacks still by the sole force and virtue of Mr. Leeds's name.'

In next year's preface the fooling is still more exquisite: 'Having received much abuse from Titan Leeds deceased (Titan Leeds, when living, would not have used me so); I say, having received much abuse from the ghost of Titan Leeds, who pretends to be still living, and to write almanacks in spight of me and my predictions, I cannot help saying that tho' I take it patiently, I take it very unkindly. And whatever he may pretend, 't is undoubtedly true that he is really defunct and dead. First, because the stars are seldom disappointed; never but in the case of wise men, *sapiens dominabitur astris,* and they foreshowed his death at the time I predicted it. Secondly, 't was requisite and necessary he should die punctually at that time for the honor of astrology, the art professed both by him and his father before him. Thirdly, 't is plain to every one that reads his two last almanacks (for 1734 and '35) that they are not written with that life his performances used to be written with: the wit is low and flat; the little hints dull and spiritless; nothing smart in them but Hudibras's verses against astrology at the heads of the months in the last, which no astrologer but a *dead one* would have inserted, and no man *living* would or could write such stuff as the rest.'

Titan Leeds retorted by saying that there was not and never had been such a person as Richard Saunders; to which, next year, Franklin humourously replied. One preface purported to be written by Bridget Saunders, the wife of Poor Richard, and another contained a long letter from the departed spirit of Titan Leeds, assuring his old friend that he *did* die at the time predicted by him.

From the numbers of *Poor Richard* that are accessible, I select, as specimens of its proverbial philosophy, the following:

‘Love well, whip well.’

‘The proof of gold is fire; the proof of a woman, gold; the proof of a man, a woman.’

‘There is no little enemy.’

‘A new truth is a truth; an old error is an error.’

‘Drink water; put the money in your pocket, and leave the dry belly-ache in the punch-bowl.’

‘Necessity never made a good bargain.’

‘Three may keep a secret, if two of them are dead.’

‘Deny self for self’s sake.’

‘Keep thy shop and thy shop will keep thee.’

‘Opportunity is the great bawd.’

‘Here comes the orator with his flood of words and his drop of reason.’

‘Sal laughs at every thing you say; why? because she has fine teeth.’

‘An old young man will be a young old man.’

‘He is no clown that drives the plough, but he that does clownish things.’

‘Forewarned, forearmed.’

‘Fish and visitors smell in three days.’

‘Diligence is the mother of good luck.’

‘Wealth is not his that has it, but his that enjoys it.’

‘Let thy maid-servant be faithful, strong, and homely.’

‘He that can have patience can have what he will.’

‘Don’t throw stones at your neighbors, if your own windows are glass.’

‘Good wives and good plantations are made by good husbands.’

‘God heals, the doctor takes the fee.’

‘The noblest question in the world is, what good may I do in it?’

‘There are three faithful friends, an old wife, an old dog, and ready money.’

‘Who has deceived thee so oft as thyself?’

‘Fly pleasures, and they ’ll follow you.’

‘Hast thou virtue? acquire also the graces and beauties of virtue.’

‘He that would have a short Lent, let him borrow money to be repaid at Easter.’

‘Keep your eyes wide open before marriage; half shut afterwards.’

‘As we must account for every idle word, so we must for every idle silence.’

‘Search others for their virtues, thyself for thy vices.’

‘Grace thou thy house, and let not that grace thee.’

‘Let thy child’s first lesson be obedience, and the second will be what thou wilt.’

‘Let thy discontents be thy secrets.’

‘Industry need not wish.’

‘Happy that nation, fortunate that age whose history is not diverting.’

‘To bear other people’s afflictions, every one has courage enough and to spare.’

‘There are lazy minds as well as lazy bodies.’

‘Tricks and treachery are the practice of fools that have not wit enough to be honest.’

‘Let no pleasure tempt thee, no profit allure thee, no ambition corrupt thee, no example sway thee, no persuasion move thee to do any thing which thou knowest to be evil; so shalt thou always live jollily, for a good conscience is a continual Christmas.’

A large part of the contents of *Poor Richard* is rhyme, and rhyme too generally of an indifferent quality. The following specimens are much above the average:

Altho’ thy teacher act not as he preaches,
Yet ne’ertheless, if good, do what he teaches;
Good counsel, failing men may give, for why?
He that ’s aground knows where the shoal doth lie.
My old friend Berryman oft, when alive,
Taught others thrift, himself could never thrive.
Thus like the whetstone, many men are wont
To sharpen others while themselves are blunt.
Syl. dreamt that bury’d in his fellow clay,
Close by a common beggar’s side he lay;
And, as so mean a neighbour shock’d his pride,
Thus, like a corpse of consequence, he cry’d:
Scoundrel, begone; and henceforth touch me not;
More manners learn; and, at a distance, rot.
How! scoundrel! in a haughtier tone cry’d he:
Proud lump of dirt, I scorn thy words and thee;
Here all are equal; now thy case is mine;
This is my rotting place, and that is thine.
When Robin now three days had married been,
And all his friends and neighbours gave him joy,
This question of his wife he asked then,
Why till her marriage day she proved so coy?
Indeed, said he, ’t was well thou didst not yield,
For doubtless then my purpose was to leave thee:
O, sir, I once before was so beguil’d,
And was resolved the next should not deceive me.

POETRY FOR DECEMBER, 1733

She that will eat her breakfast in her bed,
And spend the morn in dressing of her head,
And sit at dinner like a maiden bride,
And talk of nothing all day but of pride;
God in his mercy may do much to save her,
But what a case is he in that shall have her.

POETRY FOR DECEMBER, 1734

By Mrs. Bridget Saunders, my Duchess, in answer to the December verses of last year

> He that for the sake of drink neglects his trade,
> And spends each night in taverns till ’t is late,
> And rises when the sun is four hours high,
> And ne’er regards his starving family;
> God in his mercy may do much to save him,
> But woe to the poor wife whose lot it is to have him.

The astronomical notices of *Poor Richard* have in them a strong spice of the comic, and he has many paragraphs in ridicule of the predictions which the almanac-makers of that day were accustomed to insert.

‘During the first visible eclipse *Saturn* is retrograde: For which reason the crabs will go sidelong, and the ropemakers backward. *Mercury* will have his share in these affairs, and so confound the speech of the people, that when a *Pennsylvanian* would say panther he shall say painter. When a *New Yorker* thinks to say this he shall say diss, and the people of *New England* and *Cape May* will not be able to say cow for their lives, but will be forced to say keow by a certain involuntary twist in the root of their tongues. No *Connecticut man* nor *Marylander* will be able to open his mouth this year but sir shall be the first or last syllable he pronounces, and sometimes both.—Brutes shall speak in many places, and there will be about seven and twenty irregular verbs made this year, if Grammar don’t interpose.—Who can help these misfortunes? This year the stone-blind shall see but very little; the deaf shall hear but poorly; and the dumb sha’n’t speak very plain. And it ’s much, if my Dame *Bridget* talks at all this year. Whole flocks, herds, and droves of sheep, swine and oxen, cocks and hens, ducks and drakes, geese and ganders shall go to pot; but the mortality will not be altogether so great among cats, dogs, and horses. As to old age, ’t will be incurable this year, because of the years past. And towards the fall some people will be seized with an unaccountable inclination to roast and eat their own ears: Should this be called madness, Doctors? I think not. But the worst disease of all will be a certain most horrid, dreadful, malignant, catching, perverse, and odious malady, almost epidemical, insomuch that many shall run mad upon it; I quake for very fear when I think on ’t: for I assure you very few will escape this disease, which is called by the learned Albromazar *Lacko’mony.*’ ”

RIVALSHIP IN ALMANAC-MAKING

Courteous Reader:

This is the ninth year of my endeavours to serve thee in the capacity of a calendar-writer. The encouragement I have met with must be ascribed, in a great measure, to your charity, excited by the open, honest declaration I made of my poverty at my first appearance. This my brother *Philomaths* could, without being conjurers, discover; and *Poor Richard's* success has produced ye a *Poor Will,* and a *Poor Robin;* and no doubt *Poor John,* &c., will follow, and we shall all be, *in name,* what some folks say we are already *in fact,* a parcel of *poor almanac-makers.* During the course of these nine years, what buffetings have I not sustained! The fraternity have been all in arms. Honest *Titan,* deceased, was raised and made to abuse his old friend. Both authors and printers were angry. Hard names, and many, were bestowed on me. *They denied me to be the author of my own works;* declared there never was any such person; asserted that I was dead sixty years ago; prognosticated my death to happen within a twelvemonth; with many other malicious inconsistencies, the effects of blind passion, envy at my success, and a vain hope of depriving me, dear reader, of thy wonted countenance and favor. *Who knows him?* they cry; *where does he live?* But what is that to them? If I delight in a private life, have they any right to drag me out of my retirement? I have good reasons for concealing the place of my abode. It is time for an old man, as I am, to think of preparing for his great remove. The perpetual teasing of both neighbours and strangers to calculate nativities, give judgments on schemes, and erect figures, discover thieves, detect horse-stealers, describe the route of runaways and strayed cattle; the crowd of visitors with a thousand trifling questions, *Will my ship return safe? Will my mare win the race? Will her next colt be a pacer? When will my wife die? Who shall be my husband? and how long first? When is the best time to cut hair, trim cocks, or sow sallad?* these and the like impertinences I have now neither taste nor leisure for. I have had enough of them. All that these angry folks can say will never provoke me to tell them where I live; I would eat my nails first.

My last adversary is *J. J——n, Philomat.,* who *declares and protests* (in his preface, 1741), that the *false prophecy put in my Almanac, concerning him, the year before, is altogether* false and untrue, *and that I am one of Baal's false prophets.* This *false, false prophecy* he speaks of, related to his reconciliation with the church of Rome; which, notwithstanding his declaring and protesting, is, I fear, too true. Two things in his elegiac verses confirm me in this suspicion. He calls the first of November *All-Hallows Day.* Reader, does not this smell of Popery? Does it in the least savour of the pure language of Friends? But the plainest thing is his adoration of saints, which he confesses to be his practice, in these words, page 4,

> When any trouble did me befall,
> To my dear *Mary* then I would call.

Did he think the whole world were so stupid as not to take notice of this? So ignorant as not to know that all Catholics pay the highest regard to the *Virgin Mary?* Ah, friend *John,* we must allow you to be a poet, but you are certainly no Protestant. I could heartily wish your religion were as good as your verses.

Richard Saunders.[1]

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XXIII

CAUSES OF EARTHQUAKES[1]

The late earthquake felt here, and probably in all the neighbouring provinces, having made many people desirous to know what may be the natural cause of such violent concussions, we shall endeavour to gratify their curiosity by giving them the various opinions of the learned on that head.

Here naturalists are divided. Some ascribe them to water, others to fire, and others to air; and all of them with some appearance of reason. To conceive which, it is to be observed that the earth everywhere abounds in huge subterraneous caverns, veins, and canals, particularly about the roots of mountains; that of these cavities, veins, &c., some are full of water, whence are composed gulfs, abysses, springs, rivulets; and others full of exhalations; and that some parts of the earth are replete with nitre, sulphur, bitumen, vitriol, &c. This premised:

1. The earth itself may sometimes be the cause of its own shaking; when the roots, or basis of some large mass being dissolved or worn away by a fluid underneath, it sinks into the same and with its weight occasions a tremor of the adjacent parts, produces a noise, and frequently an inundation of water.

2. The subterraneous waters may occasion earthquakes by their overflowing, cutting out new courses, &c. Add that the water, being heated and rarefied by the subterraneous fires, may emit fumes, blasts, &c., which, by their action either on the water or immediately on the earth itself, may occasion great succussions.

3. The air may be the cause of earthquakes; for, the air being a collection of fumes and vapors raised from the earth and water, if it be pent up in too narrow viscera of the earth, the subterraneous or its own native heat rarefying and expanding it, the force wherewith it endeavours to escape may shake the earth; hence there arise divers species of earthquakes, according to the different position, quantity, &c., of the imprisoned *aura.*

Lastly, fire is a principal cause of earthquakes: both as it produces the aforesaid subterraneous *aura* or vapors; and as this *aura* or spirit, from the different matter and composition whereof arise sulphur, bitumen, and other inflammable matters, takes fire either from other fire it meets withal, or from its collision against hard bodies, or its intermixture with other fluids; by which means bursting out into a greater compass the place becomes too narrow for it, so that pressing against it on all sides the adjoining parts are shaken, till, having made itself a passage, it spends itself in a volcano or burning mountain.

But to come nearer to the point. Dr. Lister is of opinion that the material cause of thunder, lightning, and earthquakes is one and the same—viz., the inflammable breath of the pyrites, which is a substantial sulphur and takes fire of itself.

The difference between these three terrible phenomena he takes only to consist in this: that this sulphur, in the former, is fired in the air, and in the latter under ground. Which is a notion that Pliny had long before him; "*Quid enim,*" says he, "*aliud est in terrâ tremor, quam in nube tonitru?*"

This he thinks abundantly indicated by the same sulphurous smell being found in any thing burnt with lightning, and in the waters, &c., cast up in earthquakes, and even in the air before and after them.

Add that they agree in the manner of the noise, which is carried on as in a train fired; the one, rolling and rattling through the air, takes fire as the vapors chance to drive; as the other fired under ground, in like manner, moves with a desultory noise.

Thunder, which is the effect of the trembling of the air, caused by the same vapors dispersed through it, has force enough to shake our houses; and why there may not be thunder and lightning under ground, in some vast repositories there, I see no reason; especially if we reflect that the matter which composes the noisy vapor above us is in much larger quantities under ground.

That the earth abounds in cavities, everybody allows; and that these subterraneous cavities are, at certain times and in certain seasons, full of inflammable vapors, the damps in mines sufficiently witness, which fired do every thing as in an earthquake, save in a lesser degree.

Add that the pyrites alone, of all the known minerals, yields this inflammable vapor, is highly probable; for that no mineral or ore whatsoever is sulphurous, but as it is wholly, or in part, a pyrites; and that there is but one species of brimstone which the pyrites naturally and only yields. The *sulphur vive,* or natural brimstone, which is found in and about the burning mountains, is certainly the effects of sublimation; and those great quantities of it, said to be found about the skirts of volcanoes, is only an argument of the long duration and vehemence of those fires. Possibly the pyrites of the volcanoes or burning mountains may be more sulphurous than ours; and indeed it is plain that some of ours in England are very lean and hold but little sulphur; others again very much; which may be one reason why England is so little troubled with earthquakes, and Italy, and almost all round the Mediterranean Sea, so very much; though another reason is the paucity of pyrites in England.

Comparing our earthquakes, thunder, and lightning with theirs, it is observed that there it lightens almost daily, especially in summer-time; here seldom: there thunder and lightning is of long duration, here it is soon over: there the earthquakes are frequent, long, and terrible, with many paroxysms in a day, and that for many days; here very short, a few minutes, and scarce perceptible. To this purpose the subterraneous caverns in England are small and few compared to the vast vaults in those parts of the world; which is evident from the sudden disappearance of whole mountains and islands.

Dr. Woodward gives us another theory of earthquakes. He endeavours to show that the subterraneous heat or fire (which is continually elevating water out of the abyss to furnish the earth with rain, dew, springs, and rivers), being stopped in any part of the earth, and so diverted from its ordinary course by some accidental glut or obstruction in the pores or passages through which it used to ascend to the surface, becomes, by such means, preternaturally assembled in a greater quantity than usual into one place, and therefore causeth a great rarefaction and intumescence of the water of the abyss, putting it into great commotions and disorders, and at the same time making the like effort on the earth, which, being expanded upon the face of the abyss, occasions that agitation and concussion we call an earthquake.

This effort in some earthquakes, he observes, is so vehement that it splits and tears the earth, making cracks and chasms in it some miles in length, which open at the instant of the shock, and close again in the intervals betwixt them; nay, it is sometimes so violent that it forces the superincumbent strata, breaks them all throughout, and thereby perfectly undermines and ruins the foundation of them; so that, these falling, the whole tract, as soon as the shock is over, sinks down into the abyss and is swallowed up by it; the water thereof immediately rising up and forming a lake in the place where the said tract before was. That this effort being made in all directions indifferently, the fire, dilating and expanding on all hands, and endeavouring to get room and make its way through all obstacles, falls as foul on the waters of the abyss beneath as on the earth above, forcing it forth which way soever it can find vent or passage, as well through its ordinary exits, wells, springs, and the outlets of rivers, as through the chasms then newly opened, through the *camini* or spiracles of Ætna or other neighbouring volcanoes, and those hiatuses at the bottom of the sea, whereby the abyss below opens into it and communicates with it. That, as the water resident in the abyss is, in all parts of it, stored with a considerable quantity of heat, and more especially in those where those extraordinary aggregations of this fire happen, so likewise is the water which is thus forced out of it; insomuch that when thrown forth and mixed with the waters of wells or springs of rivers and the sea, it renders them very sensibly hot.

He adds that though the abyss be liable to those commotions, in all parts, yet the effects are nowhere very remarkable except in those countries which are mountainous, and consequently stony or cavernous underneath, and especially where the disposition of the strata is such that those caverns open into the abyss, and so freely admit and entertain the fire, which, assembling therein, is the cause of the shock; it naturally steering its course that way where it finds the readiest reception, which is towards those caverns. Besides, that those parts of the earth which abound with strata of stone or marble, making the strongest opposition to this effort, are the most furiously shattered and suffer much more by it than those which consist of gravel, sand, and the like laxer matter, which more easily give way and make not so great resistance. But, above all, those countries which yield great store of sulphur and nitre are by far the most injured by earthquakes; those minerals constituting in the earth a kind of natural gun-powder, which, taking fire upon this assemblage and approach of it, occasions that murmuring noise, that subterraneous thunder, which is heard rumbling in the bowels of the earth during earthquakes, and by the assistance of its explosive power renders the shock much greater, so as sometimes to make miserable havoc and destruction.

And it is for this reason that Italy, Sicily, Anatolia, and some parts of Greece have been so long and often alarmed and harassed by earthquakes; these countries being all mountainous and cavernous, abounding with stone and marble and affording sulphur and nitre in great plenty.

Further, that Ætna, Vesuvius, Hecla, and the other volcanoes are only so many spiracles, serving for the discharge of this subterraneous fire when it is thus preternaturally assembled. That where there happens to be such a structure and conformation of the interior parts of the earth, as that the fire may pass freely and without impediment from the caverns wherein it assembles unto those spiracles, it then readily gets out from time to time without shaking or disturbing the earth; but where such communication is wanting, or passage not sufficiently large and open, so that it cannot come at the spiracles, it heaves up and shocks the earth with greater or lesser impetuosity according to the quantity of fire thus assembled, till it has made its way to the mouth of the volcano. That therefore there are scarce any countries much annoyed by earthquakes but have one of these fiery vents, which are constantly in flames when any earthquake happens, as disgorging that fire which, whilst underneath, was the cause of the disaster. Lastly, that were it not for these *diverticula,* it would rage in the bowels of the earth much more furiously and make greater havoc than it doth.

We have seen what fire and water may do; and that either of them are sufficient for all the phenomena of earthquakes; if they should both fail, we have a third agent, scarce inferior to either of them; the reader must not be surprised when we tell him it is air.

Monsieur Amontons, in his *Mémoires de l'Académie des Sciences, An* 1703, has an express discourse to prove that on the foot of the new experiments of the weight and spring of the air, a moderate degree of heat may bring the air into a condition capable of causing earthquakes. It is shown that at the depth of 43,528 fathoms below the surface of the earth, air is only one fourth less heavy than mercury. Now this depth of 43,528 fathoms is only a seventy-fourth part of the semidiameter of the earth. And the vast sphere beyond this depth, in diameter 6,451,538 fathoms, may probably be only filled with air; which will be here greatly condensed and much heavier than the heaviest bodies we know in nature. But it is found by experiment that the more air is compressed, the more does the same degree of heat increase its spring, and the more capable does it render it of a violent effect; and that, for instance, the degree of heat of boiling water increases the spring of the air above what it has in its natural state, in our climate, by a quantity equal to a third of the weight wherewith it is pressed. Whence we may conclude that a degree of heat, which on the surface of the earth will only have a moderate effect, may be capable of a very violent one below. And, as we are assured, that there are in nature degrees of heat much more considerable than that of boiling water, it is very possible there may be some whose violence, further assisted by the exceeding weight of the air, may be more than sufficient to break and overturn this solid orb of 43,528 fathoms; whose weight, compared to that of the included air, would be but a trifle.

Chemistry furnishes us a method of making artificial earthquakes, which shall have all the great effects of natural ones; which, as it may illustrate the process of nature in the production of these terrible phenomena under ground, we shall here add.

To twenty pounds of iron filings, add as many of sulphur; mix, work, and temper the whole together with a little water, so as to form a mass half moist and half dry. This being buried three or four feet under ground, in six or seven hours time will have a prodigious effect; the earth will begin to tremble, crack, and smoke, and fire and flame burst through.

Such is the effect even of the two cold bodies, in cold ground; there only wants a sufficient quantity of this mixture to produce a true Ætna. If it were supposed to burst out under the sea, it would produce a spout; and if it were in the clouds, the effect would be thunder and lightning.

An earthquake is defined to be a vehement shake or agitation of some considerable place or part of the earth from natural causes, attended with a huge noise like thunder, and frequently with an eruption of water, or fire, or smoke, or winds, &c.

They are the greatest and most formidable phenomena of nature. Aristotle and Pliny distinguish two kinds, with respect to the manner of the shake—viz., a tremor and a pulsation: the first being horizontal, in alternate vibrations, compared to the shaking of a person in ague; the second, perpendicular, up and down, their motion resembling that of boiling.

Agricola increases the number, and makes four kinds; which Albertus Magnus again reduces to three—viz., inclination, when the earth vibrates alternately from right to left, by which mountains have been sometimes brought to meet and clash against each other; pulsation, when it beats up and down like an artery; and trembling, when it shakes and totters every way like a flame.

The *Philosophical Transactions* furnish us with abundance of histories of earthquakes; particularly one at Oxford, in 1665, by Dr. Wallis and Mr. Boyle. Another at the same place in 1683, by Mr. Pigot. Another in Sicily, in 1692-3, by Mr. Hartop, Father Alessandro Burgos, and Vin. Bonajutus, which last is one of the most terrible ones in all history.

It shook the whole island; and not only that, but Naples and Malta shared in the shock. It was of the second kind mentioned by Aristotle and Pliny—viz., a perpendicular pulsation or succussion. It was impossible, says the noble Bonajutus, for anybody in this country to keep on their legs on the dancing earth; nay, those that lay on the ground were tossed from side to side as on a rolling billow; high walls leaped from their foundations several paces.

The mischief it did is amazing; almost all the buildings in the countries were thrown down. Fifty-four cities and towns, besides an incredible number of villages, were either destroyed or greatly damaged. We shall only instance the fate of Catania, one of the most famous, ancient, and flourishing cities in the kingdom, the residence of several monarchs and a university. “This once famous, now unhappy Catania,” to use words of Father Burgos, “had the greatest share in the tragedy. Father Antonio Serovita, being on his way thither, and at the distance of a few miles, observed a black cloud like night hovering over the city; and there arose from the mouth of Mongibello great spires of flame, which spread all round. The sea all of a sudden began to roar and rise in billows; and there was a blow as if all the artillery in the world had been at once discharged. The birds flew about astonished, the cattle in the fields ran crying, &c. His and his companion’s horse stopped short, trembling; so that they were forced to alight. They were no sooner off, but they were lifted from the ground above two palms. When casting his eyes towards Catania, he with amazement saw nothing but a thick cloud of dust in the air. This was the scene of their calamity; for of the magnificent Catania there is not the least footstep to be seen.” Bonajutus assures us that of 18,914 inhabitants 18,000 perished therein. The same author, from a computation of the inhabitants before and after the earthquake, in the several cities and towns, finds that near 60,000 perished out of 254,900.

Jamaica is remarkable for earthquakes. The inhabitants, Dr. Sloane informs us, expect one every year. That author gives us the history of one in 1687; another horrible one, in 1692, is described by several anonymous authors. In two minutes time it shook down and drowned nine tenths of the town of Port Royal. The houses sunk outright thirty or forty fathoms deep. The earth opening swallowed up people, and they rose in other streets; some in the middle of the harbour, and yet were saved; though there were two thousand people lost and one thousand acres of land sunk. All the houses were thrown down throughout the island. One Hopkins had his plantation removed half a mile from its place. Of all wells, from one fathom to six or seven, the water flew out at the top with a vehement motion. While the houses on the one side of the street were swallowed up, on the other they were thrown on heaps; and the sand in the street rose like waves in the sea, lifting up everybody that stood on it, and immediately dropping down into pits; and at the same instant a flood of waters breaking in rolled them over and over; some catching hold of beams and rafters, &c. Ships and sloops in the harbour were overset and lost; the *Swan* frigate particularly, by the motion of the sea, and sinking of the wharf, was driven over the tops of many houses.

It was attended with a hollow rumbling noise like that of thunder. In less than a minute three quarters of the houses, and the ground they stood on, with the inhabitants, were all sunk quite under water; and the little pile left behind was no better than a heap of rubbish. The shake was so violent that it threw people down on their knees or their faces, as they were running about for shelter. The ground heaved and swelled like a rolling sea, and several houses still standing were shuffled and moved some yards out of their places. A whole street is said to be twice as broad now as before; and in many places the earth would crack, and open, and shut, quick and fast. Of which openings, two or three hundred might be seen at a time; in some whereof the people were swallowed up; others the closing earth caught by the middle and pressed to death; in others the heads only appeared. The larger openings swallowed up houses; and out of some would issue whole rivers of water spouted up a great height into the air, and threatening a deluge to that part the earthquake spared. The whole was attended with stenches and offensive smells, the noise of falling mountains at a distance, &c., and the sky in a minute's time was turned dull and reddish, like a glowing oven. Yet as great a sufferer as Port Royal was, more houses were left standing therein than on the whole island beside. Scarce a planting-house or sugar-work was left standing in all Jamaica. A great part of them were swallowed up, houses, people, trees, and all at one gape; in lieu of which afterwards appeared great pools of water, which when dried up left nothing but sand, without any mark that ever tree or plant had been thereon.

About twelve miles from the sea, the earth gaped and spouted out with a prodigious force vast quantities of water into the air; yet the greatest violences were among the mountains and rocks; and it is a general opinion that the nearer the mountains the greater the shake; and that the cause thereof lay there. Most of the rivers were stopped up for twenty-four hours by the falling of the mountains, till, swelling up, they found themselves new tracts and channels, tearing up in their passage trees, &c. After the great shake, those people who escaped got on board ships in the harbour, where many continued above two months; the shakes all that time being so violent, and coming so thick, sometimes two or three in an hour, accompanied with frightful noises, like a ruffling wind, or a hollow, rumbling thunder, with brimstone blasts, that they durst not come ashore. The consequence of the earthquake was a general sickness, from the noisome vapors belched forth, which swept away above three thousand persons.

After the detail of these horrible convulsions, the reader will have but little curiosity left for the less considerable phenomena of the earthquake at Lima, in 1687, described by Father Alvarez de Toledo, wherein above five thousand persons were destroyed; this being of the vibratory kind, so that the bells in the church rung of themselves; or that at Batavia in 1699, by Witsen; that in the north of England in 1703, by Mr. Thoresby; or, lastly, those in New England in 1663 and 1670, by Dr. Mather.

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XXIV

TO JOSIAH FRANKLIN

Philadelphia, 13 April, 1738.

Honored Father:

I have your favors of the 21st of March, in which you both seem concerned lest I have imbibed some erroneous opinions. Doubtless I have my share; and when the natural weakness and imperfection of human understanding is considered, the unavoidable influence of education, custom, books, and company upon our ways of thinking, I imagine a man must have a good deal of vanity who believes, and a good deal of boldness who affirms, that all the doctrines he holds are true, and all he rejects are false. And perhaps the same may be justly said of every sect, church, and society of men, when they assume to themselves that infallibility which they deny to the Pope and councils.

I think opinions should be judged of by their influences and effects; and if a man holds none that tend to make him less virtuous or more vicious, it may be concluded he holds none that are dangerous; which I hope is the case with me.

I am sorry you should have any uneasiness on my account; and if it were a thing possible for one to alter his opinions in order to please another, I know none whom I ought more willingly to oblige in that respect than yourselves. But since it is no more in a man's power to *think* than to *look* like another, methinks all that should be expected from me is to keep my mind open to conviction, to hear patiently and examine attentively whatever is offered me for that end; and if after all I continue in the same errors, I believe your usual charity will induce you to rather pity and excuse, than blame me. In the mean time your care and concern for me is what I am very thankful for.

My mother grieves that one of her sons is an Arian, another an Arminian. What an Arminian or an Arian is, I cannot say that I very well know. The truth is I make such distinctions very little my study. I think vital religion has always suffered when orthodoxy is more regarded than virtue; and the Scriptures assure me that at the last day we shall not be examined what we *thought,* but what we *did;* and our recommendation will not be that we said, *Lord! Lord!* but that we did good to our fellow-creatures. See Matt. xxv.

As to the freemasons, I know no way of giving my mother a better account of them than she seems to have at present, since it is not allowed that women should be admitted into that secret society. She has, I must confess, on that account some reason to be displeased with it; but for any thing else I must entreat her to suspend her judgment till she is better informed, unless she will believe me when I assure her that they are in general a very harmless sort of people, and have no principles or practices that are inconsistent with religion and good manners.

We have had great rains here lately, which, with the thawing of snow on the mountains back of our country, have made vast floods in our rivers, and, by carrying away bridges, boats, &c., made travelling almost impracticable for a week past; so that our post has entirely missed making one trip.

I hear nothing of Dr. Crook, nor can I learn any such person has ever been here.

I hope my sister Jenny’s child is by this time recovered, I am your dutiful son.

B. Franklin.

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XXV

TO MRS. JANE MECOM

Philadelphia, 28 July, 1743.

Dearest Sister Jenny:

I took your admonition very kindly, and was far from being offended at you for it. If I say any thing about it to you, it is only to rectify some wrong opinions you seem to have entertained of me; and this I do only because they give you some uneasiness, which I am unwilling to be the occasion of. You express yourself as if you thought I was against the worshipping of God, and doubt that good works would merit heaven; which are both fancies of your own, I think, without foundation. I am so far from thinking that God is not to be worshipped, that I have composed and wrote a whole book of devotions for my own use; and I imagine there are few if any in the world so weak as to imagine that the little good we can do here can merit so vast a reward hereafter.

There are some things in your New England doctrine and worship, which I do not agree with; but I do not therefore condemn them, or desire to shake your belief or practice of them. We may dislike things that are nevertheless right in themselves. I would only have you make me the same allowance, and have a better opinion both of morality and your brother. Read the pages of Mr. Edwards's late book, entitled *Some Thoughts concerning the Present Revival of Religion in New England,* from 367 to 375, and when you judge of others, if you can perceive the fruit to be good, don't terrify yourself that the tree may be evil; but be assured it is not so, for you know who has said, "Men do not gather grapes of thorns and figs of thistles."

I have no time to add but that I shall always be your affectionate brother,

B. Franklin.

P. S.—It was not kind in you, when your sister commended your good works, to suppose she intended it a reproach to you. It was very far from her thoughts.

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XXVI

A PROPOSAL

for promoting useful knowledge among the british plantations in america[1]

Philadelphia, 14 May, 1743.

The English are possessed of a long tract of continent, from Nova Scotia to Georgia, extending north and south through different climates, having different soils, producing different plants, mines, and minerals, and capable of different improvements, manufactures, &c.

The first drudgery of settling new colonies, which confines the attention of people to mere necessaries, is now pretty well over; and there are many in every province in circumstances that set them at ease, and afford leisure to cultivate the finer arts and improve the common stock of knowledge. To such of these who are men of speculation many hints must from time to time arise, many observations occur, which, if well examined, pursued, and improved, might produce discoveries to the advantage of some or all of the British plantations or to the benefit of mankind in general.

But as from the extent of the country such persons are widely separated, and seldom can see and converse or be acquainted with each other, so that many useful particulars remain uncommunicated, die with the discoverers, and are lost to mankind; it is, to remedy this inconvenience for the future, proposed:

That one society be formed of *virtuosi* or ingenious men residing in the several colonies, to be called *The American Philosophical Society,* who are to maintain a constant correspondence.

That Philadelphia, being the city nearest the centre of the continent colonies, communicating with all of them northward and southward by post, and with all the islands by sea, and having the advantage of a good growing library, be the centre of the Society.

That at Philadelphia there be always at least seven members, viz., a physician, a botanist, a mathematician, a chemist, a mechanician, a geographer, and a general natural philosopher, besides a president, treasurer, and secretary.

That these members meet once a month or oftener, at their own expense, to communicate to each other their observations and experiments; to receive, read, and consider such letters, communications, or queries as shall be sent from distant members; to direct the dispersing of copies of such communications as are valuable, to other distant members, in order to procure their sentiments thereupon.

That the subjects of the correspondence be: all new-discovered plants, herbs, trees, roots, their virtues, uses, &c.; methods of propagating them, and making such as are useful, but particular to some plantations, more general; improvements of vegetable juices, as ciders, wines, &c.; new methods of curing or preventing diseases; all new-discovered fossils in different countries, as mines, minerals, and quarries; new and useful improvements in any branch of mathematics; new discoveries in chemistry, such as improvements in distillation, brewing, and assaying of ores; new mechanical inventions for saving labor, as mills and carriages, and for raising and conveying of water, draining of meadows, &c.; all new arts, trades, and manufactures that may be proposed or thought of; surveys, maps, and charts of particular parts of the sea-coasts or inland countries; course and junction of rivers and great roads, situation of lakes and mountains, nature of the soil and productions; new methods of improving the breed of useful animals; introducing other sorts from foreign countries; new improvements in planting, gardening, and clearing land; and all philosophical experiments that let light into the nature of things, tend to increase the power of man over matter and multiply the conveniences or pleasures of life.

That a correspondence already begun by some intended members shall be kept up by this Society with the Royal Society of London and with the Dublin Society.

That every member shall have abstracts sent him quarterly of every thing valuable communicated to the Society's Secretary at Philadelphia, free of all charge, except the yearly payment hereafter mentioned.

That, by permission of the postmaster-general, such communications pass between the Secretary of the Society and the members, postage-free.

That, for defraying the expense of such experiments as the Society shall judge proper to cause to be made, and other contingent charges for the common good, every member send a piece of eight per annum to the treasurer, at Philadelphia, to form a common stock, to be disbursed by order of the President, with the consent of the majority of the members that can conveniently be consulted thereupon, to such persons and places where and by whom the experiments are to be made, and otherwise as there shall be occasion; of which disbursements an exact account shall be kept, and communicated yearly to every member.

That, at the first meetings of the members at Philadelphia, such rules be formed for regulating their meetings and transactions for the general benefit as shall be convenient and necessary; to be afterwards changed and improved as there shall be occasion, wherein due regard is to be had to the advice of distant members.

That, at the end of every year, collections be made and printed of such experiments, discoveries, and improvements as may be thought of public advantage; and that every member have a copy sent him.

That the business and duty of the Secretary be to receive all letters intended for the Society, and lay them before the President and members at their meetings; to abstract, correct, and methodize such papers as require it, and as he shall be directed to do by the President, after they have been considered, debated, and digested in the Society; to enter copies thereof in the Society's books, and make out copies for distant members; to answer their letters by direction of the President; and keep records of all material transactions of the Society.

Benjamin Franklin, the writer of this Proposal, offers himself to serve the Society as their secretary, till they shall be provided with one more capable.

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XXVII

TO CADWALLADER COLDEN[1]

Philadelphia, 4 November, 1743.

Sir:—

I received the favor of yours with the proposal for a new method of printing, which I am much pleased with; and since you express some confidence in my opinion, I shall consider it very attentively and particularly, and in a post or two send you some observations on every article.

My long absence from home in the summer put my business so much behindhand that I have been in a continual hurry ever since my return, and had no leisure to forward the scheme of the Society. But that hurry being now near over, I purpose to proceed in the affair very soon, your approbation being no small encouragement to me.

I cannot but be fond of engaging in a correspondence so advantageous to me as yours must be. I shall always receive your favors as such, and with great pleasure.

I wish I could by any means have made your son's longer stay here as agreeable to him as it would have been to those who began to be acquainted with him. I am, Sir, with much respect,

Your Most Humble Servant,

B. Franklin.

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XXVIII

TO EDWARD AND JANE MECOM

Philadelphia [date uncertain].

Dear Brother And Sister:

If you still continue your inclination to send Benny,[1] you may do it by the first vessel to New York. Write a line by him, directed to Mr. James Parker, Printer, on Hunter's Key, New York. I am confident he will be kindly used there, and I shall hear from him every week. You will advise him to be very cheerful, and ready to do every thing he is bid, and endeavour to oblige everybody, for that is the true way to get friends.

Dear Sister, I love you tenderly for your care of our father in his sickness. I am, in great haste, your loving brother,

B. Franklin.

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XXIX

TO MRS. JANE MECOM

Philadelphia [date uncertain].

Dear Sister:

I received your letter, with one for Benny, and one for Mr. Parker, and also two of Benny's letters of complaint, which, as you observe, do not amount to much. I should have had a very bad opinion of him if he had written to you those accusations of his master which you mention, because, from long acquaintance with his master, who lived some years in my house, I know him to be a sober, pious, and conscientious man, so that Newport, to whom you seem to have given too much credit, must have wronged Mr. Parker very much in his accounts, and have wronged Benny too, if he says Benny told him such things, for I am confident he never did.

As to the bad attendance afforded him in the smallpox, I believe, if the negro woman did not do her duty, her master or mistress would, if they had known it, have had that matter mended. But Mrs. Parker was herself, if I am not mistaken, sick at that time, and her child also. And though he gives the woman a bad character in general, all he charges her with in particular is, that she never brought him what he called for directly, and sometimes not at all. He had the distemper favorably, and yet I suppose was bad enough to be, like other sick people, a little impatient, and perhaps might think a short time long, and sometimes call for things not proper for one in his condition.

As to clothes, I am frequently at New York, and I never saw him unprovided with what was good, decent, and sufficient. I was there no longer ago than March last, and he was then well clothed and made no complaint to me of any kind. I heard both his master and mistress call upon him on Sunday morning to get ready to go to meeting, and tell him of his frequently delaying and shuffling till it was too late, and he made not the least objection about clothes. I did not think it any thing extraordinary that he should be sometimes willing to evade going to meeting, for I believe it is the case with all boys, or almost all. I have brought up four or five myself, and have frequently observed that if their shoes were bad they would say nothing of a new pair till Sunday morning, just as the bell rung, when, if you asked them why they did not get ready, the answer was prepared, "I have no shoes," and so of other things, hats and the like; or, if they knew of any thing that wanted mending, it was a secret till Sunday morning, and sometimes I believe they would rather tear a little than be without the excuse.

As to going on petty errands, no boys love it, but all must do it. As soon as they become fit for better business they naturally get rid of that, for the master's interest comes in to their relief. I make no doubt but Mr. Parker will take another apprentice as soon as he can meet with a likely one. In the mean time I should be glad if Benny would exercise a little patience. There is a negro woman that does a great many of those errands.

I do not think his going on board the privateer arose from any difference between him and his master, or any ill usage he had received. When boys see prizes brought in and quantities of money shared among the men, and their gay living, it fills their heads with notions that half distract them and put them quite out of conceit with trades and the dull ways of getting money by working. This I suppose was Ben's case, the *Catherine* being just before arrived with three rich prizes, and that the glory of having taken a privateer of the enemy, for which both officers and men were highly extolled, treated, presented, &c., worked strongly upon his imagination, you will see, by his answer to my letter, is not unlikely. I send it to you enclosed. I wrote him largely on the occasion; and, though he might possibly, to excuse that slip to others, complain of his place, you may see he says not a syllable of any such thing to me. My only son, before I permitted him to go to Albany, left my house unknown to us all and got on board a privateer, from whence I fetched him. No one imagined it was hard usage at home that made him do this. Every one that knows me thinks I am too indulgent a parent as well as master.

I shall tire you, perhaps, with the length of this letter; but I am the more particular, in order, if possible, to satisfy your mind about your son's situation. His master has, by a letter this post, desired me to write to him about his staying out of nights, sometimes all night, and refusing to give an account where he spends his time, or in what company. This I had not heard of before, though I perceive you have. I do not wonder at his correcting him for that. If he was my own son I should think his master did not do his duty by him if he omitted it, for to be sure it is the high road to destruction. And I think the correction very light, and not likely to be very effectual, if the strokes left no marks.

His master says farther, as follows: "I think I cannot charge my conscience with being much short of my duty to him. I shall now desire you, if you have not done it already, to invite him to lay his complaints before you, that I may know how to remedy them." Thus far the words of his letter, which giving me a fair opening to inquire into the affair, I shall accordingly do it, and I hope settle every thing to all your satisfactions. In the mean time I have laid by your letters both to Mr. Parker and Benny, and shall not send them till I hear again from you; because I think your appearing to give ear to such groundless stories may give offence and create a greater misunderstanding, and because I think what you write to Benny about getting him discharged may tend to unsettle his mind, and therefore improper at this time.

I have a very good opinion of Benny in the main, and have great hopes of his becoming a worthy man, his faults being only such as are commonly incident to boys of his years, and he has many good qualities, for which I love him. I never knew an apprentice contented with the clothes allowed him by his master, let them be what they would. Jemmy Franklin, when with me, was always dissatisfied and grumbling. When I was last in Boston, his aunt bid him go to a shop and please himself, which the gentleman did, and bought a suit of clothes on my account dearer by one half than any I ever afforded myself, one suit excepted; which I don't mention by way of complaint of Jemmy, for he and I are good friends, but only to show you the nature of boys.

The letters to Mr. Vanhorne were sent by Mr. Whitefield, under my cover.

I am, with love to brother and all yours, and duty to mother, to whom I have not time now to write, your affectionate brother,

B. Franklin.

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XXX

AN ACCOUNT OF THE NEW-INVENTED PENNSYLVANIAN FIRE-PLACES[1] ;

wherein

their construction and manner of operation is particularly explained; their advantages above every other method of warming rooms demonstrated; and all objections that have been raised against the use of them answered and obviated. with directions for putting them up, and for using them to the best advantage. and a copper-plate in which the several parts of the machine are exactly laid down, from a scale of equal parts.

PHILADELPHIA;

printed and sold by b. franklin, 1744.

In these northern colonies the inhabitants keep fires to sit by generally seven months in the year; that is, from the beginning of October to the end of April, and, in some winters, near eight months, by taking in part of September and May.

Wood, our common fuel, which within these hundred years might be had at any man’s door, must now be fetched near one hundred miles to some towns, and makes a very considerable article in the expense of families.

As therefore so much of the comfort and conveniency of our lives, for so great a part of the year, depends on the article of *fire;* since fuel is become so expensive, and, as the country is more cleared and settled, will of course grow scarcer and dearer, any new proposal for saving the wood, and for lessening the charge and augmenting the benefit of fire, by some particular method of making and managing it, may at least be thought worth consideration.

The new fire-places are a late invention to that purpose, of which this paper is intended to give a particular account.

That the reader may the better judge, whether this method of managing fire has any advantage over those heretofore in use, it may be proper to consider both the old and new methods, separately and particularly, and afterwards make the comparison.

In order to do this it is necessary to understand well some few of the properties of air and fire, viz.:

1. Air is rarefied by *heat,* and condensed by *cold;* that is, the same quantity of air takes up more space when warm than when cold. This may be shown by several very easy experiments. Take any clear glass bottle (a Florence flask stript of the straw is best), place it before the fire, and, as the air within is warmed and rarefied, part of it will be driven out of the bottle; turn it up, place its mouth in a vessel of water, and remove it from the fire; then, as the air within cools and contracts, you will see the water rise in the neck of the bottle, supplying the place of just so much air as was driven out. Hold a large hot coal near the side of the bottle, and, as the air within feels the heat, it will again distend and force out the water. Or, fill a bladder not quite full of air, tie the neck tight, and lay it before a fire as near as may be without scorching the bladder; as the air within heats, you will perceive it to swell and fill the bladder, till it becomes tight, as if full blown; remove it to a cool place, and you will see it fall gradually, till it becomes as lank as at first.

2. Air rarefied and distended by heat is specifically[1] lighter than it was before, and will rise in other air of greater density. As wood, oil, or any other matter specifically lighter than water, if placed at the bottom of a vessel of water, will rise till it comes to the top, so rarefied air will rise in common air, till it either comes to air of equal weight or is by cold reduced to its former density.

A fire, then, being made in any chimney, the air over the fire is rarefied by the heat, becomes lighter, and therefore immediately rises in the funnel, and goes out; the other air in the room (flowing towards the chimney) supplies its place, is rarefied in its turn, and rises likewise; the place of the air thus carried out of the room is supplied by fresh air coming in through doors and windows, or, if they be shut, through every crevice with violence, as may be seen by holding a candle to a key-hole. If the room be so tight as that all the crevices together will not supply so much air as is continually carried off, then, in a little time, the current up the funnel must flag, and the smoke, being no longer driven up, must come into the room.

1. Fire (that is, common fire) throws out light, heat, and smoke (or fume). The two first move in right lines, and with great swiftness; the latter is but just separated from the fuel, and then moves only as it is carried by the stream of rarefied air, and without a continual accession and recession of air to carry off the smoky fumes, they would remain crowded about the fire and stifle it.

2. Heat may be separated from the smoke, as well as from the light, by means of a plate of iron, which will suffer heat to pass through it without the others.

3. Fire sends out its rays of heat, as well as rays of light, equally every way; but the greatest sensible heat is over the fire, where there is, besides the rays of heat shot upwards, a continual rising stream of hot air, heated by the rays shot round on every side.

These things being understood, we proceed to consider the fire-places heretofore in use, viz.:

1. The large open fire-places used in the days of our fathers, and still generally in the country, and in kitchens.

2. The newer-fashioned fire-places, with low breasts and narrow hearths.

3. Fire-places with hollow backs, hearths and jambs of iron (described by M. Gauger in his tract entitled *La Méchanique de Feu*), for warming the air as it comes into the room.

4. The Holland stoves, with iron doors opening into the room.

5. The German stoves, which have no opening in the room where they are used, but the fire is put in from some other room, or from without.

6. Iron pots, with open charcoal fires, placed in the middle of a room.

1. The first of these methods has generally the conveniency of two warm seats, one in each corner; but they are sometimes too hot to abide in, and, at other times, incommoded with the smoke; there is likewise good room for the cook to move, to hang on pots, &c. Their inconveniences are that they almost always smoke, if the door be not left open; that they require a large funnel, and a large funnel carries off a great quantity of air, which occasions what is called a strong draft to the chimney, without which strong draft the smoke would come out of some part or other of so large an opening, so that the door can seldom be shut; and the cold air so nips the backs and heels of those that sit before the fire, that they have no comfort till either screens or settles are provided (at a considerable expense) to keep it off, which both cumber the room and darken the fireside. A moderate quantity of wood on the fire in so large a hearth seems but little, and in so strong and cold a draft warms but little; so that people are continually laying on more. In short, it is next to impossible to warm a room with such a fire-place; and I suppose our ancestors never thought of warming rooms to sit in; all

they purposed was to have a place to make a fire in, by which they might warm themselves when cold.

2. Most of these old-fashioned chimneys in towns and cities have been, of late years, reduced to the second sort mentioned, by building jambs within them, narrowing the hearth, and making a low arch or breast. It is strange, methinks, that though chimneys have been so long in use, their construction should be so little understood till lately, that no workman pretended to make one which should always carry off all smoke, but a chimney-cloth was looked upon as essential to a chimney. This improvement, however, by small openings and low breasts, has been made in our days; and success in the first experiments has brought it into general use in cities, so that almost all new chimneys are now made of that sort, and much fewer bricks will make a stack of chimneys now than formerly. An improvement so lately made may give us room to believe that still farther improvements may be found to remedy the inconveniences yet remaining. For these new chimneys, though they keep rooms generally free from smoke, and, the opening being contracted, will allow the door to be shut, yet, the funnel still requiring a considerable quantity of air, it rushes in at every crevice so strongly as to make a continual whistling or howling; and it is very uncomfortable, as well as dangerous, to sit against any such crevice. Many colds are caught from this cause only, it being safer to sit in the open street; for then the pores do all close together, and the air does not strike so sharply against any particular part of the body.

The Spaniards have a proverbial saying:

> If the wind blows on you through a hole,
> Make your will, and take care of your soul.

Women particularly, from this cause, as they sit much in the house, get colds in the head, rheums, and defluctions, which fall into their jaws and gums and have destroyed early many a fine set of teeth in these northern colonies. Great and bright fires do also very much contribute to damage the eyes, dry and shrivel the skin, and bring on early the appearances of old age. In short, many of the diseases proceeding from colds, as fevers, pleurisies, &c., fatal to very great numbers of people, may be ascribed to strong-drawing chimneys, whereby, in severe weather, a man is scorched before, while he is froze behind.[1] In the mean time very little is done by these chimneys towards warming the room; for the air round the fire-place, which is warmed by the direct rays from the fire, does not continue in the room, but is continually crowded and gathered into the chimney by the current of cold air coming behind it, and so is presently carried off.

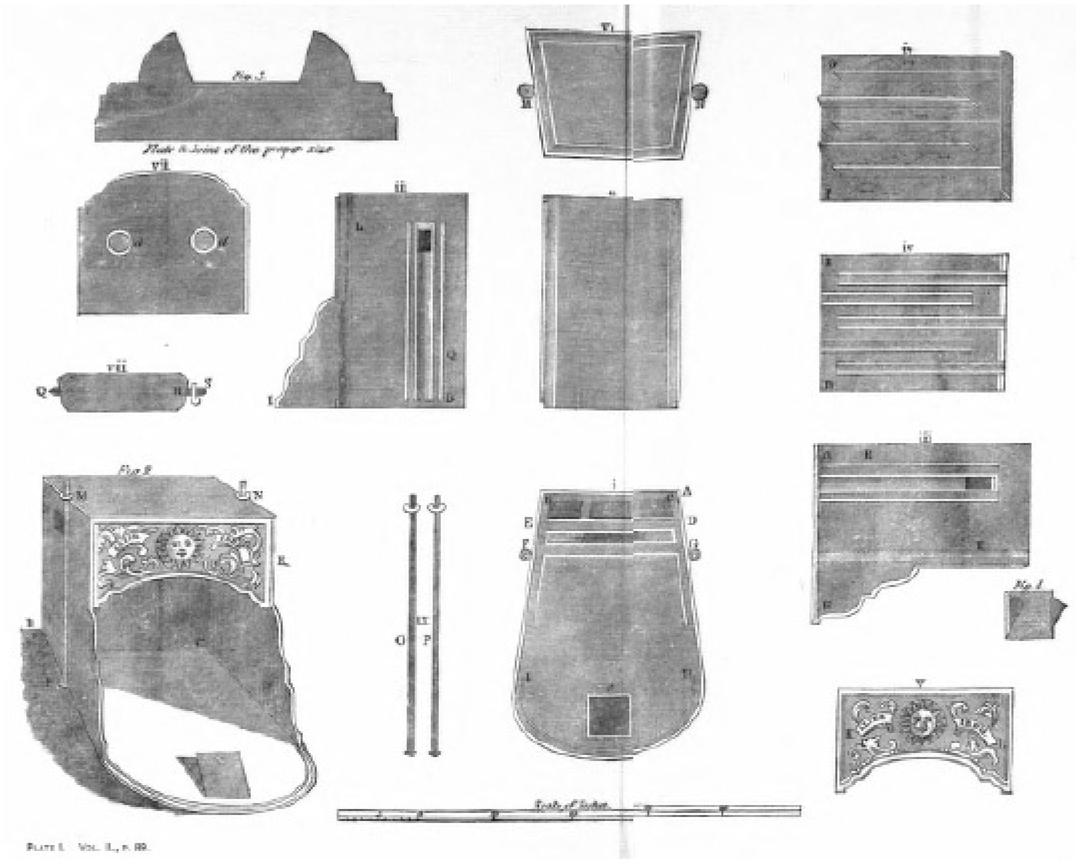
In both these sorts of fire-places, the greatest part of the heat from the fire is lost; for, as fire naturally darts heat every way, the back, the two jambs, and the hearth drink up almost all that is given them, very little being reflected from bodies so dark, porous, and unpolished; and the upright heat, which is by far the greatest, flies directly up the chimney. Thus five sixths at least of the heat (and consequently of the fuel) is wasted, and contributes nothing towards warming the room.

3. To remedy this the Sieur Gauger gives, in his book entitled *La Méchanique de Feu,* published in 1709, seven different constructions of the third sort of chimneys mentioned above, in which there are hollow cavities, made by iron plates in the back, jambs, and hearths, through which plates the heat passing warms the air in those cavities, which is continually coming into the room fresh and warm. The invention was very ingenious, and had many conveniences; the room was warmed in all parts, by the air flowing through the heated cavities; cold air was prevented rushing through the crevices, the funnel being sufficiently supplied by those cavities; much less fuel would serve, &c. But the first expense, which was very great, the intricacy of the design, and the difficulty of execution, especially in old chimneys, discouraged the propagation of the invention; so that there are, I suppose, very few such chimneys now in use. The upright heat, too, was almost all lost in these, as in the common chimneys.

4. The Holland iron stove, which has a flue proceeding from the top, and a small iron door opening into the room, comes next to be considered. Its conveniences are, that it makes a room all over warm; for, the chimney being wholly closed except the flue of the stove, very little air is required to supply that, and therefore not much rushes in at crevices, or at the door when it is opened. Little fuel serves, the heat being almost all saved; for it rays out almost equally from the four sides, the bottom, and the top, into the room, and presently warms the air around it, which, being rarefied, rises to the ceiling, and its place is supplied by the lower air of the room, which flows gradually towards the stove, and is there warmed, and rises in its turn, so that there is a continual circulation till all the air in the room is warmed. The air, too, is gradually changed by the stove-door's being in the room, through which part of it is continually passing, and that makes these stoves wholesomer or at least pleasanter than the German stoves, next to be spoken of. But they have these inconveniences. There is no sight of the fire, which is in itself a pleasant thing. One cannot conveniently make any other use of the fire but that of warming the room. When the room is warm, people, not seeing the fire, are apt to forget supplying it with fuel till it is almost out, then, growing cold, a great deal of wood is put in, which soon makes it too hot. The change of air is

not carried on quite quick enough; so that, if any smoke or ill smell happens in the room, it is a long time before it is discharged. For these reasons the Holland stove has not obtained much among the English (who love the sight of the fire) unless in some workshops, where people are obliged to sit near windows for the light, and in such places they have been found of good use.

5. The German stove is like a box, one side wanting. It is composed of five iron plates, screwed together, and fixed so as that you may put the fuel into it from another room, or from the outside of the house. It is a kind of oven reversed, its mouth being without, and body within, the room that is to be warmed by it. This invention certainly warms a room very speedily and thoroughly with little fuel; no quantity of cold air comes in at any crevice, because there is no discharge of air which it might supply, there being no passage into the stove from the room. These are its conveniences. Its inconveniences are, that people have not even so much sight or use of the fire as in the Holland stoves, and are, moreover, obliged to breathe the same unchanged air continually, mixed with the breath and perspiration from one another's bodies, which is very disagreeable to those who have not been accustomed to it.



6. Charcoal fires in pots are used chiefly in the shops of handicraftsmen. They warm a room (that is kept close, and has no chimney to carry off the warmed air) very speedily and uniformly;

but, there being no draft to change the air, the sulphurous fumes from the coals (be they ever so well kindled before they are brought in, there will be some) mix with it, render it disagreeable, hurtful to some constitutions, and sometimes, when the door is long kept shut, produce fatal consequences.

To avoid the several inconveniences, and at the same time retain all the advantages of other fire-places, was contrived the Pennsylvanian Fire-place, now to be described.

This machine consists of:

A bottom plate (i.). (See Plate I.)

A back plate (ii.).

Two side plates (iii., iii.).

Two middle plates (iv., iv.), which, joined together, form a tight box with winding passages in it for warming the air.

A front plate (v.).

A top plate (vi.).

These are all cast of iron, with mouldings or ledges where the plates come together, to hold them fast and retain the mortar used for pointing to make tight joints. When the plates are all in their places a pair of slender rods, with screws, are sufficient to bind the whole very firmly together, as it appears in Figure 2.

There are, moreover, two thin plates of wrought iron, viz., the shutter (vii.), and the register (viii.), besides the screw-rods, *O, P,* all which we shall explain in their order.

(i.) The bottom plate or hearth-piece is round before, with a rising moulding that serves as a fender to keep coals and ashes from coming to the floor, &c. It has two ears *F, G,* perforated to receive the screw-rods *O, P;* a long air-hole *a a,* through which the fresh outward air passes up into the air-box; and three smoke-holes *B, C,* through which the smoke descends and passes away, all represented by dark squares. It has also double ledges to receive between them the bottom edges of the back plate, the two side plates, and the two middle plates. These ledges are about an inch asunder and about half an inch high; a profile of two of them, joined to a fragment of plate, appears in Figure 3.

(ii.) The back plate is without holes, having only a pair of ledges on each side to receive the back edges of the two (iii., iii.) Side plates; these have each a pair of ledges to receive the side edges of the front plate, and a little shoulder for it to rest on; also two pair of ledges to receive the side edges of the two middle plates, which form the air-box; and an oblong air-hole near the top through which is discharged into the room the air warmed in the air-box. Each has also a wing or bracket, *H* and *I,* to keep in falling brands, coals, &c., and a small hole, *Q* and *R,* for the axis of the register to turn in.

(iv., iv.) The air-box is composed of the two middle plates *D, E* and *F, G.* The first have five thin ledges or partitions cast on it two inches deep, the edges of which are received in so many pair of ledges cast in the other. The tops of all the cavities formed by these thin, deep ledges are also covered by a ledge of the same form and depth cast with them, so that when the plates are put together and the joints luted there is no communication between the air-box and the smoke. In the winding passages of this box fresh air is warmed as it passes into the room.

(v.) The front plate is arched on the under side, and ornamented with foliages, &c.; it has no ledges.

(vi.) The top plate has a pair of ears, *M, N,* answerable to those in the bottom plate, and perforated for the same purpose; it has also a pair of ledges running round the under side to receive the top edges of the front, back, and side plates. The air-box does not reach up to the top plate by two inches and a half.

(vii.) The shutter is of thin wrought iron and light, of such a length and breadth as to close well the opening of the fire-place. It is used to blow up the fire, and to shut up and secure it at nights. It has two brass knobs for handles, *d, d,* and commonly slides up and down in a groove left, in putting up the fire-place, between the foremost ledge of the side plates and the face of the front plate; but some choose to set it aside when it is not in use, and apply it on occasion.

(viii.) The register is also of thin wrought iron. It is placed between the back plate and air-box, and can, by means of the key *S,* be turned on its axis so as to lie in any position between level and upright.

The screw-rods, *O, P,* are of wrought iron, about a third of an inch thick, with a button at bottom, and a screw and nut at top, and may be ornamented with two small brasses screwed on above the nuts.

To put this machine to work:

1. A false back of four-inch (or, in shallow small chimneys two-inch) brick work is to be made in the chimney, four inches or more from the true back; from the top of this false back a closing is to be made over to the breast of the chimney, that no air may pass into the chimney but what goes under the false back and up behind it.

2. Some bricks of the hearth are to be taken up, to form a hollow under the bottom plate; across which hollow runs a thin, tight partition, to keep apart the air entering the hollow and the smoke; and is therefore placed between the air-hole and smoke-holes.

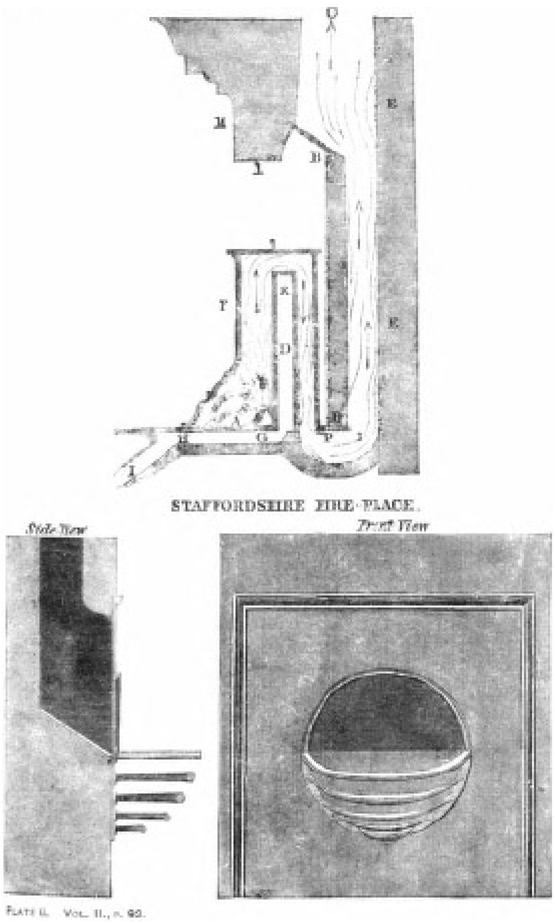
3. A passage is made, communicating with the outward air, to introduce that air into the fore part of the hollow under the bottom plate, whence it may rise through the air-hole into the air-box.

4. A passage is made from the back part of the hollow, communicating with the flue behind the false back; through this passage the smoke is to pass.

The fire-place is to be erected upon these hollows, by putting all the plates in their places, and screwing them together.

Its operation may be conceived by observing the plate entitled, *Profile of the Chimney and Fire-place.* (See Plate II.)

M The mantel-piece, or breast of the chimney.



PROFILE OF THE PENNSYLVANIA CHIMNEY AND FIRE-PLACE.

C The funnel.

B The false back and closing.

E True back of the chimney.

T Top of the fire-place.

F The front of it.

A The place where the fire is made.

D The air-box.

K The hole in the side plate, through which the warmed air is discharged out of the air-box into the room.

H The hollow filled with fresh air, entering at the passage *I,* and ascending into the air-box through the air-hole in the bottom-plate, near

G The partition in the hollow to keep the air and smoke apart.

P The passage under the false back and part of the hearth for the smoke.

The arrows show the course of the smoke.

The fire being made at *A,* the flame and smoke will ascend and strike the top *T,* which will thereby receive a considerable heat. The smoke, finding no passage upwards, turns over the top of the air-box, and descends between it and the back plate to the holes in the bottom plate, heating, as it passes, both plates of the air-box, and the said back plate; the front, bottom, and side plates are also all heated at the same time. The smoke proceeds in the passage that leads it under and behind the false back, and so rises into the chimney. The air of the room, warmed behind the back plate, and by the sides, front, and top plates, becoming specifically lighter than the other air in the room, is obliged to rise; but the closure over the fire-place hindering it from going up the chimney, it is forced out into the room, rises by the mantel-piece to the ceiling, and spreads all over the top of the room, whence being crowded down gradually by the stream of newly-warmed air that follows and rises above it, the whole room becomes in a short time equally warmed.

At the same time the air, warmed under the bottom plate and in the air-box, rises and comes out of the holes in the side plates very swiftly if the door of the room be shut, and joins its current with the stream before mentioned, rising from the side, back, and top plates.

The air that enters the room through the air-box is fresh, though warm; and, computing the swiftness of its motion with the areas of the holes, it is found that near ten barrels of fresh air are hourly introduced by the air-box; and by this means the air in the room is continually changed, and kept at the same time sweet and warm.

It is to be observed that the entering air will not be warm at first lighting the fire, but heats gradually as the fire increases.

A square opening for a trap-door should be left in the closing of the chimney, for the sweeper to go up; the door may be made of slate or tin, and commonly kept close shut, but so placed as that, turning up against the back of the chimney when open, it closes the vacancy behind the false back, and shoots the soot that falls in sweeping, out upon the hearth. This trap-door is a very convenient thing.

In rooms where much smoking of tobacco is used, it is also convenient to have a small hole about five or six inches square, cut near the ceiling through into the funnel; this hole must have a shutter, by which it may be closed or operated at pleasure. When open there will be a strong draft of air through it into the chimney, which will presently carry off a cloud of smoke and keep the room clear; if the room be too hot likewise, it will carry off as much of the warm air as you please, and then you may stop it entirely or in part as you think fit. By this means it is that the tobacco smoke does not descend among the heads of the company near the fire, as it must do before it can get into common chimneys.

The Manner Of Using This Fire-place

Your cord-wood must be cut into three lengths; or else a short piece fit for the fire-place, cut off, and the longer left for the kitchen or other fires. Dry hickory or ash, or any woods that burn with a clear flame, are rather to be chosen, because such are less apt to foul the smoke passages with soot; and flame communicates with its light, as well as by contact, greater heat to the plates and room. But, where more ordinary wood is used, half a dry fagot of brushwood, burnt at the first making the fire in the morning, is very advantageous, as it immediately, by its sudden blaze, heats the plates and warms the room (which with bad wood slowly kindling would not be done so soon), and at the same time by the length of its flame, turning in the passages, consumes and cleanses away the soot that such bad, smoky wood had produced therein the preceding day, and so keeps them always free and clean. When you have laid a little back log, and placed your billets on small dogs, as in common chimneys, and put some fire to them, then slide down your shutter as low as the dogs, and the opening being by that means contracted, the air rushes in briskly and presently blows up the flames. When the fire is sufficiently kindled, slide it up again.[1] In some of these fire-places there is a little six inch square trap-door of thin wrought iron or brass, covering a hole of like dimensions near the fore part of the bottom plate, which being by a ring lifted up towards the fire, about an inch, where it will be retained by two springing sides fixed to it perpendicularly (see Plate I., Fig. 4), the air rushes in from the hollow under the bottom plate, and blows the fire. Where this is used, the shutter serves only to close the fire at nights. The more forward you can make your fire on the hearth-plate, not to be incommoded by the smoke, the sooner and more will the room be warmed. At night, when you go to bed, cover the coals or brands with ashes as usual; then take away the dogs, and slide down the shutter close to the bottom plate, sweeping a little ashes against it that no air may pass under it; then turn the register so as very near to stop the flue behind. If no smoke then comes out at crevices into the room, it is right; if any smoke is perceived to come out, move the register, so as to give a little draft, and it will go the right way. Thus the room will be kept warm all night; for, the chimney being almost entirely stopt, very little cold air, if any, will enter the room at any crevice. When you come to rekindle the fire in the morning, turn open the register before you lift up the slider, otherwise, if there be any smoke in the fire-place, it will come out into the room. By the same use of the shutter and register, a blazing fire may be presently stifled, as well as secured, when you have occasion to leave it for any time; and at your return you will find the brands warm, and ready for a speedy rekindling. The shutter alone will not stifle a fire, for it cannot well be made to fit so exactly but that air will enter, and that in a violent stream, so as to blow up and keep alive the flames and consume the wood, if the draft be not checked by turning the register to shut the flue behind. The register has also two other uses. If you observe the draft of air into your fire-place to be stronger than is necessary (as in extreme cold weather it often is), so that the wood is consumed faster than usual; in that case, a quarter, half, or two-thirds turn of the register will check the violence of the draft and let your fire burn with the moderation you desire; and at the same time both the fire-place and the room will be the warmer, because less cold air will enter and pass through them. And, if the chimney should happen to take fire (which indeed there is very little danger of, if the preceding direction be observed in making fires, and it be well swept once a year; for, much less wood being burnt, less soot is proportionably made; and, the fuel being soon blown into flame by the shutter, or the trap-door bellows, there is consequently less smoke from the fuel to make soot; then, though the funnel should be foul, yet the sparks have such a crooked, up and down, roundabout way to go, that they are out before they get at it); I say, if ever it should be on fire, a turn of the register shuts all close and prevents any air going into the chimney, and so the fire may be easily stifled and mastered.

The Advantages Of This Fire-place

Its advantages above the common fire-places are:

1. That your whole room is equally warmed, so that people need not crowd so close round the fire, but may sit near the window, and have the benefit of the light for reading, writing, needlework, &c. They may sit with comfort in any part of the room, which is a very considerable advantage in a large family, where there must often be two fires kept, because all cannot conveniently come at one.

2. If you sit near the fire you have not that cold draft of uncomfortable air nipping your back and heels as when before common fires, by which many catch cold, being scorched before and, as it were, froze behind.

3. If you sit against a crevice there is not that sharp draft of cold air playing on you as in rooms where there are fires in the common way, by which many catch cold, whence proceed coughs,[1] catarrhs, toothaches, fevers, pleurisies, and many other diseases.

4. In case of sickness they make most excellent nursing-rooms, as they constantly supply a sufficiency of fresh air, so warmed at the same time as to be no way inconvenient or dangerous. A small one does well in a chamber, and, the chimneys being fitted for it, it may be removed from one room to another, as occasion requires, and fixed in half an hour. The equal temper, too, and warmth of the air of the room, is thought to be particularly advantageous in some distempers; for it was observed in the winters of 1730 and 1736, when the small-pox spread in Pennsylvania, that very few children of the Germans died of that distemper in proportion to those of the English, which was ascribed by some to the warmth and equal temper of air in their stove-rooms, which made the disease as favorable as it commonly is in the West Indies. But this conjecture we submit to the judgment of physicians.

5. In common chimneys the strongest heat from the fire, which is upwards, goes directly up the chimney and is lost, and there is such a strong draft into the chimney that not only the upright heat but also the back, sides, and downward heats are carried up the chimney by that draft of air, and the warmth given before the fire by the rays that strike out towards the room is continually driven back, crowded into the chimney, and carried up by the same draft of air. But here the upright heat strikes and heats the top plate, which warms the air above it, and that comes into the room. The heat likewise which the fire communicates to the sides, back, bottom, and air-box, is all brought into the room; for you will find a constant current of warm air coming out of the chimney corner into the room. Hold a candle just under the mantel-piece or breast of your chimney, and you will see the flame bent outwards; by laying a piece of smoking paper on the hearth, on either side, you may see how the current of air moves and where it tends, for it will turn and carry the smoke with it.

6. Thus, as very little of the heat is lost when this fire-place is used, *much less wood*[1] will serve you, which is a considerable advantage where wood is dear.

7. When you burn candles near this fire-place, you will find that the flame burns quite upright, and does not blare and run the tallow down by drawing towards the chimney, as against common fires.

8. This fire-place cures most smoky chimneys, and thereby preserves both the eyes and furniture.

9. It prevents the fouling of chimneys; much of the lint and dust that contributes to foul a chimney being, by the low arch, obliged to pass through the flame, where it is consumed. Then, less wood being burnt, there is less smoke made. Again, the shutter, or trap-bellows, soon blowing the wood into a flame, the same wood does not yield so much smoke as if burnt in a common chimney; for, as soon as flame begins, smoke in proportion ceases.

10. And if a chimney should be foul, it is much less likely to take fire. If it should take fire, it is easily stifled and extinguished.

11. A fire may be very speedily made in this fire-place by the help of the shutter or trap-bellows, as aforesaid.

12. A fire may be soon extinguished by closing it with the shutter before, and turning the register behind, which will stifle it, and the brands will remain ready to rekindle.

13. The room being once warm, the warmth may be retained in it all night.

14. And, lastly, the fire is so secured at night that not one spark can fly out into the room to do damage.

With all these conveniences, you do not lose the pleasing sight nor use of the fire, as in the Dutch stoves, but may boil the tea-kettle, warm the flat-irons, heat heaters, keep warm a dish of victuals by setting it on the top, &c.

Objections Answered

There are some objections commonly made by people that are unacquainted with these fire-places which it may not be amiss to endeavour to remove, as they arise from prejudices which might otherwise obstruct, in some degree, the general use of this beneficial machine. We frequently hear it said, *They are of the nature of Dutch stoves; stoves have an unpleasant smell; stoves are unwholesome; and warm rooms make people tender and apt to catch cold.* As to the first, that they are of the nature of Dutch stoves, the description of those stoves, in the beginning of this paper, compared with that of these machines, shows that there is a most material difference, and that these have vastly the advantage, if it were only in the single article of the admission and circulation of the fresh air. But it must be allowed there may have been some cause to complain of the offensive smell of iron stoves. This smell, however, never proceeded from the iron itself, which, in its nature, whether hot or cold, is one of the sweetest of metals, but from the general uncleanly manner of using those stoves. If they are kept clean they are as sweet as an ironing-box, which, though ever so hot, never offends the smell of the nicest lady; but it is common to let them be greased, by setting candlesticks on them or otherwise; to rub greasy hands on them; and, above all, to spit upon them, to try how hot they are, which is an inconsiderate, filthy, unmannerly custom; for the slimy matter of spittle, drying on, burns and fumes when the stove is hot, as well as the grease, and smells most nauseously, which makes such close stove-rooms, where there is no draft to carry off those filthy vapors, almost intolerable to those that are not from their infancy accustomed to them. At the same time nothing is more easy than to keep them clean; for, when by any accident they happen to be fouled, a lie made of ashes and water, with a brush, will scour them perfectly, as will also a little strong soft soap and water.

That hot iron of itself gives no offensive smell, those know very well who have (as the writer of this had) been present at a furnace when the workmen were pouring out the flowing metal to cast large plates, and not the least smell of it to be perceived. That hot iron does not, like lead, brass, and some other metals, give out unwholesome vapors, is plain from the general health and strength of those who constantly work in iron, as furnace-men, forge-men, and smiths; that it is in its nature a metal perfectly wholesome to the body of man, is known from the beneficial use of chalybeate or iron-mine waters, from the good done by taking steel filings in several disorders, and that even the smithy water in which hot irons are quenched is found advantageous to the human constitution. The ingenious and learned Dr. Desaguliers, to whose instructive writings the contriver of this machine acknowledges himself much indebted, relates an experiment he made to try whether heated iron would yield unwholesome vapors. He took a cube of iron, and, having given it a very great heat, he fixed it so to a receiver, exhausted by the air-pump, that all the air rushing in to fill the receiver should first pass through a hole in the hot iron. He then put a small bird into the receiver, who breathed that air without any inconvenience or suffering the least disorder. But the same experiment being made with a cube of hot brass, a bird put into that air died in a few minutes. Brass, indeed, stinks even when cold, and much more when hot; lead, too, when hot, yields a very unwholesome steam; but iron is always sweet, and every way taken is wholesome and friendly to the human body, except in weapons.

That warmed rooms make people tender and apt to catch cold, is a mistake as great as it is (among the English) general. We have seen in the preceding pages how the common rooms are apt to give colds; but the writer of this paper may affirm from his own experience and that of his family and friends, who have used warm rooms for these four winters past, that by the use of such rooms people are rendered *less liable* to take cold, and, indeed, *actually hardened.* If sitting warm in a room made one subject to take cold on going out, lying warm in bed should, by a parity of reason, produce the same effect when we rise. Yet we find we can leap out of the warmest bed naked in the coldest morning without any such danger; and in the same manner out of warm clothes into a cold bed. The reason is that in these cases the pores all close at once, the cold is shut out, and the heat within augmented, as we soon after feel by the glowing of the flesh and skin. Thus no one was ever known to catch cold by the use of the cold bath; and are not cold baths allowed to harden the bodies of those that use them? Are they not therefore frequently prescribed to the tenderest constitutions? Now every time you go out of a warm room into the cold, freezing air, you do, as it were, plunge into a cold bath, and the effect is in proportion the same; for (though perhaps you may feel somewhat chilly at first) you find in a little time your bodies hardened and strengthened, your blood is driven round with a brisker circulation, and a comfortable, steady, uniform, inward warmth succeeds that equal outward warmth you first received in the room. Farther to confirm this assertion, we instance the Swedes, the Danes, and the Russians. These nations are said to live in rooms, compared to ours, as hot as ovens[1] ; yet where are the hardy soldiers, though bred in their boasted cool houses, that can, like these people, bear the fatigues of a winter campaign in so severe a climate, march whole days to the neck in snow, and at night intrench in ice as they do?

The mentioning of those northern nations puts me in mind of a considerable *public advantage* that may arise from the general use of these fire-places. It is observable that, though those countries have been well inhabited for many ages, wood is still their fuel, and yet at no very great price; which could not have been, if they had not universally used stoves, but consumed it as we do in great quantities, by open fires. By the help of this saving invention our wood may grow as fast as we consume it, and our posterity may warm themselves at a moderate rate, without being obliged to fetch their fuel over the Atlantic; as, if pit-coal should not be here discovered (which is an uncertainty) they must necessarily do.

We leave it to the *political arithmetician* to compute how much money will be saved to a country, by its spending two thirds less of fuel; how much labor saved in cutting and carriage of it; how much more land may be cleared by cultivation; how great the profit by the additional quantity of work done, in those trades particularly that do not exercise the body so much, but that the workfolks are obliged to run frequently to the fire to warm themselves; and to physicians to say how much healthier thick-built towns and cities will be, now half suffocated with sulphury smoke, when so much less of that smoke shall be made, and the air breathed by the inhabitants be consequently so much purer. These things it will suffice just to have mentioned; let us proceed to give some necessary directions to the workman who is to fix or set up these fire-places.

Directions To The Bricklayer

The chimney being first well swept and cleansed from soot, &c., lay the bottom plate down on the hearth, in the place where the fire-place is to stand, which may be as forward as the hearth will allow. Chalk a line from one of its back corners round the plate to the other corner, that you may afterwards know its place when you come to fix it; and from those corners, two parallel lines to the back of the chimney; make marks also on each side, that you may know where the partition is to stand, which is to prevent any communication between the air and smoke. Then, removing the plate, make a hollow under it and beyond it, by taking up as many of the bricks or tiles as you can, within your chalked lines, quite to the chimney-back. Dig out six or eight inches deep of the earth or rubbish, all the breadth and length of your hollow; then make a passage of four inches square (if the place will allow so much) leading from the hollow to some place communicating with the outer air; by *outer air* we mean air without the room you intend to warm. This passage may be made to enter your hollow on either side, or in the fore part, just as you find most convenient, the circumstances of your chimney considered. If the fire-place is to be put up in a chamber, you may have this communication of outer air from the staircase; or sometimes more easily from between the chamber floor and the ceiling of the lower room, making only a small hole in the wall of the house entering the space betwixt those two joists with which your air-passage in the hearth communicates. If this air-passage be so situated as that mice may enter it, and nestle in the hollow, a little grate of wire will keep them out. This passage being made, and, if it runs under any part of the hearth, tiled over securely, you may proceed to raise your false back. This may be of four inches or two inches thickness, as you have room; but let it stand at least four inches from the true chimney back. In narrow chimneys this false back runs from jamb to jamb; but in large, old-fashioned chimneys, you need not make it wider than the back of the fire-place. To begin it, you may form an arch nearly flat, of three bricks end to end, over the hollow, to leave a passage the breadth of the iron fire-place and five or six inches deep, rounding at bottom, for the smoke to turn and pass under the false back, and so behind it up the chimney. The false back is to rise till it is as high as the breast of the chimney, and then to close over to the breast[1] ; always observing, if there is a wooden mantel-tree, to close above it. If there is no wood in the breast, you may arch over and close even with the lower part of the breast. By this closing the chimney is made tight, that no air or smoke may pass up it, without going under the false back. Then from side to side of your hollow, against the marks you made with chalk, raise a tight partition, brick-on-edge, to separate the air from the smoke, bevelling away to half an inch the brick that comes just under the air-hole, that the air may have a free passage up into the air-box. Lastly, close the hearth over that part of the hollow that is between the false back and the place of the bottom plate, coming about half an inch under the plate, which piece of hollow hearth may be supported by a bit or two of old iron hoop; then is your chimney fitted to receive the fire-place.

To set it, lay first a little bed of mortar all round the edges of the hollow, and over the top of the partition; then lay down your bottom plate in its place (with the rods in it) and tread it till it lies firm. Then put a little fine mortar (made of loam and lime, with a little hair) into its joints, and set in your back plate, leaning it for the present against the false back; then set in your air-box, with a little mortar in its joints; then put in the two sides, closing them up against the air-box, with mortar in their grooves, and fixing at the same time your register; then bring up your back to its place, with mortar in its grooves, and that will bind the sides together. Then put in your front plate, placing it as far back in the groove as you can, to leave room for the sliding plate; then lay on your top plate, with mortar in its grooves also, screwing the whole firmly together by means of the rods. The capital letters, *A, B, D, E,* &c. in the cut [Plate II.], show the corresponding parts of the several plates. Lastly, the joints being pointed all round on the outside, the fire-place is fit for use.

When you make your first fire in it, perhaps, if the chimney be thoroughly cold, it may not draw, the work too being all cold and damp. In such case, put first a few shovels of hot coals in the fire-place, then lift up the chimney sweeper's trap-door, and putting in a sheet or two of flaming paper, shut it again, which will set the chimney a drawing immediately, and when once it is filled with a column of warm air it will draw strongly and continually.

The drying of the mortar and work by the first fire may smell unpleasantly, but that will soon be over.

In some shallow chimneys, to make more room for the false back and its flue, four inches or more of the chimney-back may be picked away.

Let the room be made as tight as conveniently it may be; so will the outer air that must come in to supply the room and draft of the fire be all obliged to enter through the passage under the bottom plate, and up through the air-box, by which means it will not come cold to your backs, but be warmed as it comes in, and mixed with the warm air round the fire-place before it spreads into the room.

But as a great quantity of cold air, in extreme cold weather especially, will presently enter a room if the door be carelessly left open, it is good to have some contrivance to shut it, either by means of screw hinges, a spring, or a pulley.

When the pointing in the joints is all dry and hard, get some powder of black lead (broken bits of black lead crucibles from the silversmiths, pounded fine, will do), and mixing it with a little rum and water, lay it on, when the plates are warm, with a hard brush, over the top and front plates, part of the side and bottom plates, and over all the pointing; and as it dries, rub it to a gloss with the same brush, so the joints will not be discerned, but it will look all of a piece, and shine like new iron. And, the false back being plastered and whitewashed, and the hearth reddened, the whole will make a pretty appearance. Before the black lead is laid on, it would not be amiss to wash the plates with strong lie and a brush, or soap and water, to cleanse them from any spots of grease or filth that may be on them. If any grease should afterwards come on them, a little wet ashes will get it out.

If it be well set up, and in a tolerably good chimney, smoke will draw in from as far as the fore part of the bottom plate, as you may try by a bit of burning paper.

People are at first apt to make their rooms too warm, not imagining how little a fire will be sufficient. When the plates are no hotter than that one may just bear the hand on them, the room will generally be as warm as you desire it.[1]

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XXXI

TO THE HON. CADWALLADER COLDEN

New York, 5 April, 1744.

Sir:—

Happening to be in this city about some particular affairs, I have the pleasure of receiving yours of the 28th past, here; and can now acquaint you that the Society,1 as far as it relates to Philadelphia, is actually formed, and has had several meetings to mutual satisfaction. As soon as I get home I shall send you a short account of what has been done and proposed at these meetings. The members are:

Dr. Thomas Bond, as Physician.
Mr. John Bartram, as Botanist.
Mr. Thomas Godfrey, as Mathematician.
Mr. Samuel Rhoads, as Mechanician.
Mr. William Parsons, as Geographer.
Dr. Phineas Bond, as General Nat. Philosopher.
Mr. Thomas Hopkinson, President.
Mr. William Coleman, Treasurer.
B. F——, Secretary.

To whom the following members have since been added, viz.: Mr. Alexander, of New York; Mr. Morris, Chief Justice of the Jerseys; Mr. Home, Secretary of do.; Mr. John Coxe, of Trenton; and Mr. Martyn, of the same place. Mr. Nicholls tells me of several other gentlemen of this city that incline to encourage the thing; and there are a number of others, in Virginia, Maryland, and the New England colonies, we expect to join us as soon as they are acquainted that the Society has begun to form itself.

I Am, Sir, With Much Respect,
Your Most Humble Servant,

B. Franklin.

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XXXII

TO JOSIAH AND ABIAH FRANKLIN

Philadelphia, 6 September, 1744.

Honored Father And Mother:

I apprehend I am too busy in prescribing and meddling in the doctor’s sphere, when any of you complain of ails in your letters. But as I always employ a physician myself when any disorder arises in my family, and submit implicitly to his orders in every thing, so I hope you consider my advice, when I give any, only as a mark of my good will, and put no more of it in practice than happens to agree with what your doctor directs.

Your notion of the use of strong lye I suppose may have a good deal in it. The salt of tartar, or salt of wormwood, frequently prescribed for cutting, opening, and cleansing, is nothing more than the salt of lye procured by evaporation. Mrs. Stevens’s medicine for the stone and gravel, the secret of which was lately purchased at a great price by the Parliament, has for its principal ingredient salt, which Boerhaave calls the most universal remedy. The same salt intimately mixed with oil of turpentine, which you also mentioned, makes the *sapo philosophorum,* wonderfully extolled by some chemists for like purposes. It is highly probable, as your doctor says, that medicines are much altered in passing between the stomach and bladder; but such salts seem well fitted in their nature to pass with the least alteration of almost any thing we know; and, if they will not dissolve gravel and stone, yet I am half persuaded that a moderate use of them may go a great way towards preventing these disorders, as they assist a weaker digestion in the stomach, and powerfully dissolve crudities such as those which I have frequently experienced. As to honey and molasses, I did not mention them merely as openers and looseners, but also from conjecture that, as they are heavier in themselves than our common drink, they might when dissolved in our bodies increase the gravity of our fluids, the urine in particular, and by that means keep separate and suspended therein those particles which, when unused, form gravel, &c.

I will inquire after the herb you mention. We have a botanist here, an intimate friend of mine, who knows all the plants in the country. He would be glad of the correspondence of some gentlemen of the same taste with you, and has twice, through my hands, sent specimens of the famous Chinese *ginseng,* found here, to persons who desired it in Boston, neither of whom has had the civility to write him a word in answer, or even to acknowledge the receipt of it, of which please to give a hint to brother John.

We have had a very healthy summer and a fine harvest; the country is filled with bread; but as trade declines since the war began, I know not what our farmers will do for a market. I am your affectionate and dutiful son,

B. Franklin.

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XXXIII

TO CADWALLADER COLDEN

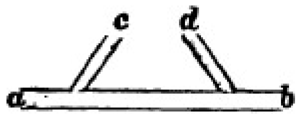
Philadelphia, 15 August, 1745.

Sir:—

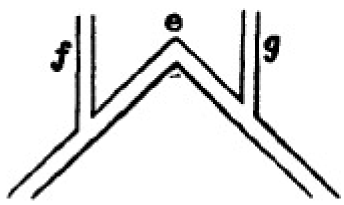
I received your favor of the 20th past, which your medical piece enclosed, the reading of which gave me a great deal of pleasure. I showed it to our friend Mr. Bartram, who carried it home, and, as he since tells me, is taking a copy of it. His keeping of it for that end has prevented my showing it to any other gentleman as you desired, and hitherto prevented my writing to you upon it, as I intended. But, lest you should conclude me the very worst correspondent in the world, I shall delay no longer giving you some thoughts that occurred to me in reading of it, choosing rather to be blamed for not writing to the purpose than for not writing at all.

I am extremely pleased with your doctrine of the *absorbent vessels* intermixed with the perspiratory ducts, both on the external and internal superficies of the body. After I had read Sanctorius, I imagined a constant stream of the perspirable matter issuing at *every* pore in the skin. But then I was puzzled to account for the effects of mercurial unctions for the strangury, sometimes occasioned by an outward application of the flies, and the like; since whatever virtue or quality might be in a medicine laid upon the skin, if it would enter the body it must go against wind and tide, as one may say. Dr. Hales helped me a little when he informed me, in his *Vegetable Statics,* that the body is not always in a perspirable, but sometimes in an *imbibing, state,* as he expresses it, and will at times actually grow heavier by being exposed to moist air. But this did not quite remove my difficulty, since, as these fits of imbibing did not appear to be regular or frequent, a blistering plaster might lie on the body a week, or a mercurial unguent be used a month, to no purpose, if the body should so long continue in a perspirable state. Your doctrine, which was quite new to me, makes all easy, since the body may perspire and absorb at the same time, through the different ducts destined to those different ends.

I must own, however, that I have one objection to the explanation you give of the operation of these absorbents. That they should communicate with the veins, and the perspirants with the arteries only, seems natural enough; but as all fluids by the hydrostatical law pass equally in all directions, I question whether the *mere direction* of one of those minute vessels, where it joins with a vein or artery, *with* or *against* the stream of blood in the larger vessel, would be sufficient to produce such contrary effects as *perspiring* and *absorbing.* If it would, both perspirants and absorbents might proceed from the arteries only, or from the veins only, or from both indifferently; as, by the figure in the margin, whether the vessel *a b* is an artery or a vein, if the stream moves from *a* to *b,* the minute communicating vessel *c* shall be a perspirant, and *d* an absorbent; and the contrary, if it moves from *b* to *a.* Yet I cannot say I am certain the mere direction of the vessel will have no effect; I only suspect it, and am making a little machine to try an experiment with for satisfaction.



It is a siphon made of two large joints of Carolina cane united at *e,* into which two small glass tubes, *f* and *g,* are to be inserted, one on the descending and the other on the ascending side. I propose to fill the siphon and the two glass tubes with water, and, when it is playing, unstop at the same instant the tops of both glass tubes, observing in which the water sinks fastest. You shall know the success. I conceive the pressure of the atmosphere on the apertures of the two glass tubes to be no way different from the pressure of the same on the mouths of the perspirants and absorbents, and if the water sinks equally in the two tubes, notwithstanding the direction of one against and the other with the stream, I shall be ready to think we must look out for another solution. You will say, perhaps, that it will then be time enough when the experiment is tried, and succeeds as I suspect; yet I cannot forbear attempting at one beforehand while some thoughts are present in my mind. If a new solution should be found necessary, this may be ready for consideration.



I do not remember that any anatomist that has fallen in my way has assigned any other cause of the motion of the blood through its whole circle than the contractile force of the heart, by which that fluid is driven with violence into the arteries, and so continually propelled by repetitions of the same force till it arrives at the heart again. May we for our present purpose suppose another cause producing half the effect, and say that the ventricles of the heart, like syringes, *draw* when they dilate as well as force when they contract? That this is not unlikely may be judged from the valves nature has placed in the arteries to prevent the drawing back of the blood in those vessels when the heart dilates, while no such obstacles prevent its sucking (to use the vulgar expression) from the veins. If this be allowed, and the insertion of the absorbents into the veins and of the perspirants into the arteries be agreed to, it will be of no importance in what direction they are inserted. For, as the branches of the arteries are continually lessening in their diameters, and the motion of the blood decreasing by means of the increased resistance, there must, as more is constantly pressed on behind, arise a kind of *crowding* in the extremities of those vessels, which will naturally *force out* what is contained in the perspirants that communicate with them. This lessens the quantity of blood, so that the heart cannot receive again by the veins all it had discharged into the arteries, which occasions it to draw strongly upon the absorbents that communicate with them. And thus the body is continually perspiring and imbibing. Hence after long fasting the body is more liable to receive infection from bad air, and food, before it is sufficiently chylified, is drawn crude into the blood by the absorbents that open into the bowels.

To confirm this position, that the heart *draws* as well as *drives* the blood, let me add this particular. If you sit or lean long in such a manner as to compress the principal artery that supplies a limb with blood, so that it does not furnish a due quantity, you will be sensible of a pricking pain in the extremities like that of a thousand needles, and the veins, which used to raise your skin in ridges, will be (with the skin) sunk in channels, the blood being drawn out of them, and their sides pressed so closely together that it is with difficulty and slowly that the blood afterwards enters them when the compressed artery is relieved. If the blood was not drawn by the heart, the compression of an artery would not empty a vein, and I conjecture that the pricking pain is occasioned by the sides of the small vessels being pressed together.

I am not without apprehension that this hypothesis is either not new, or, if it is new, not good for any thing. It may, however, in this letter, with the enclosed paper on a kindred subject, serve to show the great confidence I place in your candor, since to you I so freely hazard myself (*ultra crepidam*) in meddling with matters directly pertaining to your profession, and entirely out of the way of my own. If you give yourself the trouble of reading them, it is all I can modestly expect. Your silence about them afterwards will be sufficient to convince me that I am in the wrong, and that I ought to study the sciences I dabble in before I presume to set pen to paper. I will endeavour, however, to make you some amends by procuring you from better judges some better remarks on the rest of your piece, and shall observe your caution not to let them know from whom I had it.

The piece on Fluxions I purpose shortly to read again, and that on the several species of matter, when you shall have what little I shall be able to say about them.

The members of our Society here are very idle gentlemen. They will take no pains. I must, I believe, alter the scheme and proceed with the papers I have, and may receive, in the manner you advise in one of your former letters. The mention of your former letter puts me in mind how much I am in arrear with you. Like some honest insolvent debtors, I must resolve to pay ready money for what I have hereafter, and discharge the old debt by little and little as I am able.

The impertinence of these mosquitos to me (now I am in the humor of writing) prevents a great deal of mine to you, so that, for once, they are of some use in the world. I am, Sir,

Your Most Humble Servant,

B. Franklin.

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XXXIV

TO CADWALLADER COLDEN

Philadelphia, 28 November, 1745.

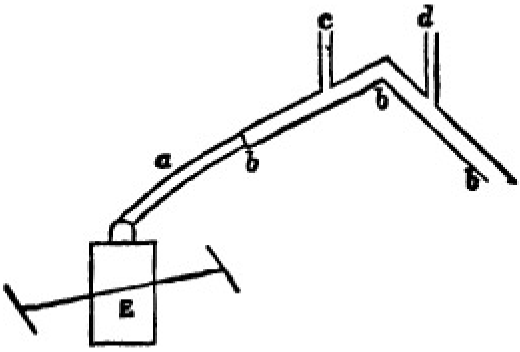
Sir:—

I shall be very willing and ready, when you think proper to publish your piece on gravitation, to print it at my own expense and risk. If I can be the means of communicating any thing valuable to the world, I do not always think of gaining, nor even of saving, by my business; but a piece of that kind, as it must excite the curiosity of all the learned, can hardly fail of bearing its own expense.

I must not pretend to dispute with you on any part of the animal economy. You are quite too strong for me. I shall just mention two or three little things, that I am not quite clear in.

If there is no contrivance in the frame of the auricles or ventricles of the heart by which they dilate themselves, I cannot conceive how they are dilated. It is said, by the force of the venal blood rushing into them. But if that blood has no force which was not first given to it by the contraction of the heart, how can it (diminished as it must be by the resisting friction of the vessels it has passed through) be strong enough to overcome that contraction? Your doctrine of fermentation in the capillaries helps me a little; for if the returning blood be rarefied by the fermentation, its motion must be increased; but, as it seems to me that it must by its expansion resist the arterial blood behind it, as much as it accelerates the venal blood before it, I am still somewhat unsatisfied. I have heard or read somewhere, too, that the hearts of some animals continue to contract and dilate, or to beat, as it is commonly expressed, after they are separated from the other vessels and taken out of the body. If this be true, their dilation is not caused by the force of the returning blood.

I should be glad to satisfy myself, too, whether the blood is always quicker in motion when the pulse beats quicker. Perhaps more blood is driven forward by one strong, deep stroke than by two that are weak and light; as a man may breathe more air by one long, common respiration, when in health, than by two quick, short ones in a fever. I applied the siphon I mentioned to you in a former letter to the pipe of a water-engine. *E* is the engine; *a,* its pipe; *b b b,* the siphon; *c* and *d,* the two glass pipes communicating with the siphon. Upon working the engine, the water flowed through the siphon and the glass tube *c;* but none was discharged through *d.* When I stopped with my finger the end of the siphon, the water issued at both glass tubes with equal force, and on only half stopping the end of the siphon, it did the same. I imagine the sudden bending of the siphon gives such a resistance to the stream as to occasion its issuing out of the glass tube *c.* But I intend to try a farther experiment, of which I shall give you an account.



I am now determined to publish an *American Philosophical Miscellany,* monthly or quarterly. I shall begin with next January, and proceed as I find encouragement and assistance. As I purpose to take the compiling wholly upon myself, the reputation of no gentleman or society will be affected by what I insert of another's; and that perhaps will make them more free to communicate. Their names shall be published or concealed, as they think proper, and care taken to do exact justice to matters of invention, &c. I shall be glad of your advice in any particulars that occurred to you in thinking of this scheme; for, as you first proposed it to me, I doubt not but you have well considered it.[1]

I have not the original of Dr. Mitchell's tract on the Yellow Fever.[2] Mine is a copy I had taken, with his leave, when here. Mr. Evans will make a copy of it for you.

I hope it will be confirmed by future experiment that the *yaws* are to be cured by tar-water. The case you relate to Dr. Mitchell gives great hopes of it, and should be published, to induce people to make trials. For, though it should not always succeed, I suppose there is no danger of its doing any harm.

As to your pieces on Fluxions and the different species of matter, it is not owing to reservedness that I have not yet sent you my thoughts; but because I cannot please myself with them, having had no leisure yet to digest them. If I was clear that you are anywhere mistaken, I would tell you so, and give my reasons with all freedom, as believing nothing I could do would be more obliging to you. I am persuaded you think, as I do, that he who removes a prejudice or an error from our minds contributes to their beauty, as he would do to that of our faces who should clear them of a wart or a wen.

I have a friend gone to New York with a view of settling there, if he can meet with encouragement. It is Dr. John Bard,[1] whom I esteem an ingenious physician and surgeon and a discreet, worthy, and honest man. If, upon conversation with him, you find this character just, I doubt not but you will afford him your advice and countenance, which will be of great service to him in a place where he is entirely a stranger, and very much oblige, Sir,

Your Most Humble Servant,

B. Franklin.

P. S.—I shall forward your letter to Dr. Mitchell. Thank you for leaving it open for my perusal.

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XXXV

TO CADWALLADER COLDEN

[Date uncertain]

Sir:—

I received yours with others enclosed for Mr. Bartram and Mr. Armit, to which I suppose the enclosed are answers. The person who brought yours said he would call for answers, but did not; or if he did, I did not see him.

I understand Parker[1] has begun upon your piece. A long sitting of our Assembly has hitherto hindered me from beginning the *Miscellany.* I shall write to Dr. Gronovius as you desire.

I wish I had mathematics enough to satisfy myself whether the much shorter voyages made by ships bound hence to England, than by those from England hither, are not in some degree owing to the diurnal motion of the earth, and if so, in what degree. It is a notion that has lately entered my mind; I know not if ever any other's. Ships in a calm at the equator move with the sea fifteen miles per minute; at our Cape suppose twelve miles per minute; in the British Channel suppose ten miles per minute. Here is a difference of two miles' velocity per minute between Cape Henlopen and the Lizard. No small matter in so weighty a body as a laden ship swimming in a fluid. How is this velocity lost in the voyage thither, if not by the resistance of the water? And if so, then the water, which resisted in part, must have given way in part to the ship, from time to time, as she proceeded continually out of parallels of latitude where the earth's motion or rotation was quicker, into others where it was slower. And thus, as her velocity tends eastward with the earth's motion, she perhaps makes her easting sooner. Suppose a vessel lying still in a calm at our Cape could be taken up, and the same instant set down in an equal calm in the English Channel, would not the difference of velocity between her and the sea she was placed in appear plainly by a violent motion of the ship through the water eastward?

I have not time to explain myself farther, the post waiting; but I believe I have said enough for you to comprehend my meaning. If the reasons hinted at should incline you to think there is any thing in this notion, I should be glad of an answer to this question, if it be capable of a precise answer, viz.

Suppose a ship sails in a northeast line from latitude 39 to latitude 52, in thirty days, how long will she be returning on the same line, winds, currents, etc., being equal? Just so much as the eastern motion of the earth helps her easting, I suppose it will hinder her westing. Perhaps the weight and dimensions or shape of the vessel should be taken into consideration, as the water resists bodies of different shapes differently.

I must beg you to excuse the incorrectness of this scrawl, as I have not time to transcribe. I am, Sir,

Your Most Humble Servant,

B. Franklin.

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XXXVI

TO JOHN FRANKLIN, AT BOSTON

Philadelphia, 1745.

— Our people are extremely impatient to hear of your success at Cape Breton.1 My shop is filled with inquirers at the coming in of every post. Some wonder the place is not yet taken. I tell them I shall be glad to hear that news three months hence. Fortified towns are hard nuts to crack; and your teeth have not been accustomed to it. Taking strong places is a particular trade, which you have taken up without serving an apprenticeship to it. Armies and veterans need skilful engineers to direct them in their attack. Have you any? But some seem to think forts are as easy taken as snuff. Father Moody's prayers look tolerably modest. You have a fast and prayer day for that purpose; in which I compute five hundred thousand petitions were offered up to the same effect in New England, which, added to the petitions of every family morning and evening, multiplied by the number of days since January 25th, make forty-five millions of prayers; which, set against the prayers of a few priests in the garrison, to the Virgin Mary, give a vast balance in your favor.

If you do not succeed, I fear I shall have but an indifferent opinion of Presbyterian prayers in such cases, as long as I live. Indeed, in attacking strong towns I should have more dependence on *works,* than on *faith;* for, like the kingdom of heaven, they are to be taken by force and violence; and in a French garrison I suppose there are devils of that kind that they are not to be cast out by prayers and fasting, unless it be by their own fasting for want of provisions. I believe there is Scripture in what I have wrote, but I cannot adorn the margin with quotations, having a bad memory, and no Concordance at hand; besides no more time than to subscribe myself, &c.

B. Franklin.

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XXXVII

TO JAMES READ

Saturday Morning, 17 August, 1745.

Dear Jemmy:

I have been reading your letter over again, and, since you desire an answer I sit down to write you one; yet, as I write in the market, it will, I believe, be but a short one, though I may be long about it. I approve of your method of writing one's mind, when one is too warm to speak it with temper; but, being quite cool myself in this affair, I might as well speak as write, if I had an opportunity.

Are you an attorney by profession, and do you know no better how to choose a proper court in which to bring your action? Would you submit to the decision of a husband, a cause between you and his wife? Don't you know that all wives are in the right? It may be you don't, for you are yet but a young husband. But see, on this head, the learned Coke, that oracle of the law, in his chapter *De Jur.Marit. Angl.* I advise you not to bring it to trial; for, if you do, you will certainly be cast.

Frequent interruptions make it impossible for me to go through all your letter. I have only time to remind you of the saying of that excellent old philosopher, Socrates, *that, in differences among friends, they that make the first concessions are the wisest;* and to hint to you that you are in danger of losing that honor in the present case, if you are not very speedy in your acknowledgments, which I persuade myself you will be, when you consider the sex of your adversary.

Your visits never had but one thing disagreeable in them—that is, they were always too short. I shall exceedingly regret the loss of them, unless you continue, as you have begun, to make it up to me by long letters.

I am, dear Jemmy, with sincere love to our dearest Suky, your very affectionate friend and cousin,

B. Franklin.

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XXXVIII

THE SPEECH OF POLLY BAKER1

The Speech of Miss Polly Baker before a Court of Judicatory, in New England, where she was prosecuted for a fifth time, for having a Bastard Child; which influenced the Court to dispense with her punishment, and which induced one of her judges to marry her the next day—by whom she had fifteen children.

"May it please the honourable bench to indulge me in a few words: I am a poor, unhappy woman, who have no money to fee lawyers to plead for me, being hard put to it to get a living. I shall not trouble your honours with long speeches; for I have not the presumption to expect that you may, by any means, be prevailed on to deviate in your sentence from the law, in my favour. All I humbly hope is, that your honours would charitably move the governor's goodness on my behalf, that my fine may be remitted. This is the fifth time, gentlemen, that I have been dragged before your court on the same account; twice I have paid heavy fines, and twice I have been brought to public punishment, for want of money to pay those fines. This may have been agreeable to the laws, and I don't dispute it; but since the laws are sometimes unreasonable in themselves, and therefore repealed; and others bear too hard on the subject in particular instances, and therefore there is left a power somewhere to dispense with the execution of them, I take the liberty to say, that I think this law, by which I am punished, both unreasonable in itself, and particularly severe with regard to me, who have always lived an inoffensive life in the neighbourhood where I was born, and defy my enemies (if I have any) to say I have wronged any man, woman, or child. Abstracted from the law, I cannot conceive (may it please your honours) what the nature of my offence is. I have brought five children into the world, at the risque of my life; I have maintained them well by my own industry, without burthening the township, and would have done it better, if it had not been for the heavy charges and fines I have paid. Can it be a crime (in the nature of things, I mean) to add to the King's subjects, in a new country that really wants people? I own it, I should think it rather a praiseworthy than a punishable action. I have debauched no other woman's husband, nor enticed any youth; these things I never was charged with; nor has any one the least cause of complaint against me, unless, perhaps, the ministers of justice, because I have had children without being married, by which they have missed a wedding fee. But can this be a fault of mine? I appeal to your honours. You are pleased to allow I don't want sense; but I must be stupefied to the last degree, not to prefer the honourable state of wedlock to the condition I have lived in. I always was, and still am willing to enter into it; and doubt not my behaving well in it, having all the industry, frugality, fertility, and skill in economy appertaining to a good wife's character. I defy any one to say I ever refused an offer of that sort; on the contrary, I readily consented to the only proposal of marriage that ever was made me, which was when I was a virgin, but too easily confiding in the person's sincerity that made it, I unhappily lost my honour by trusting to his; for he got me with child, and then forsook me.

That very person, you all know, he is now become a magistrate of this country; and I had hopes he would have appeared this day on the bench, and have endeavoured to moderate the Court in my favour; then I should have scorned to have mentioned it; but I must now complain of it, as unjust and unequal, that my betrayer, and undoer, the first cause of all my faults and miscarriages (if they must be deemed such), should be advanced to honor and power in the government that punishes my misfortunes with stripes and infamy. I should be told, 't is like, that were there no act of Assembly in the case, the precepts of religion are violated by my transgressions. If mine is a religious transgression, leave it to religious punishment. You have already excluded me from the comforts of your church communion. Is not that sufficient? What need is there then of your additional fines and whipping? You believe I have offended heaven, and must suffer eternal fire; will not that be sufficient? I own I do not think as you do, for, if I thought what you call a sin was really such, I could not presumptuously commit it. But how can it be believed that Heaven is angry at my having children, when to the little done by me towards it, God has been pleased to add his divine skill and admirable workmanship in the formation of their bodies, and crowned the whole by furnishing them with rational and immortal souls? Forgive me, gentlemen, if I talk a little extravagantly on these matters: I am no divine, but if you, gentlemen, must be making laws, do not turn natural and useful actions into crimes by your prohibitions. But take into your wise consideration the great and growing number of bachelors in the country, many of whom, from the mean fear of the expense of a family, have never sincerely and honestly courted a woman in their lives; and by their manner of living leave unproduced (which is little better than murder) hundreds of their posterity to the thousandth generation. Is not this a greater offence against the public good than mine? Compel them, then, by law, either to marriage, or to pay double the fine of fornication every year. What must poor young women do, whom customs and nature forbid to solicit the men, and who cannot force themselves upon husbands, when the laws take no care to provide them any, and yet severely punish them if they do their duty without them; the duty of the first and great command of nature and nature's God, increase and multiply; a duty, from the steady performance of which nothing has been able to deter me, but for its sake I have hazarded the loss of the public esteem, and have frequently endured public disgrace and punishment; and therefore ought, in my humble opinion, instead of a whipping, to have a statue erected to my memory."

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XXXIX

THE DRINKER’S DICTIONARY

A

He is addled.

He ’s casting up his accounts.

afflicted.

He ’s in his airs.

B

He ’s Biggy.

Bewitched.

He ’s Block and Block.

Boozy.

Bowz’d.

Been at Barbadoes.

Drunk as a Wheelbarrow.

Burdock’d.

Busky.

Buzzey.

Has stole a Manchet out of the Brewer’s Basket.

His head is full of Bees.

Has been in the Bibbing Plot.

drank more than he has bled.

He ’s Bungey.

As drunk as a Beggar.

He sees the Bears.

He ’s kiss’d Black Betty.

had a thump over the head with Sampson’s Jawbone.

Bridgey.

C

He ’s Cat.

Cagrin’d.

Capable.

He ’s Cramp’d.

Cherubimical.

Cherry Merry.

Wamble Crop’d.

Crack’d.

Concern’d.

Half way to Concord.

Has taken a Chirriping-Glass.

Got Corns in his head.

A Cup too much.

Coguy.

Copey.

He ’s heat his Copper.

Crocus.

Catch’d.

He cuts his Capers.

He ’s been in the Cellar.

in his Cups.

Non Compos.

Cock’d.

Curv’d.

Cut.

Chipper.

Chickery.

Loaded his Cart.

Been too free with the Creature.

Sir Richard has taken off his Considering Cap.

He ’s Chap-fallen.

D

He ’s Disguiz’d.

Got a Dish.

Killed his Dog.

Took his Drops.

It is a Dark Day with him.

He ’s a Dead Man.

Has Dipp’d his Bill.

He ’s Dagg’d.

seen the Devil.

E

He ’s Prince Eugene.

Enter’d.

Wet both Eyes.

Cock Ey’d.

Got the Pole Evil.

Got a brass Eye.

Made an Example.

Eat a Load & a half for breakfast.

In his Element.

F

He ’s Fishey.

Fox’d.

Fuddled.

Sore Footed.

Frozen.

Well in for ’t.

He Owes no man a Farthing.

Fears no Man.

He ’s Crump Footed.

Been to France.

Flush’d.

Froze his Mouth.

Fetter’d.

Been to a Funeral.

His Flag is out.

He ’s Fuzl’d.

Spoke with his Friend.

Been at an Indian Feast.

G

He ’s Glad.

Groatable.

Gold-headed.

Glaiz’d.

Generous.

Booz’d the Gage.

As Dizzy as a Gooze.

Been before George.

Got the Gout.

Had a Kick in the Guts.

Been with Sir John Goa.

Been at Geneva.

He ’s Globular.

Got the Glanders.

H

He ’s Half and Half.

Hardy.

Top Heavy.

Got by the Head.

Hiddey.

Got on his little Hat.

Hammerish.

Loose in the Hilts.

Knows not the way Home.

Got the Hornson.

Haunted with Evil Spirits.

Has taken Hippocrates’ Grand Elixir.

I

He ’s Intoxicated.

J

He ’s Jolly.

Jagg’d.

Jambl’d.

Going to Jerusalem.

Jocular.

He ’s Been to Jerico.

Juicy.

K

He ’s a King.

Clips the King’s English.

Seen the French King.

The King is his Cousin.

Got Kib’d Heels.

Knapt.

Het his Kettle.

L

He ’s in Liquor.

Lordly.

He makes Indentures with his Leggs.

Well to Live.

Light.

Lappy.

Limber.

M

He sees two Moons.

Merry.

He ’s Middling.

Moon-eyed.

Muddled.

Seen a Flock of Moons.

Maudlin.

Mountous.

Muddy.

Rais’d his Monuments.

Mellow.

N

He ’s Eat the Cocoa Nut.

Nimptopsical.

Got the Night Mare.

O

He ’s Oiled.

Eat Opium.

Smelt of an Onion.

Oxycrocium.

Overset.

P

He drank till he gave up his Half Penny.

He ’s Pidgeon Ey’d.

Pungey.

He ’s Priddy.

As good conditioned as a Puppy.

Has Scalt his Head Pan.

Been among the Philistines.

In his Prosperity.

He ’s been among the Philippians.

contending with Pharaoh.

Wasted his Paunch.

Polite.

Eats a Pudding Bag.

Q

He ’s Quarrelsome.

R

He ’s Rocky.

Raddled.

Rich.

Religious.

Lost his Rudder.

Ragged.

Rais’d.

Been too free with Sir Richard.

Like a Rat in Trouble.

S

He ’s Stitch’d.

Seafaring.

In the Sudds.

Strong.

Been in the Sun.

as Drunk as David’s Sow.

Swampt.

His Skin is full.

He ’s Steady.

Stiff.

burnt his Shoulder.

got his Top Gallant Sails out.

Seen the yellow Star.

As Stiff as a Ring-bolt.

Half Seas over.

His Shoe pinches him.

He ’s Staggerish.

It is Star - light with him.

He carries too much Sail.

He ’s Stew’d.

Stubb’d.

Soak’d.

Soft.

Been too free with Sir John Strawberry.

He ’s right before the wind with all his Studding Sails out.

Has sold his Senses.

T

He ’s Top’d.

Tongue-ty’d.

Tann’d.

Tipium Grove.

Double Tongu’d.

Topsy-Turvey.

Tipsey.

swallowed a Tavern Token.

Thaw’d.

in a Trance.

Trammel’d.

V

He makes Virginia Fence.

Valiant.

Got the Indian Vapours.

W

The Malt is above the Water.

He ’s Wise.

He ’s Wet.

been to the Salt Water.

He ’s Water Soaken.

very Weary.

Out of the Way.

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XL

ON SCANDAL

Mr. Gazetteer:

I was highly pleased with your last week's paper upon Scandal, as the uncommon doctrine therein preached is agreeable both to my principles and practice, and as it was published very seasonably to reprove the impertinence of a writer in the foregoing Thursday's *Mercury,* who, at the conclusion of one of his silly paragraphs, laments forsooth, that the fair sex are so peculiarly guilty of this enormous crime. Every blockhead, ancient and modern, that could handle a pen, has, I think, taken upon him to cant in the same senseless strain. If to *scandalize* be really a crime, what do these puppies mean? They describe it, they dress it up in the most odious, frightful, and detestable colors, they represent it as the worst of crimes, and then roundly and charitably charge the whole race of womankind with it. Are not they then guilty of what they condemn, at the same time that they condemn it? If they accuse us of any other crime, they must necessarily scandalize while they do it; but to scandalize us with being guilty of scandal, is in itself an egregious absurdity, and can proceed from nothing but the most consummate impudence in conjunction with the most profound stupidity.

This supposing, as they do, that to scandalize is a crime, you have convinced all reasonable people is an opinion absolutely erroneous. Let us leave, then, these select mock-moralists, while I entertain you with some account of my life and manners.

I am a young girl of about thirty-five, and live at present with my mother. I have no care upon my head of getting a living, and therefore find it my duty, as well as inclination, to exercise my talent at *censure,* for the good of my country-folks. There was, I am told, a certain generous emperor, who, if a day had passed over his head in which he had conferred no benefit on any man, used to say to his friends, in Latin, *diem perdidi,* that is, it seems, *I have lost a day.* I believe I should make use of the same expression, if it were possible for a day to pass in which I had not, or missed, an opportunity to scandalize somebody; but, thanks be praised, no such misfortune has befell me these dozen years.

Yet, whatever good I may do, I cannot pretend that I at first entered into the practice of this virtue from a principle of public spirit; for I remember that, when a child, I had a violent inclination to be ever talking in my own praise; and being continually told that it was ill manners, and once severely whipped for it, the confined stream formed for itself a new channel, and I began to speak for the future in the dispraise of others. This I found more agreeable to company, and almost as much so to myself; for what great difference can there be between putting yourself up, or putting your neighbour down? *Scandal,* like other virtues, is in part its own reward, as it gives us the satisfaction of making ourselves appear better than others, or others no better than ourselves.

My mother, good woman, and I, have heretofore differed upon this account. She argued, that scandal spoilt all good conversation; and I insisted that without it there would be no such thing. Our disputes once rose so high that we parted tea-tables, and I concluded to entertain my acquaintance in the kitchen. The first day of this separation we both drank tea at the same time, but she with her visitors in the parlour. She would not hear of the least objection to any one’s character, but began a new sort of discourse in some such queer philosophical manner as this: “I am mightily pleased sometimes,” says she, “when I observe and consider that the world is not so bad as people out of humor imagine it to be. There is something amiable, some good quality or other, in every body. If we were only to speak of people that are least respected, there is such a one is very dutiful to her father, and methinks has a fine set of teeth; such a one is very respectful to her husband; such a one is very kind to her poor neighbours, and, besides, has a very handsome shape; such a one is always ready to serve a friend, and, in my opinion, there is not a woman in town that has a more agreeable air or gait.” This fine kind of talk, which lasted near half an hour, she concluded by saying, “I do not doubt but every one of you has made the like observations, and I should be glad to have the conversation continued upon this subject.” Just at this juncture I peeped in at the door, and never in my life before saw such a set of simple, vacant countenances. They looked somehow neither glad nor sorry, nor angry nor pleased, nor indifferent nor attentive; but (excuse the simile) like so many images of rye-dough. I, in the kitchen, had already begun a ridiculous story of Mr. ——’s intrigue with his maid, and his wife’s behaviour on the discovery; at some of the passages we laughed heartily; and one of the gravest of mamma’s company, without making any answer to her discourse, got up *to go and see what the girls were so merry about.* She was followed by a second, and shortly by a third, till at last the old gentlewoman found herself quite alone, and being convinced that her project was impracticable, came herself and finished her tea with us; ever since which *Saul also has been among the prophets,* and our disputes lie dormant.

By industry and application I have made myself the centre of all the scandal in the province. There is little stirring, but I hear of it. I began the world with this maxim, that no trade can subsist without returns, and, accordingly, whenever I received a good story, I endeavoured to give two or a better in the room of it. My punctuality in this way of dealing gave such encouragement, that it has procured me an incredible deal of business, which, without diligence and good method, it would be impossible for me to go through. For, besides the stock of defamation thus naturally flowing in upon me, I practise an art by which I can pump scandal out of people that are the least inclined that way. Shall I discover my secret? Yes; to let it die with me would be inhuman. If I have never heard ill of some person, I always impute it to defective intelligence; *for there are none without their faults; no, not one.* If she be a woman, I take the first opportunity to let all her acquaintance know I have heard that one of the handsomest or best men in town has said something in praise either of her beauty, her wit, her virtue, or her good management. If you know any thing of human nature, you perceive that this naturally introduces a conversation turning upon all her failings, past, present, and to come. To the same purpose, and with the same success, I cause every man of reputation to be praised before his competitors in love, business, or esteem, on account of any particular qualification. Near the times of election, if I find it necessary, I commend every candidate before some of the opposite party, listening attentively to what is said of him in answer. But commendations in this latter case are not always necessary, and should be used judiciously. Of late years I needed only observe what they said of one another freely; and having, for the help of memory, taken account of all informations and accusations received, whoever peruses my writings after my death may happen to think that during a certain time the people of Pennsylvania chose into all their offices of honor and trust the veriest knaves, fools, and rascals in the whole province. The time of election used to be a busy time with me; but this year, with concern I speak it, people are grown so good-natured, so intent upon mutual feasting and friendly entertainment, that I see no prospect of much employment from that quarter.

I mentioned above, that without good method I could not go through my business. In my father’s lifetime I had some instruction in accounts, which I now apply with advantage to my own affairs. I keep a regular set of books, and can tell, at an hour’s warning, how it stands between me and the world. In my *Daybook* I enter every article of defamation as it is transacted; for scandals *received in* I give credit, and when I pay them out again I make the persons to whom they respectively relate *debtor.* In my *Journal* I add to each story, by way of improvement, such probable circumstances as I think it will bear; and in my *Ledger* the whole is regularly posted.

I suppose the reader already condemns me in his heart for this particular of *adding circumstances;* but I justify this part of my practice thus. It is a principle with me, that none ought to have a greater share of reputation than they really deserve; if they have, it is an imposition upon the public. I know it is every one’s interest, and therefore believe they endeavour to conceal all their vices and follies; and I hold that those people are *extraordinary* foolish or careless, who suffer one fourth of their failings to come to public knowledge. Taking then the common prudence and imprudence of mankind in a lump, I suppose none suffer above one fifth to be discovered; therefore, when I hear of any person’s misdoing, I think I keep within bounds if in relating it I only make it three times worse than it is; and I reserve to myself the privilege of charging them with one fault in four, which for aught I know they may be entirely innocent of. You see, there are but few so careful of doing justice as myself. What reason then have mankind to complain of *scandal?* In a general way the worst that is said of us is only half what might be said, if all our faults were seen.

But, alas! two great evils have lately befallen me at the same time: an extreme cold, that I can scarce speak; and a most terrible tooth-ache, that I dare hardly open my mouth. For some days past I have received ten stories for one I have paid; and I am not able to balance my accounts without your assistance. I have long thought that if you would make your paper a vehicle of scandal, you would double the number of your subscribers. I send you herewith accounts of four knavish tricks, two * * *, five * * * * *, three drubbed wives, and four henpecked husbands, all within this fortnight; which you may, as articles of news, deliver to the public, and, if my tooth-ache continues, I shall send you more, being in the mean time your constant reader,

Alice Addertongue.

I thank my correspondent, Mrs. Addertongue, for her good will, but desire to be excused inserting the articles of news she has sent me, such things being in reality no news at all.

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XLI

A CASE OF CASUISTRY

to the printer of the "gazette"

According to the request of your correspondent, T. P., I send you my thoughts on the following case by him proposed, viz.:

A man bargains for the keeping of his horse six months, whilst he is making a voyage to Barbadoes. The horse strays or is stolen soon after the keeper has him in possession. When the owner demands the value of his horse in money, may not the other as justly demand so much deducted as the keeping of the horse six months amounts to?

It does not appear that they had any dispute about the value of the horse, whence we may conclude there was no reason for such dispute, but it was well known how much he cost, and that he could not honestly have been sold again for more. But the value of the horse is not expressed in the case, nor the sum agreed for keeping him six months; wherefore, in order to our more clear apprehension of the thing, let *ten pounds* represent the horse's value, and *three pounds* the sum agreed upon for his keeping.

Now the sole foundation on which the keeper can found his demand of a deduction for keeping a horse he did not keep, is this: "Your horse," he may say, "which I was to restore to you at the end of six months, was worth ten pounds; if I now give you ten pounds, it is an equivalent for your horse, and equal to returning the horse itself. Had I returned your horse (value ten pounds), you would have paid me three pounds for his keeping, and therefore would have received in fact, but seven pounds clear. You then suffer no injury, if I now pay you seven pounds, and consequently you ought in reason to allow me the remaining three pounds, according to our agreement."

But the owner of the horse may possibly insist upon being paid the whole sum of ten pounds, without allowing any deduction for his keeping after he was lost, and that for these reasons:

1. It is always supposed, unless an express agreement be made to the contrary, when horses are put out to keep, that the keeper is at the risk of them, unavoidable accidents only excepted, wherein no care of the keeper can be supposed sufficient to preserve them,

such as their being slain by lightning or the like. This you yourself tacitly allow when you offer to restore me the value of my horse. Were it otherwise, people, having no security against a keeper’s neglect or mismanagement, would never put horses out to keep.

2. Keepers, considering the risk they run, always demand such a price for keeping horses that, if they were to follow the business twenty years, they may have a living profit, though they now and then pay for a horse they have lost; and if they were to be at no risk they might afford to keep horses for less than they usually have. So that what a man pays for his horse’s keeping, more than the keeper could afford to take if he ran no risk, is in the nature of a premium for the insurance of his horse. If I then pay you for the few days you kept my horse, you should restore me his full value.

3. You acknowledge that my horse eat of your hay and oats but a few days. It is unjust, then, to charge me for all the hay and oats that he only might have eat in the remainder of the six months, and which you have now still good in your stable. If, as the proverb says, it is unreasonable to expect a horse should void oats, which never eat any, it is certainly as unreasonable to expect payment for those oats.

4. If men in such cases as this are to be paid for keeping horses when they were not kept, then they have a great opportunity of wronging the owners of horses. For by privately selling my horse for his value (ten pounds) soon after you had him in possession, and returning me, at the expiration of the time, only seven pounds, demanding three pounds as a deduction agreed for his keeping, you get that three pounds clear into your pocket, besides the use of my money six months for nothing.

5. But, you say, the value of my horse being ten pounds, if you deduct three for his keeping and return me seven, it is all I would in fact have received had you returned my horse; therefore, as I am no loser, I ought to be satisfied. This argument, were there any weight in it, might serve to justify a man in selling, as above, as many of the horses he takes to keep as he conveniently can, putting clear into his own pocket that charge their owners must have been at for their keeping; for, this being no loss to the owners, he may say: “Where no man is a loser, why should not I be a gainer?” I need only answer to this, that I allow the horse cost me but ten pounds, nor could I have sold him for more had I been disposed to part with him; but this can be no reason why you should buy him of me at that price, whether I will sell him or not. For it is plain I valued him at thirteen pounds, otherwise I should not have paid ten pounds for him, and agreed to give you three pounds more for his keeping till I had occasion to use him. Thus, though you pay me the

whole ten pounds which he cost me (deducting only for his keeping those few days), I am still a loser: I lose the charge of those days' keeping; I lose the three pounds at which I valued him above what he cost me; and I lose the advantage I might have made of my money in six months, either by the interest, or by joining it to my stock in trade in my voyage to Barbadoes.

6. Lastly, whenever a horse is put to keep, the agreement naturally runs thus: The keeper says: "I will feed your horse six months on good hay and oats, if, at the end of that time, you pay me three pounds." The owner says: "If you will feed my horse six months on good hay and oats, I will pay you three pounds at the end of that time." Now we may plainly see the keeper's performance of his part of the agreement must be antecedent to that of the owner; and, the agreement being wholly conditional, the owner's part is not in force till the keeper has performed his. You, then, not having fed my horse six months, as you agreed to do, there lies no obligation on me to pay for so much feeding.

Thus we have heard what can be said on both sides. Upon the whole, I am of opinion that no deduction should be allowed for the keeping of the horse after the time of his straying.

I Am Yours, &C.,

The Casuist.

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XLII

PLAIN TRUTH OR SERIOUS CONSIDERATIONS ON THE PRESENT STATE OF THE CITY OF PHILADELPHIA AND PROVINCE OF PENNSYLVANIA

by a tradesman of philadelphia

Captâ urbe, nihil fit reliqui victis. Sed, per deos immortales, vos ego appello, qui semper domos, villas, signa, tabulas vestras, [tantæ æstimationis] fecistis; si ista, cujuscumque modi sint, quæ amplexamini, retinere, si voluptatibus vestris otium præbere vultis; expergiscimini aliquando, et capessite rempublicam. Non agitur [nunc] . . . . de sociorum injuriis; *libertas et anima* nostra in dubio est. . . . . . Duc hostium cum exercitu supra caput est. Vos cunctamini etiam nunc, et dubitatis quid . . . . . faciatis? . . . . . Scilicet res ipsa aspera est, sed vos non timetis eam. Imo vero maxime; sed inertiâ et mollitiâ animi, alius alium exspectantes, cunctamini; videlicet diis immortalibus confisi, qui hanc rempublicam in maximis sæpe periculis servavere. *Non votis neque suppliciis muliebribus, auxilia deorum parantur;* vigilando, agendo, bene consulendo, prospere omnia cedunt. Ubi socordiæ te atque ignaviæ tradideris, nequicquam deos implores; irati infestique sunt.—*M. por. Cato, in Sallust.*

TRANSLATION

Should the city be taken, all will be lost to the conquered. Therefore, if you desire to preserve your buildings, houses, and country-seats, your statues, paintings, and all your other possessions, which you so highly esteem; if you wish to continue in the enjoyment of them, or to have leisure for any future pleasures, I beseech you by the immortal Gods, rouse at last, awake from your lethargy, and save the commonwealth. It is not the trifling concern of injuries from your allies that demands your attention; your liberties, lives, and fortunes, with every thing that is interesting and dear to you, are in the most imminent danger. Can you doubt of or delay what you ought to do, now, when the enemy's swords are unsheathed, and descending on your heads? The affair is shocking and horrid! Yet, perhaps, you are not afraid. Yes, you are terrified to the highest degree. But through indolence and supineness of soul, gazing at each other, to see who shall first rise to your succor; and a presumptuous dependence on the immortal Gods, who indeed have preserved this republic in many dangerous seasons; you delay and neglect every thing necessary for your preservation. Be not deceived; Divine assistance and protection are not to be obtained by timorous prayers and womanish supplications. To succeed, you must join salutary counsels, vigilance, and courageous actions. If you sink into effeminacy and cowardice; if you desert the tender and helpless, by Providence committed to your charge, never presume to implore the Gods; it will provoke them, and raise their indignation against you.[1]

It is said the wise Italians make this proverbial remark on our nation, viz.: "The English *feel* but they do not *see.*" That is, they are sensible of inconveniences when they are present, but do not take sufficient care to prevent them; their natural courage makes them too little apprehensive of danger, so that they are often surprised by it, unprovided of the proper means of security. When it is too late they are sensible of their imprudence; after great fires they provide buckets and engines; after a pestilence they think of keeping clean their streets and common sewers; and when a town has been sacked by their enemies, they provide for its defence, &c. This kind of after-wisdom is indeed so common with us as to occasion the vulgar though very significant saying, *When the steed is stolen you shut the stable door.*

But the more insensible we generally are of public danger and indifferent when warned of it, so much the more freely, openly, and earnestly ought such as apprehend it, to speak their sentiments, that, if possible, those who seem to sleep, may be awakened to think of some means of avoiding or preventing the mischief before it be too late.

Believing, therefore, that it is my *duty,* I shall honestly speak my mind in the following paper.

War at this time rages over a great part of the known world; our newspapers are weekly filled with fresh accounts of the destruction it everywhere occasions. Pennsylvania, indeed, situate in the centre of the colonies, has hitherto enjoyed profound repose; and though our nation is engaged in a bloody war with two great and powerful kingdoms, yet, defended in a great degree from the French on the one hand, by the northern provinces, and from the Spaniards on the other, by the southern, at no small expense to each, our people have till lately slept securely in their habitations.

There is no British colony, excepting this, but has made some kind of provision for its defence; many of them have therefore never been attempted by an enemy; and others that were attacked have generally defended themselves with success. The length and difficulty of our bay and river have been thought so effectual a security to us, that hitherto no means have been entered into that might discourage an attempt upon us or prevent its succeeding.

But whatever security this might have been while both country and city were poor, and the advantage to be expected scarce worth the hazard of an attempt, it is now doubted whether we can any longer safely depend upon it. Our wealth, of late years much increased, is one strong temptation, our defenceless state another, to induce an enemy to attack us; while the acquaintance they have lately gained with our bay and river, by means of the prisoners and flags of truce they have had among us, by spies which they almost everywhere maintain, and perhaps from traitors among ourselves; with the facility of getting pilots to conduct them; and the known absence of ships of war during the greatest part of the year from both Virginia and New York ever since the war began, render the appearance of success to the enemy far more promising, and therefore highly increase our danger.

That our enemies may have spies abroad, and some even in these colonies, will not be made much doubt of, when it is considered that such has been the practice of all nations in all ages, whenever they were engaged, or intended to engage, in war. Of this we have an early example in the Book of Judges (too pertinent to our case, and therefore I must beg leave a little to enlarge upon it), where we are told (Chap. xviii. v. 2,) that *the children of Dan sent of their family five men from their coasts to spy out the land, and search it, saying, Go, search the land.* These Danites, it seems, were at this time not very orthodox in their religion, and their spies met with a certain idolatrous priest of their own persuasion (v. 3), and they said to him, *Who brought thee hither? What makest thou in this place? And what hast thou here?* [Would to God no such priests were to be found among us.] *And they said unto him* (v. 5), *Ask counsel of God, that we may know whether our way which we go shall be prosperous; and the priest said unto them, Go in peace; before the Lord is your way wherein you go.* [Are there no priests among us, think you, that might, in the like case, give an enemy as good encouragement? It is well known that we have numbers of the same religion with those who of late encouraged the French to invade our mother country.] *And they came* (v. 7), *to Laish, and saw the people that were therein, how they dwelt*careless,*after the manner of the Zidonians,*quiet,*and*secure. They *thought* themselves secure, no doubt; and as they *never had been* disturbed, vainly imagined they *never should be.* It is not unlikely that some might see the danger they were exposed to by living in that *careless* manner; but that, if these publicly expressed their apprehensions, the rest reproached them as timorous persons, wanting courage or confidence in their gods, who (they might say) had hitherto protected them. But the spies (v. 8) returned, and said to their countrymen (v. 9): *Arise, that we may go up against them; for we have seen the land, and behold it is very good. And are ye still? Be not slothful to go.* (Verse 10): *When ye go, ye shall come to a people*secure [that is, a people that apprehend no danger, and therefore have made no provision against it; great encouragement this!], *and to a large land, and a place where there is no want of any thing.* What could they desire more? Accordingly, we find in the following verses that *six hundred men* only, *appointed with weapons of war,* undertook the conquest of this *large land;* knowing that six hundred men, armed and disciplined, would be an overmatch perhaps for sixty thousand unarmed, undisciplined, and off their guard. And when they went against it, the idolatrous priest (v. 17), *with his graven image, and his ephod, and his teraphim, and his molten image* (plenty of superstitious trinkets), joined with them, and, no doubt, gave them all the intelligence and assistance in his power; his heart, as the text assures us, *being glad,* perhaps for reasons more than one. And, now, what was the fate of poor Laish? The six hundred men being arrived, found, as the spies had reported, a people quiet and secure (vv. 27, 28). *And they smote them with the edge of the sword, and burnt the city with*fire;*and there was no*deliverer,*because it was far from Zidon.*—Not so far from Zidon, however, as Pennsylvania is from Britain; and yet we are, if possible, more careless than the people of Laish! As the Scriptures are given for our reproof, instruction, and warning, may we make a due use of this example before it be too late!

And is our country, any more than our city, altogether free from danger? Perhaps not. We have, it is true, had a long peace with the Indians; but it is a long peace indeed, as well as a long lane, that has no ending. The French know the power and importance of the Six Nations, and spare no artifice, pains, or expense to gain them to their interest. By their priests they have converted many to their religion, and these[1] have openly espoused their cause. The rest appear irresolute what part to take; no persuasions, though enforced with costly presents, having yet been able to engage them generally on our side, though we had numerous forces on their borders ready to second and support them. What then may be expected, now those forces are, by orders from the crown, to be disbanded; when our boasted expedition is laid aside through want (as it may appear to them) either of strength or courage; when they see that the French and their Indians boldly and with impunity ravage the frontiers of New York, and scalp the inhabitants; when those few Indians that engaged with us against the French are left exposed to their resentment? When they consider these things, is there no danger, through disgust at our usage, joined with fear of the French power, and greater confidence in their promises and protection than in ours, they may be wholly gained over by our enemies, and join in the war against us? If such should be the case, which God forbid, how soon may the mischief spread to our frontier counties? And what may we expect to be the consequence, but desertion of plantations, ruin, bloodshed, and confusion?

Perhaps some in the city, towns, and plantations near the river may say to themselves: "An Indian war on the frontiers will not affect us; the enemy will never come near our habitations; let those concerned take care of themselves." And others who live in the country, when they are told of the danger the city is in from attempts by sea, may say: "What is that to us? The enemy will be satisfied with the plunder of the town, and never think it worth his while to visit our plantations; let the town take care of itself." These are not mere suppositions, for I have heard some talk in this strange manner. But are these the sentiments of true Pennsylvanians, of fellow-countrymen, or even of men that have common-sense or goodness? Is not the whole province one body, united by living under the same laws and enjoying the same privileges? Are not the people of city and country connected as relations, both by blood and marriage, and in friendships equally dear? Are they not likewise united in interest, and mutually useful and necessary to each other? When the feet are wounded, shall the head say: "It is not I; I will not trouble myself to contrive relief!" Or if the head is in danger, shall the hands say: "We are not affected, and therefore will lend no assistance!" No. For so would the body be easily destroyed; but when all parts join their endeavours for its security, it is often preserved. And such should be the union between the country and the town; and such their mutual endeavours for the safety of the whole. When New England, a distant colony, involved itself in a grievous debt to reduce Cape Breton, we freely gave four thousand pounds for *her* relief. And at another time, remembering that Great Britain, still more distant, groaned under heavy taxes in supporting the war, we threw in our mite to her assistance, by a free gift of three thousand pounds; and shall country and town join in helping strangers (as those comparatively are), and yet refuse to assist each other?

But whatever different opinions we have of our security in other respects, our trade, all seem to agree, is in danger of being ruined in another year. The great success of our enemies, in two different cruises this last summer in our bay, must give them the greatest encouragement to repeat more frequently their visits, the profit being almost certain, and the risk next to nothing. Will not the first effect of this be an enhancing of the price of all foreign goods to the tradesman and farmer who use or consume them? For the rate of insurance will increase in proportion to the hazard of importing them; and in the same proportion will the price of those goods increase. If the price of the tradesman's work and the farmer's produce would increase equally with the price of foreign commodities, the damage would not be so great; but the direct contrary must happen. For the same hazard or rate of insurance that raises the price of what is imported, must be deducted out of and lower the price of what is exported. Without this addition and deduction, as long as the enemy cruise at our capes, and take those vessels that attempt to *go out,* as well as those that endeavour to *come in,* none can afford to trade, and business must be soon at a stand. And will not the consequences be a discouragement of many of the vessels that used to come from other places to purchase our produce, and thereby a turning of the trade to ports that can be entered with less danger, and capable of furnishing them with the same commodities as New York, &c.; a lessening of business to every shopkeeper, together with multitudes of bad debts, the high rate of goods discouraging the buyers, and the low rates of their labor and produce rendering them unable to pay for what they had bought; loss of employment to the tradesman, and bad pay for what little he does; and, lastly, loss of many inhabitants, who will retire to other provinces not subject to the like inconveniences; whence a lowering of the value of lands, lots, and houses?

The enemy, no doubt, have been told that the people of Pennsylvania are Quakers, and against all defence, from a principle of conscience. This, though true of a part, and that a small part only, of the inhabitants, is commonly said of the whole; and what may make it look probable to strangers is that, in fact, nothing is done by any part of the people towards their defence. But to refuse defending one’s self, or one’s country, is so unusual a thing among mankind, that possibly they may not believe it till, by experience, they find they can come higher and higher up our river, seize our vessels, land and plunder our plantations and villages, and retire with their booty unmolested. Will not this confirm the report, and give them the greatest encouragement to strike one bold stroke for the city and for the whole plunder of the river?

It is said by some that the expense of a vessel to guard our trade would be very heavy, greater than perhaps all the enemy can be supposed to take from us at sea would amount to, and that it would be cheaper for the government to open an insurance office and pay all losses. But is this right reasoning? I think not; for what the enemy takes is clear loss to us and gain to him, increasing his riches and strength as much as it diminishes ours, so making the difference double; whereas the money paid our own tradesmen for building and fitting out a vessel of defence remains in the country and circulates among us; what is paid to the officers and seamen that navigate her is also spent ashore, and soon gets into other hands; the farmer receives the money for her provisions, and, on the whole, nothing is clearly lost to the country but her wear and tear, or so much as she sells for at the end of the war less than her first cost. This loss, and a trifling one it is, is all the inconvenience; but how many and how great are the conveniences and advantages! And should the enemy, through our supineness and neglect to provide for the defence both of our trade and country, be encouraged to attempt this city, and, after plundering us of our goods, either burn it or put it to ransom, how great would that loss be, besides the confusion, terror, and distress so many hundreds of families would be involved in!

The thought of this latter circumstance so much affects me that I cannot forbear expatiating somewhat more upon it. You have, my dear countrymen and fellow-citizens, riches to tempt a considerable force to unite and attack you, but are under no ties or engagements to unite for your defence. Hence, on the first alarm, terror will spread over all; and as no man can with certainty depend that another will stand by him, beyond doubt very many will seek safety by a speedy flight. Those that are reputed rich will flee through fear of torture to make them produce more than they are able. The man that has a wife and children will find them hanging on his neck, beseeching him with tears to quit the city and save his life, to guide and protect them in that time of general desolation and ruin. All will run into confusion, amidst cries and lamentations, and the hurry and disorder of departers carrying away their effects. The few that remain will be unable to resist. Sacking the city will be the first, and burning it, in all probability, the last act of the enemy. This, I believe, will be the case if you have timely notice. But what must be your condition, if suddenly surprised, without previous alarm, perhaps in the night! Confined to your houses, you will have nothing to trust to but the enemy’s mercy. Your best fortune will be to fall under the power of commanders of king’s ships able to control the mariners, and not into the hands of *licentious privateers.* Who can, without the utmost horror, conceive the miseries from the latter, when your persons, fortunes, wives, and daughters shall be subject to the wanton and unbridled rage, rapine, and lust of negroes, mulattoes, and others, the vilest and most abandoned of mankind.[1] A dreadful scene! which some may represent as exaggerated. I think it my duty to warn you; judge for yourselves.

It is true, with very little notice the rich may shift for themselves. The means of speedy flight are ready in their hands; and with some previous care to lodge money and effects in distant and secure places, though they should lose much, yet enough may be left them, and to spare. But most unhappily circumstanced indeed are we, the middling people, the tradesmen, shopkeepers, and farmers of the province and city! We cannot all fly with our families; and if we could, how shall we subsist? No; we and they, and what little we have gained by hard labor and industry, must bear the brunt; the weight of contributions extorted by the enemy (as it is of taxes among ourselves) must be surely borne by us. Nor can it be avoided, as we stand at present; for though we are numerous we are quite defenceless, having neither forts, arms, union, nor discipline. And though it were true that our trade might be protected at no great expense, and our country and our city easily defended, if proper measures were but taken, yet who shall take these measures? Who shall pay that expense? On whom may we fix our eyes with the least expectation that they will do any thing for our security? Should we address that wealthy and powerful body of people who have ever since the war governed our elections and filled almost every seat in our Assembly;—should we entreat them to consider, if not as friends, at least as legislators, that *protection* is as truly due from the government to the people, as *obedience* from the people to the government; and that if, on account of their religious scruples, they themselves could do no act for our defence, yet they might retire, relinquish their power for a season, quit the helm to freer hands during the present tempest—to hands, chosen by their own interest too, whose prudence and moderation, with regard to them, they might safely confide in, secure, from their own native strength, of resuming again their present station whenever it shall please them;—should we remind them, that the public money, raised *from all,* belongs *to all;* that since they have, for their own ease, and to secure themselves in the quiet enjoyment of their religious principles (and may they long enjoy them), expended such large sums to oppose petitions, and engage favorable representations of their conduct, if they themselves could by no means be free to appropriate any part of the public money for our defence, yet it would be no more than justice to spare us a reasonable sum for that purpose, which they might easily give to the King’s use as heretofore, leaving all the appropriation to others, who would faithfully apply it as we desired;—should we tell them, that, though the treasury be at present empty, it may soon be filled by the outstanding public debts collected, or at least credit might be had for such a sum, on a single vote of the Assembly; that though *they* themselves may be resigned and easy under this naked, defenceless state of the country, it is far otherwise with a very great part of the people,—with *us,* who can have no confidence that God will protect those that neglect the use of rational means for their security, nor have any reason to hope that our losses, if we should suffer any, may be made up by collections in our favor at home;—should we conjure them by all the ties of neighbourhood, friendship, justice, and humanity to consider these things; and what distraction, misery, and confusion, what desolation and distress, may possibly be the effect of their *unseasonable* predominancy and perseverance:—yet all would be in vain; for they have already been, by great numbers of the people, petitioned in vain. Our late Governor did for years solicit, request, and even threaten them in vain. The Council have since twice remonstrated to them in vain. Their religious prepossessions are unchangeable, their obstinacy invincible. Is there, then, the least hope remaining, that from that quarter any thing should arise for our security?

And is our prospect better, if we turn our eyes to the strength of the opposite party, those great and rich men, merchants and others, who are ever railing at Quakers for doing what their principles seem to require, and what in charity we ought to believe they think their duty, but take no one step themselves for the public safety? They have so much wealth and influence, if they would use it, that they might easily, by their endeavours and example, raise a military spirit among us, make us fond, studious of, and expert in, martial discipline, and effect every thing that is necessary, under God, for our protection. But *envy* seems to have taken possession of their hearts, and to have eaten out and destroyed every generous, noble, public-spirited sentiment. *Rage,* at the disappointment of their little schemes for power, gnaws their souls, and fills them with such cordial hatred to their opponents, that every proposal, by the execution of which *those* may receive benefit as well as themselves, is rejected with indignation. “What,” they say, “shall we lay out our money to protect the trade of Quakers? Shall we fight to defend Quakers? No; let the trade perish, and the city burn; let what will happen, we shall never lift a finger to prevent it.” Yet the Quakers have *conscience* to plead for their resolution not to fight, which these gentlemen have not. Conscience with you, gentlemen, is on the other side of the question; conscience enjoins it as a *duty* on you (and, indeed, I think it such on every man) to defend your country, your friends, your aged parents, your wives, and helpless children; and yet you resolve not to perform this duty, but act contrary to your own consciences, because the Quakers act according to theirs. Till of late, I could scarce believe the story of him who refused to pump in a sinking ship, because one on board, whom he hated, would be saved by it as well as himself. But such, it seems, is the unhappiness of human nature, that our passions, when violent, often are too hard for the united force of reason, duty, and religion.

Thus unfortunately are we circumstanced at this time, my dear countrymen and fellow-citizens; we, I mean, the middling people, the farmers, shopkeepers, and tradesmen of this city and country. Through the dissensions of our leaders, through mistaken principles of religion, joined with a love of worldly power, on the one hand; through pride, envy, and implacable resentment on the other; our lives, our families, and little fortunes, dear to us as any great man’s can be to him, are to remain continually exposed to destruction from an enterprising, cruel, now well-informed, and by success, encouraged enemy. It seems as if Heaven, justly displeased at our growing wickedness, and determined to punish[1] this once-favored land, had suffered our chiefs to engage in these foolish and mischievous contentions for little posts and paltry distinctions, that our hands might be bound up, our understandings darkened and misled, and every means of our security neglected. It seems as if our greatest men, our *cives nobilissimi*[2] of both parties, had sworn the ruin of the country, and invited the French, our most inveterate enemy, to destroy it. Where then shall we seek for succour and protection? The government we are immediately under denies it to us; and if the enemy comes, we are *far from Zidon, and there is no deliverer near*. Our case is dangerously bad; but perhaps there is yet a remedy, if we have but the prudence and the spirit to apply it.

If this new, flourishing city and greatly improving colony is destroyed and ruined, it will not be for want of numbers of inhabitants able to bear arms in its defence. It is computed that we have at least (exclusive of the Quakers) sixty thousand fighting men, acquainted with firearms, many of them hunters and marksmen, hardy and bold. All we want is order, discipline, and a few cannon. At present we are like the separate filaments of flax before the thread is formed, without strength, because without connexion; but union would make us strong and even formidable, though the *great* should neither help nor join us; though they should even oppose our uniting, from some mean views of their own, yet, if we resolve upon it, and it pleases God to inspire us with the necessary prudence and vigor, it *may* be effected. Great numbers of our people are of British race; and, though the fierce fighting animals of those happy Islands are said to abate their native fire and intrepidity when removed to a foreign clime, yet with the people it is not so; our neighbours of New England afford the world a convincing proof that Britons, though a hundred years transplanted, and to the remotest part of the earth, may yet retain, even to the third and fourth descent, that zeal for the public good, that military prowess, and that undaunted spirit which has in every age distinguished their nation. What numbers have we likewise of *thosebrave people,* whose fathers in the last age made so glorious a stand for our religion and liberties, when invaded by a powerful French army, joined by Irish Catholics, under a bigoted Popish king! Let the memorable siege of Londonderry, and the signal actions of the Iniskillingers, by which the heart of that Prince’s schemes were broken, be perpetual testimonies of the courage and conduct of those noble warriors! Nor are there wanting amongst us thousands of that warlike nation, whose sons have ever since the time of Cæsar maintained the character he gave their fathers, of joining the most obstinate courage to all the other military virtues,—I mean the brave and steady Germans, numbers of whom have actually borne arms in the service of their respective Princes; and if they fought well for their tyrants and oppressors, would they refuse to unite with us in defence of their newly acquired and most precious liberty and property? Were this union formed, were we once united, thoroughly armed and disciplined, was every thing in our power done for our security, as far as human means and foresight could provide, we might then, with more propriety, humbly ask the assistance of Heaven, and a blessing on our lawful endeavours. The very fame of our strength and readiness would be a means of discouraging our enemies; for it is a wise and true saying, that *one sword often keeps another in the scabbard.* The way to secure peace is to be prepared for war. They that are on their guard, and appear ready to receive their adversaries, are in much less danger of being attacked than the supine, secure, and negligent. We have yet a winter before us which may afford a good and almost sufficient opportunity for this, if we seize and improve it with a becoming vigor. And if the hints contained in this paper are so happy as to meet with a suitable disposition of mind in his countrymen and fellow-citizens, the writer of it will, in a few days, lay before them a form of association for the purposes herein mentioned, together with a practicable scheme for raising the money necessary for the defence of our trade, city, and country, without laying a burthen on any man.

May the God of wisdom, strength, and power, the Lord of the armies of Israel, inspire us with prudence in this time of danger, take away from us all the seeds of contention and division, and unite the hearts and counsels of all of us, of whatever sect or nation, in one bond of peace, brotherly love, and generous public spirit; may he give us strength and resolution to amend our lives and remove from among us every thing that is displeasing to him, afford us his most gracious protection, confound the designs of our enemies, and give peace in all our borders, is the sincere prayer of

A Tradesman of Philadelphia.

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XLIII

TO PETER COLLINSON

Philadelphia, 28 March, 1747.

Sir:—

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

I Am, &C.,

B. Franklin.

While on a visit to Boston, in 1746, Franklin witnessed some electrical experiments performed by a Mr. Spence, recently arrived from Scotland. Shortly after his return to Philadelphia the Library Company received from Mr. Collinson, of London, and a member of the Royal Society, a glass tube, with instructions for making experiments with it. With this tube Franklin began a course of experiments which resulted in discoveries which, humanly speaking, seem to be exerting a larger material influence upon the industries of the world than any other discovery of the human intellect. Dr. Stuber, then a resident of Philadelphia, and author of the first continuation of Franklin's life, who seems to have enjoyed peculiar opportunities of obtaining full and authentic information upon the subject, gives us the following account of the observations which this letter brought for the first time to the notice of the world through Mr. Collinson.

"His observations," says Dr. Stuber, "he communicated, in a series of letters, to his friend Collinson, the first of which is dated March

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

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

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

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

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

By these experiments Franklin's theory was established in the most convincing manner.

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

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."

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

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

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

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

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

Dr. Priestley, in his *History of Electricity,* published in the year 1767, gives a full account of Franklin's experiments and discoveries.

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

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

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

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XLIV

TO PETER COLLINSON

Philadelphia, 11 July, 1747.

Sir:—

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

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

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

To show that points will *throw off*[1] as well as *draw off* the electrical fire; lay a long sharp needle upon the shot, and you cannot electrize the shot so as to make it repel the cork ball. Or fix a needle to the end of a suspended gun-barrel, or iron rod, so as to point beyond it like a little bayonet,[2] and while it remains there, the gun-barrel or rod cannot, by applying the tube to the other end, be electrized so as to give a spark, the fire continually running out silently at the point. In the dark you may see it make the same appearance as it does in the case before mentioned.

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

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.[1]

We had for some time been of opinion that the electrical fire was not created by friction, but collected, being really an element diffused among, and attracted by other matter, particularly by water and metals. We had even discovered and demonstrated its afflux to the electrical sphere, as well as its efflux, by means of little, light windmill-wheels made of stiff paper vanes fixed obliquely, and turning freely on fine wire axes; also by little wheels of the same matter, but formed like water-wheels. Of the disposition and application of which wheels, and the various phenomena resulting, I could, if I had time, fill you a sheet.[2] The impossibility of electrizing one's self (though standing on wax) by rubbing the tube, and drawing the fire from it; and the manner of doing it by passing the tube near a person or thing standing on the floor, &c., had also occurred to us some months before Mr. Watson's ingenious *Sequel* came to hand; and these were some of the new things I intended to have communicated to you. But now I need only mention some particulars not hinted in that piece, with our reasonings thereupon; though perhaps the latter might well enough be spared.

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

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

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

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

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

As the vessel is just upon sailing, I cannot give you so large an account of American electricity as I intended; I shall only mention a few particulars more. We find granulated lead better to fill the phial with than water, being easily warmed, and keeping warm and dry in damp air. We fire spirits with the wire of the phial. We light candles, just blown out, by drawing a spark among the smoke between the wire and snuffers. We represent lightning by passing the wire in the dark over a China plate that has gilt flowers, or applying it to gilt frames of looking glasses, &c. We electrize a person twenty or more times running, with a touch of the finger on the wire, thus: He stands on wax. Give him the electrized bottle in his hand. Touch the wire with your finger and then touch his hand or face; there are sparks every time.[1] We increase the force of the electrical kiss vastly, thus: Let *A* and *B* stand on wax, or *A* on wax and *B* on the floor; give one of them the electrized phial in hand; let the other take hold of the wire; there will be a small spark; but when their lips approach they will be struck and shocked. The same if another gentleman and lady, *C* and *D,* standing also on wax, and joining hands with *A* and *B,* salute or shake hands. We suspend by fine silk thread a counterfeit spider made of a small piece of burnt cork, with legs of linen thread, and a grain or two of lead stuck in him to give him more weight. Upon the table, over which he hangs, we stick a wire upright, as high as the phial and wire, four or five inches from the spider; then we animate him by setting the electrified phial at the same distance on the other side of him; he will immediately fly to the wire of the phial, bend his legs in touching it, then spring off and fly to the wire in the table, thence again to the wire of the phial, playing with his legs against both, in a very entertaining manner, appearing perfectly alive to persons unacquainted. He will continue this motion an hour or more in dry weather. We electrify, upon wax in the dark, a book that has a double line of gold round upon the covers, and then apply a knuckle to the gilding; the fire appears everywhere upon the gold like a flash of lightning; not upon the leather, nor if you touch the leather instead of the gold. We rub our tubes with buckskin and observe always to keep the same side to the tube and never to sully the tube by handling; thus they work readily and easily without the least fatigue, especially if kept in tight pasteboard cases lined with flannel, and sitting close to the tube.[1] This I mention because the European papers on electricity frequently speak of rubbing the tubes as a fatiguing exercise. Our spheres are fixed on iron axes which pass through them. At one end of the axis there is a small handle with which you turn the sphere like a common grindstone. This we find very commodious, as the machine takes up but little room, is portable, and may be enclosed in a tight box when not in use. It is true the sphere does not turn so swift as when the great wheel is used; but swiftness we think of little importance, since a few turns will charge the phial, &c., sufficiently.[1]

I Am, &C.,

B. Franklin.

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XLV

TO JARED ELIOT2

Philadelphia, July 16, 1747.

Dear Sir:—

I received your favor of the 4th instant. I ought before this time to have acknowledged the receipt of the book, which came very safe, and in good order, to hand. We have many oil-mills in this province, it being a great country for flax. Linseed oil may now be bought for three shillings per gallon; sometimes for two shillings and six pence; but at New York, I have been told, it generally holds up at about eight shillings. Of this you can easily be satisfied, it being your neighbor government.

In your last, you inquired about the kind of land from which our hemp is raised. I am told it must be very rich land. Sometimes they use drained swamps and banked meadows; but the greater part of our hemp is brought from Conestago, which is a large and very rich tract of land on the banks of the Susquehanna, a large fresh-water river. It is brought down in wagons.

If you should send any of your steel saws here for sale, I should not be wanting where my recommendation might be of service.

We have had as wet a summer as has been known here these thirty years, so that it was with difficulty our people got in their harvest. In some parts of the country a great deal of hay has been lost, and some corn mildewed; but in general the harvest has been very great. The two preceding summers (particularly the last) were excessively dry. I think with you, it might be of advantage to know what the seasons are in the several parts of the country. One's curiosity in some philosophical points might also be gratified by it.

We have frequently, along this North American coast, storms from the northeast, which blow violently sometimes three or four days. Of these I have had a very singular opinion some years, viz., that, though the course of the wind is from northeast to southwest, yet the course of the storm is from southwest to northeast; that is, the air is in violent motion in Virginia before it moves in Connecticut, and in Connecticut before it moves at Cape Sable, &c. My reasons for this opinion (if the like have not occurred to you) I will give in my next.

I thank you for the curious facts you have communicated to me relating to springs. I think with you, that most springs arise from rains, dews, or ponds, on higher ground; yet possibly some, that break out near the tops of high hollow mountains, may proceed from the abyss, or from water in the caverns of the earth, rarefied by its internal heat, and raised in vapor, till the cold region near the tops of such mountains condenses the vapor into water again, which comes forth in springs, and runs down on the outside of the mountains, as it ascended on the inside. There is said to be a large spring near the top of Teneriffe; and that mountain was formerly a volcano, consequently hollow within. Such springs, if such there be, may properly be called springs of *distilled* water.

Now I mention mountains, it occurs to tell you that the great Appalachian Mountains, which run from York River, back of these colonies, to the Bay of Mexico, show in many places, near the highest parts of them, strata of sea shells; in some places the marks of them are in the solid rocks. It is certainly the *wreck* of a world we live on! We have specimens of these sea-shell rocks, broken off near the tops of these mountains, brought and deposited in our library as curiosities. If you have not seen the like, I will send you a piece. Farther, about mountains (for ideas will string themselves like ropes of onions); when I was once riding in your country, Mr. Walker showed me at a distance the bluff side or end of a mountain, which appeared striped from top to bottom, and told me the stone or rock of that mountain was divided by nature into pillars; of this I should be glad to have a particular account from you. I think I was somewhere near New Haven when I saw it.

You made some mistake when you intended to favor me with some of the new valuable grass seed (I think you called it herd-seed), for what you gave me is grown up and proves mere timothy; so I suppose you took it out of a wrong paper or parcel.

I wish your new law may have the good effect expected from it, in extricating your government from the heavy debt this war has obliged them to contract. I am too little acquainted with your particular circumstances to judge of the prudence of such a law for your colony with any degree of exactness. But to a friend one may hazard one’s notions, right or wrong; and as you are pleased to desire my thoughts, you shall have them and welcome. I wish they were better.

First, I imagine that the five per cent. duty on goods imported from your neighboring governments, though paid at first hand by the importer, will not upon the whole come out of his pocket, but be paid in fact by the consumer; for the importer will be sure to sell his goods as much dearer to reimburse himself; so that it is only another mode of taxing your own people, though perhaps meant to raise money on your neighbours. Yet, if you can make some of the goods, heretofore imported, among yourselves, the advanced price of five per cent. may encourage your own manufacture, and in time make the importation of such articles unnecessary, which will be an advantage.

Secondly, I imagine the law will be difficult to execute, and require many officers to prevent smuggling in so extended a coast as yours; and the charge considerable; and, if smuggling is not prevented, the fair trader will be undersold and ruined. If the officers are many and busy, there will arise numbers of vexatious lawsuits and dissensions among your people. *Quære,* whether the advantages will overbalance.

Thirdly, if there is any part of your produce that you can well spare, and would desire to have taken off by your neighbours in exchange for something you more want, perhaps they, taking offence at your selfish law, may in return lay such heavy duties or discouragements on that article, as to leave it a drug on your hands. As to the duty on transporting lumber (unless in Connecticut bottoms to the West Indies), I suppose the design is to raise the price of such lumber on your neighbours, and throw that advanced price into your treasury. But may not your neighbours supply themselves elsewhere? Or, if numbers of your people have lumber to dispose of, and want goods from, or have debts to pay to, your neighbours, will they not (unless you employ numbers of officers to watch all your creeks and landings) run their lumber, and so defeat the law? Or, if the law is strictly executed, and the duty discourage the transportation to your neighbours, will not all your people that want to dispose of lumber be laid at the mercy of those few merchants that send it to the West Indies, who will buy it at their own price, and make such pay for it as they think proper?

If I had seen the law and heard the reasons that are given for making it, I might have judged and talked of it more to the purpose. At present I shoot my bolt pretty much in the dark; but you can excuse and make proper allowance.

My best respects to good Mrs. Eliot and your sons; and, if it falls in your way, my service to the kind, hospitable people near the river, whose name I am sorry I have forgot.

I am, dear Sir, with the utmost regard,

Your Obliged And Humble Servant,

B. Franklin.

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XLVI

TO JARED ELIOT

Sir:—

I have perused your two Essays on Field Husbandry, and think the public may be much benefited by them; but, if the farmers in your neighborhood are as unwilling to leave the beaten road of their ancestors as they are near me, it will be difficult to persuade them to attempt any improvement. Where the cash is to be laid out on a probability of a return, they are very averse to the running any risk at all, or even expending freely, where a gentleman of a more public spirit has given them ocular demonstration of the success.

About eighteen months ago, I made a purchase of about three hundred acres of land near Burlington, and resolved to improve it in the best and speediest manner, that I might be enabled to indulge myself in that kind of life which was most agreeable. My fortune, thank God, is such that I can enjoy all the necessaries and many of the indulgences of life; but I think that in duty to my children I ought so to manage, that the profits of my farm may balance the loss my income will suffer by my retreat to it. In order to this, I began with the meadow on which there had never been much timber, but it was always overflowed. The soil is very fine, and black about three feet; then it comes to a bluish clay. Of this deep meadow I have about eighty acres, forty of which had been ditched and mowed. The grass which comes in first after ditching is spear-grass and white clover; but the weeds are to be mowed four or five years before they will be subdued, as the vegetation is very luxuriant.

This meadow had been ditched and planted with Indian corn, of which it produced above sixty bushels per acre. I first scoured up my ditches and drains, and took off all the weeds; then I ploughed it, and sowed it with oats in the last of May. In July I mowed them down together with the weeds, which grew plentifully among them, and they made good fodder. I immediately ploughed it again, and kept harrowing till there was an appearance of rain; and, on the 23d of August, I sowed near thirty acres with red clover and herd-grass, allowing six quarts of herd-grass and four pounds of red clover to an acre in most parts of it; in other parts, four quarts of herd-grass and three pounds of red clover. The red clover came up in four days and the herd-grass in six days; and I now find that, where I allowed the most seed, it protects itself the best against the frost. I also sowed an acre with twelve pounds of red clover, and it does well. I sowed an acre more with two bushels of rye-grass seed and five pounds of red clover; the rye-grass seed failed, and the red clover heaves out much for want of being thicker. However, in March next I intend to throw in six pounds more of red clover, as the ground is open and loose. As these grasses are represented not durable, I have sown two bushels of the sweeping of hay-lofts (where the best hay was used), well riddled, per acre, supposing that the spear-grass and white clover seed would be more equally scattered when the other shall fail.

What surprised me was to find that the herd-grass, whose roots are small and spread near the surface, should be less affected by the frost than the red clover, whose roots I measured in the last of October, and found that many of their tap roots penetrated five inches, and from its sides threw out near thirty horizontal roots, some of which were six inches long, and branched. From the figure of this root, I flattered myself that it would endure the heaving of the frost; but I now see that wherever it is thin sown it is generally hove so far out that but a few of the horizontal and a small part of the tap roots remain covered, and I fear will not recover. Take the whole together, it is well matted, and looks like a green corn-field.

I have about ten acres more of this ground ready for seed in the spring, but expect to combat with the weeds a year or two. That sown in August I believe will rise so soon in the spring as to suppress them in a great measure.

My next undertaking was a round pond of twelve acres. Ditching round it, with a large drain through the middle, and other smaller drains, laid it perfectly dry. This, having first taken up all the rubbish, I ploughed up and harrowed it many times over, till it was smooth. Its soil is blackish; but, in about a foot or ten inches, you come to a sand of the same color with the upland. From the birch that grew upon it, I took it to be of a cold nature, and therefore I procured a grass which would best suit that kind of ground, intermixed with many others, that I might thereby see which suited it best. On the 8th of September, I laid it down with rye, which being harrowed in, I threw in the following grass seed: a bushel of Salem grass or feather-grass, half a bushel of timothy or herd-grass, half a bushel of rye-grass, a peck of burden-grass or blue bent, and two pints of red clover per acre (all the seed in the chaff except the clover), and bushed them in. I could wish they had been clean, as they would have come up sooner, and been better grown before the frost; and I have found by experiment, that a bushel of clean chaff of timothy or Salem grass will yield five quarts of seed. The rye looks well, and there is abundance of timothy or Salem grass come up amongst it; but it is yet small, and in that state there is scarce any knowing those grasses apart. I expect from the sand lying so near the surface, that it will suffer much in dry weather.

B. Franklin.

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XLVII

TO PETER COLLINSON

Philadelphia, 1 September, 1747.

Sir:—

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

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

2. At the same time that the wire and the top of the bottle, &c., is electrized *positively* or *plus,* the bottom of the bottle is electrized *negatively* or *minus,* in exact proportion; that is, whatever quantity of electrical fire is thrown in at the top, an equal quantity goes out of the bottom.[2] To understand this, suppose the common quantity of electricity in each part of the bottle, before the operation begins, is equal to twenty; and at every stroke of the tube, suppose a quantity equal to one is thrown in; then, after the first stroke, the quantity contained in the wire and upper part of the bottle will be twenty-one, in the bottom nineteen; after the second, the upper part will have twenty-two, the lower eighteen; and so on, till after twenty strokes, the upper part will have a quantity of electrical fire equal to forty, the lower part none; and then the operation ends, for no more can be thrown into the upper part when no more can be driven out of the lower part. If you attempt to throw more in, it is spewed back through the wire, or flies out in loud cracks through the sides of the bottle.

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

quickness inexpressible; or touching each alternately, in which case the equilibrium is restored by degrees.

4. As no more electrical fire can be thrown into the top of the bottle, when all is driven out of the bottom, so, in a bottle not yet electrized, none can be thrown into the top when none *can* get out at the bottom; which happens either when the bottom is too thick, or when the bottle is placed on an electric *per se.* Again, when the bottle is electrized, but little of the electrical fire can be *drawn out* from the top, by touching the wire, unless an equal quantity can at the same time *get in* at the bottom.[1] Thus, place an electrized bottle on clean glass or dry wax, and you will not, by touching the wire, get out the fire from the top. Place it on a non-electric, and touch the wire, you will get it out in a short time,—but soonest when you form a direct communication as above.

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

5. The shock to the nerves (or convulsion rather) is occasioned by the sudden passing of the fire through the body in its way from the top to the bottom of the bottle. The fire takes the shortest[2] 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.

Experiments Confirming The Above

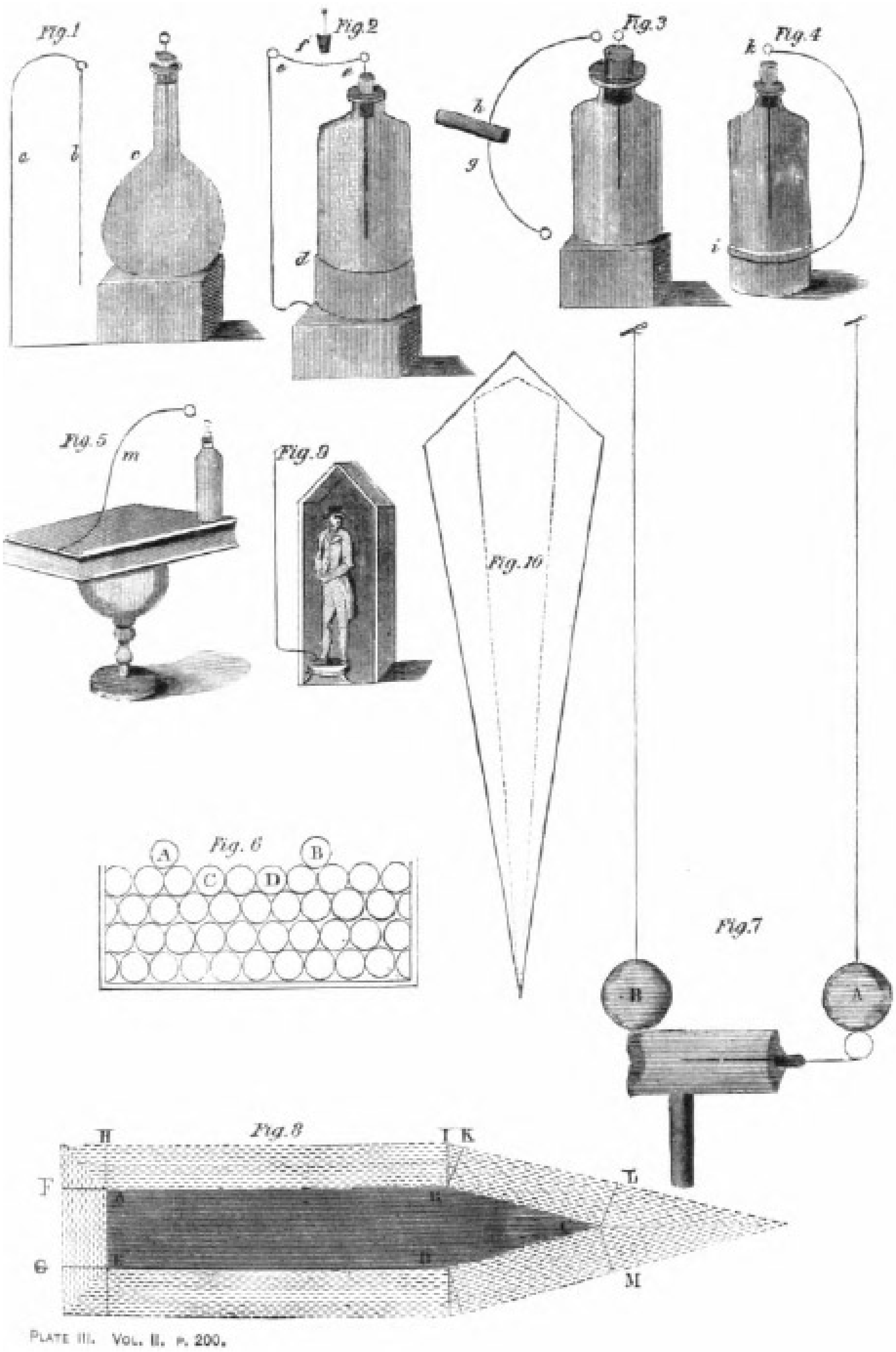
EXPERIMENT I

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

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

EXPERIMENT II

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



EXPERIMENT III

Fig. 2.—Fix a wire in the lead, with which the bottom of the bottle is armed (*d*), so as that, bending upwards, its ring-end may be level with the top or ring-end of the wire in the cork (*e*), and at three or four inches distance. Then electrize the bottle and place it on wax. If a cork, suspended by a silk thread (*f*), hang between these two wires, it will play incessantly from one to the other till the bottle is no longer electrized; that is, it fetches and carries fire from the top to the bottom[1] of the bottle till the equilibrium is restored.

EXPERIMENT IV

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

EXPERIMENT V

Fig. 4.—Let a ring of thin lead or paper surround a bottle (*i*), even at some distance from or above the bottom. From that ring let a wire proceed up till it touch the wire of the cork (*k*). A bottle so fixed cannot by any means be electrized; the equilibrium is never destroyed; for while the communication between the upper and lower parts of the bottle is continued by the outside wire, the fire only circulates; what is driven out at bottom is constantly supplied from the top.[1] Hence a bottle cannot be electrized 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 bottom of the bottle.

EXPERIMENT VII

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

EXPERIMENT VIII

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

EXPERIMENT IX

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

EXPERIMENT X

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

EXPERIMENT XI

The passing of the electrical fire from the upper to the lower part[1] of the bottle, to restore the equilibrium, is rendered strongly visible by the following pretty experiment. Take a book whose covering is filleted with gold; bend a wire of eight or ten inches long in the form of (*m*), Fig. 5, slip it on the end of the cover of the book, over the gold line, so as that the shoulder of it may press upon one end of the gold line, the ring up, but leaning towards the other end of the book. Lay the book on a glass or wax,[2] and on the other end of the gold line set the bottle electrized; then bend the springing wire by pressing it with a stick of wax till its ring approaches the ring of the bottle wire; instantly there is a strong spark and stroke, and the whole line of gold, which completes the communication between the top and bottom of the bottle, will appear a vivid flame, like the sharpest lightning. The closer the contact between the shoulder of the wire and the gold at one end of the line, and between the bottom of the bottle and the gold at the other end, the better the experiment succeeds. The room should be darkened. If you would have the whole filleting round the cover appear in fire at once, let the bottle and wire touch the gold in the diagonally opposite corners.

I Am, &C.,

B. Franklin.

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XLVIII

TO CADWALLADER COLDEN

Philadelphia, 1 October, 1747.

Sir:—

I send you herewith the *History of the Five Nations.* You will perceive that Osborne, to puff up the book, has inserted the charters, &c., of his Province, all under the title of *History of the Five Nations,* which I think was not fair, but it is a common trick of booksellers.

Mr. James Read, to whom Mr. Osborne has sent a parcel of books by recommendation of Mr. Collinson, being engaged in business of another kind, talks of declining to act in disposing of them, and perhaps may put them into my hands. If he should, I will endeavour to do Mr. Osborne justice in disposing of them to the best advantage, as also of any other parcel he may send me from your recommendation.

Mr. Armit is returned well from New England. As he has your power of attorney, and somewhat more leisure at present than I have, I think to put your letter to Mr. Hughes into his hands, and desire him to manage the affair of your servant. I shall write a line besides to Hughes, that he would assist in obliging the servant to do you justice, which may be of some service, as he owns himself obliged to me, for recovering a servant for him that had been gone above a twelvemonth. I am, Sir, &c.,

B. Franklin.

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XLIX

TO CADWALLADER COLDEN

Philadelphia, 27 November, 1747.

Sir:—

The violent party spirit that appears in all the votes, &c., of your Assembly seems to me extremely unseasonable as well as unjust, and to threaten mischief not only to yourselves but to your neighbours. It begins to be plain that the French may reap great advantages from your divisions. God grant they may be as blind to their own interest, and as negligent of it as the English are of theirs. It must be inconvenient to you to remove your family, but more so to you and them to live under continual apprehensions and alarms. I shall be glad to hear you are all in a place of safety.

Though *Plain Truth*[1] bore somewhat hard on both parties here, it has had the happiness not to give much offence to either. It has wonderfully spirited us up to defend ourselves and country, to which end great numbers are entering into an association, of which I send you a copy enclosed. We are likewise setting on foot a lottery to raise three thousand pounds for erecting a battery of cannon below the city. We have petitioned the Proprietor to send us some from England, and have ordered our correspondents to send us over a parcel, if the application to the Proprietor fails. But, lest by any accident they should miscarry, I am desired to write to you and ask your opinion whether, if our government should apply to Governor Clinton to borrow a few of your spare cannon till we could be supplied, such application might probably meet with success. Pray excuse the effects of haste on this letter.

I am, Sir, with the greatest respect, your most obliged humble servant,

B. Franklin.

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L

TO JAMES LOGAN[1]

Monday Noon [4 December, 1747].

Sir:—

I am heartily glad you approve of our proceedings. We shall have arms for the poor in the spring, and a number of battering cannon. The place for the batteries is not yet fixed; but it is generally thought that near Red Bank will be most suitable, as the enemy must there have natural difficulties to struggle with, besides the channel being narrow. The Dutch are as hearty as the English. *Plain Truth* and the *Association* are in their language, and their parsons encouraged them. It is proposed to breed gunners by forming an artillery club, to go down weekly to the battery and exercise the great guns. The best engineers against Cape Breton were of such a club, tradesmen and shopkeepers of Boston. I was with them at the Castle[1] at their exercise in 1743.

I have not time to write longer, nor to wait on you till next week. In general all goes well, and there is a surprising unanimity in all ranks. Near eight hundred have signed the *Association,* and more are signing hourly. One company of Dutch is complete. I am with great respect, Sir, &c.,

B. Franklin.

LI

TO THOMAS HOPKINSON[2]

Philadelphia, 1747.

According to my promise, I send you *in writing* my observations on your book[1] ; you will be the better able to consider them, which I desire you to do at your leisure, and to set me right where I am wrong.

I stumble at the threshold of the building, and therefore have not read further. The author's *vis inertiæ essential to matter,* upon which the whole work is founded, I have not been able to comprehend. And I do not think he demonstrates at all clearly (at least to me he does not), that there is really *such a property in matter.*

He says in No. 2: “Let a given body or mass of matter be called *a,* and let any given celerity be called *c.* That *celerity* doubled, tripled, &c., or halved, thirded, &c., will be 2*c,* 3*c,* &c., or ½*c,* ⅓*c,* &c., respectively. Also the *body* doubled, tripled, or halved, thirded, will be 2*a,* 3*a,* or ½*a,* ⅓*a,* respectively.” Thus far is clear. But he adds: “Now to move the body *a,* with the celerity *c,* requires a certain force to be impressed upon it; and to move it with a celerity as 2*c,* requires *twice that force* to be impressed upon it, &c.” Here I suspect some mistake creeps in, by the author’s not distinguishing between a great force applied at once, and a small one continually applied, to a mass of matter, in order to move it. I think it is generally allowed by the philosophers, and, for aught we know, is certainly true, that there is no mass of matter, how great soever, but may be moved by any force how small soever (taking friction out of the question), and this small force, continued, will in time bring the mass to move with any velocity whatsoever. Our author himself seems to allow this towards the end of the same No. 2, when he is subdividing his celerities and forces; for as in continuing the division to eternity by his method of ½*c,* ⅓*c,* ¼*c,* ⅕*c,* &c., you can never come to a fraction of velocity that is equal to 0*c,* or no celerity at all; so, dividing the force in the same manner, you can never come to a fraction of force that will not produce an equal fraction of celerity.

Where, then, is the mighty *vis inertiæ,* and what is its strength, when the greatest assignable mass of matter will give way to, or be moved by, the *least* assignable force? Suppose two globes equal to the sun and to one another, exactly equipoised in Jove’s balance; suppose no friction in the centre of motion, in the beam, or elsewhere; if a musqueto then were to light on one of them, would he not give motion to them both, causing one to descend and the other to rise? If it is objected, that the force of gravity helps one globe to descend, I answer, the same force opposes the other’s rising. Here is an equality that leaves the whole motion to be produced by the musqueto, without whom those globes would not be moved at all. What, then, does *vis inertiæ* do in this case? and what other effect could we expect *if there were no such thing?* Surely, if it were any thing more than a phantom, there might be enough of it in such *vast* bodies to annihilate, by its opposition to motion, so trifling a force!

Our author would have reasoned more clearly, I think, if, as he has used the letter *a* for a certain quantity of matter, and *c* for a certain quantity of celerity, he had employed one letter more, and put *f,* perhaps, for a certain quantity of force. This let us suppose to be done; and then, as it is a maxim that the force of bodies in motion is equal to the quantity of matter multiplied by the celerity (or $f = c \times a$); and as the force received by and subsisting in matter, when it is put in motion, can never exceed the force given; so, if *f* moves *a* with *c,* there must needs be required 2*f* to move *a* with 2*c;* for *a* moving with 2*c* would have a force equal to 2*f,* which it could not receive from 1*f;* and this, not because there is such a thing as *vis inertiæ,* for the case would be the same *if that had no existence;* but because nothing can give more than it has. And now again, if a thing *can* give what it has, if 1*f* can to 1*a* give 1*c,* which is the same thing as giving it 1*f* (that is, if force applied to matter at rest can put it in motion and give it *equal* force), where, then, is *vis inertiæ?* If it existed at all in matter, should we not find the quantity of its resistance subtracted from the force given?

In No. 4, our author goes on and says: "The body *a* requires a certain force to be impressed on it to be moved with a celerity as *c,* or such a force is necessary; and therefore it makes a certain resistance, &c.; a body as 2*a* requires *twice* that force to be moved with the *same celerity,* or it makes twice that resistance; and so on." This I think is not true; but that the body 2*a,* moved by the force 1*f* (though the eye may judge otherwise of it), does really move with the same celerity as it did when impelled by the same force; for 2*a* is compounded of 1*a* + 1*a;* and if each of the 1*a*'s, or each part of the compound, were made to move with 1*c* (as they might be by 2*f*), then the whole would move with 2*c,* and not with 1*c,* as our author supposes. But 1*f* applied to 2*a* makes each *a* move with ½*c;* and so the whole moves with 1*c;* exactly the same as 1*a* was made to do by 1*f* before. What is equal celerity but a *measuring the same space by moving bodies in the same time?* Now if 1*a,* impelled by 1*f,* measures one hundred yards in a minute; and in 2*a,* impelled by 1*f,* each *a* measures fifty yards in a minute, which added make one hundred; are not the celerities, as the forces, equal? And since force and celerity in the same quantity of matter are always in *proportion* to each other, why should we, when the quantity of matter is doubled, allow the force to continue unimpaired, and yet suppose one half of the celerity to be lost?[1] I wonder the more at our author's mistake in this point, since in the same number I find him observing: "We may easily conceive that a body, as 3*a,* 4*a,* &c., would make three or four bodies equal to once *a,* each of which would require once the first force to be moved with the celerity *c.*" If, then, in 3*a,* each *a* requires once the first force *f* to be moved with the celerity *c,* would not each move with the force *f* and celerity *c?* and consequently the whole be 3*a* moving with 3*f* and 3*c?* After so distinct an observation, how could he miss of the consequence, and imagine that 1*c* and 3*c* were the same? Thus, as our author's abatement of celerity in the case of 2*a* moved by 1*f* is imaginary, so must be his additional resistance. And here again I am at a loss to discover any effect of the *vis inertiæ.*

In No. 6 he tells us "that all this is likewise certain when taken the contrary way, viz., *from motion to rest;* for the body *a* moving with a certain velocity, as *c,* requires a certain degree of force or resistance to stop that motion," &c., &c.; that is, in other words, equal force is necessary to destroy force. It may be so. But how does that discover a *vis inertiæ?* Would not the effect be the same *if there were no such thing?* A force 1*f* strikes a body 1*a,* and moves it with the celerity 1*c*—that is, with the force 1*f;* it requires, even according to our author, only an opposing 1*f* to stop it. But ought it not (if there were a *vis inertiæ*) to have not only the force 1*f,* but an additional force equal to the force of *vis inertiæ,* that *obstinate power by which a body endeavours with* all its might *to continue in its present state, whether of motion or rest?* I say, ought there not to be an opposing force equal to the sum of these? The truth, however, is, that there is no body, how large soever, moving with any velocity, how great soever, but may be stopped by any opposing force, how small soever, continually applied. At least all our modern philosophers agree to tell us so.

Let me turn the thing in what light I please, I cannot discover the *vis inertiæ,* nor any effect of it. It is allowed by all that a body 1*a,* moving with a velocity 1*c* and a force 1*f, striking another* body 1*a* at rest, they will afterwards *move on together,* each with ½*c* and ½*f;* which, as I said before, is equal in the whole to 1*c* and 1*f.* If *vis inertiæ,* as in this case, neither abates the force nor the velocity of bodies, what does it, or how does it discover itself?

I imagine I may venture to conclude my observations on this piece, almost in the words of the author: that, if the doctrines of the immateriality of the soul and the existence of God and of divine providence are demonstrable from no plainer principles, the *deist* (that is, *theist*) has a desperate cause in hand. I oppose *my theist* to his atheist, because I think they are diametrically opposite, and not near of kin, as Mr. Whitefield seems to suppose, where (in his Journal) he tells us: "*M. B. was a deist; I had almost said an atheist*"—that is, *chalk;* I had almost said *charcoal.*

The din of the Market[1] increases upon me; and that, with frequent interruptions, has, I find, made me say some things twice over; and, I suppose, forget some others I intended to say. It has, however, one good effect, as it obliges me to come to the relief of your patience with

Your Humble Servant,

B. Franklin.

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LII

TO CADWALLADER COLDEN

Philadelphia, 6 August, 1747.

Sir:—

The observations I sent you on Baxter's book were wrote on a sheet or two of paper in folio. He builds his whole argument on the *vis inertiæ* of matter. I boldly denied the being of such a property, and endeavoured to demonstrate the contrary. If I succeeded, all his edifice falls of course, unless some other way supported. I desired your sentiments of my argument. You left the book for me at New York, with a few lines containing a short censure upon the author, and that your time had been much taken up in town with business, but you were now about to retire into the country, where you should have leisure to peruse my papers; since which I have heard nothing from you relating to them. I hope you will easily find them, because I have lost my rough draft; but do not give yourself much trouble about them; for if they are lost it is really no great matter.

I am glad to hear that some gentlemen with you are inclined to go on with electrical experiments. I am satisfied we have workmen here who can make the apparatus as well to the full as that from London; and they will do it reasonably. By the next post I will send you their computation of the expense. If you shall conclude to have it done here I will oversee the work, and take care that every part be done to perfection as far as the nature of the thing admits.

Instead of the remainder of my rough minutes on electricity (which are indeed too rough for your view), I send you enclosed copies of two letters I lately wrote to Mr. Collinson on that subject. When you have perused them, please to leave them with Mr. Nichols, whom I shall desire to forward them per next post to a friend in Connecticut.

I am glad your Philosophical Treatise meets with so good reception in England. Mr. Collinson writes the same things to Mr. Logan; and Mr. Rose, of Virginia, writes me that he had received accounts from his correspondents to the same purpose. I perceive by the papers that they have also lately reprinted in London, your *History of the Five Nations* in octavo. If it come to your hands I should be glad to have a sight of it.

Mr. Logan, on a second reading of your piece on Fluxions lately, is satisfied that some of the faults he formerly objected to it were his own, and owing to his too little attention at that time. He desires me to tell you so, and that he asks your pardon. Upon what Mr. Collinson wrote, he again undertook to read and consider your Philosophical Treatise.[1] I have not seen him since, but shall soon, and will send you his sentiments.

I Am, Sir,
With Great Respect,
Your Most Humble Servant,

B. Franklin.

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LIII

A CONJECTURE AS TO THE CAUSE OF THE HEAT OF THE BLOOD IN HEALTH, AND OF THE COLD AND HOT FITS OF SOME FEVERS[1]

The parts of fluids are so smooth, and roll among one another with so little friction, that they will not by any (mechanical) agitation grow warmer. A phial half full of water shook with violence and long continued, the water neither heats itself nor warms the phial. Therefore the blood does not acquire its heat either from the motion and friction of its own parts, or its friction against the sides of its vessels.

But the parts of solids, by reason of their closer adhesion, cannot move among themselves without friction, and that produces heat. Thus, bend a plummet to and fro, and, in the place of bending, it shall soon grow hot. Friction on any part of our flesh heats it. Clapping of the hands warms them. Exercise warms the whole body.

The heart is a thick muscle, continually contracting and dilating nearly eighty times in a minute. By this motion there must be a constant interfrication of its constituent solid parts. That friction must produce a heat, and that heat must consequently be continually communicated to the perfluent blood.

To this may be added, that every propulsion of the blood by the contraction of the heart distends the arteries, which contract again in the intermission; and this distension and contraction of the arteries may occasion heat in them, which they must likewise communicate to the blood that flows through them.

That these causes of the heat of the blood are sufficient to produce the effect, may appear probable, if we consider that a fluid once warm requires no more heat to be applied to it in any part of time to keep it warm, than what it shall lose in an equal part of time. A smaller force will keep a pendulum going, than what first set it in motion.

The blood, thus warmed in the heart, carries warmth with it to the very extremities of the body, and communicates to them; but, as by this means its heat is gradually diminished, it is returned again to the heart by the veins for a fresh calefaction.

The blood communicates its heat, not only to the solids of our body, but to our clothes, and to a portion of the circumambient air. Every breath, though drawn in cold, is expired warm; and every particle of the *materia perspirabilis* carries off with it a portion of heat.

While the blood retains a due fluidity, it passes freely through the minutest vessels, and communicates a proper warmth to the extremities of the body. But when by any means it becomes so viscid as not to be capable of passing those minute vessels, the extremities, as the blood can bring no more heat to them, grow cold.

The same viscidity in the blood and juices checks or stops the perspiration, by clogging the perspiratory duct, or, perhaps, by not admitting the perspirable parts to separate. Paper wet with size and water will not dry so soon as if wet with water only.

A vessel of hot water, if the vapor can freely pass from it, soon cools. If there be just fire enough under it to add continually the heat it loses, it retains the same degree. If the vessel be closed, so that the vapor may be retained, there will from the same fire be a continual accession of heat to the water, till it rises to a great degree. Or, if no fire be under it, it will retain the heat it first had for a long time. I have experienced, that a bottle of hot water stopped, and put in my bed at night, has retained so much heat seven or eight hours, that I could not in the morning bear my foot against it, without some of the bedclothes intervening.

During the cold fit, then, perspiration being stopped, great part of the heat of the blood, that used to be dissipated, is confined and retained in the body; the heart continues its motion, and creates a constant accession to that heat; the inward parts grow very hot, and, by contact with the extremities, communicate that heat to them. The glue of the blood is by this heat dissolved, and the blood afterwards flows freely, as before the disorder.

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LIV

TO CADWALLADER COLDEN

Philadelphia, 27 January, 1748.

Dear Sir:—

I received your favor relating to the cannon. We have petitioned our Proprietors for some, and have besides wrote absolutely to London for a quantity, in case the application to the Proprietors should not succeed; so that, accidents excepted, we are sure of being supplied some time next summer. But, as we are extremely desirous of having some mounted early in the spring, and perhaps, if your engineer should propose to use all you have, the works he may intend will not very soon be ready to receive them, we should think ourselves exceedingly obliged to your government, if you would lend us a few for one year only. When you return to New York, I hope a great deal from your interest and influence.

Mr. Read, to whom Osborne consigned your books,[1] did not open or offer them for sale till within these two weeks, being about to remove when he received them, and having till now no conveniency of shelves, &c. In our two last papers he has advertised generally, that he has a parcel of books to sell—Greek, Latin, French, and English,—but makes no particular mention of the Indian History; it is therefore no wonder that he has sold none of them, as he told me a few days since. I had one of them from London, which I sent you before any of my friends saw it. So, as no one here has read it but myself, I can only tell you my own opinion, that it is a well-written, entertaining, and instructive piece, and must be exceedingly useful to all those colonies which have any thing to do with Indian affairs.

You have reason to be pleased with the mathematician's envious expression about your tract on gravitation. I long to see from Europe some of the deliberate and mature thoughts of their philosophers upon it.

To obtain some leisure I have taken a partner[1] into the printing-house; but, though I am thereby a good deal disengaged from private business, I find myself still fully occupied. The association, lottery, and batteries fill up at present a great part of my time.[2]

I thank you for communicating the sheet on the first principles of morality, the continuation of which I shall be glad to see. I am, &c.,

B. Franklin.

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LV

TO JAMES LOGAN

Philadelphia, 27 January, 1748.

Sir:—

I have not yet found the book, but suppose I shall to-morrow. The post goes out to-day, which allows me no time to look for it. We have a particular account from Boston of the guns there. They are in all thirty-nine, Spanish make, and new; fifteen of them are twenty-eight pounders and twenty-four are fourteen pounders. We offer by this post £1500 this currency for them all, and suppose we shall get them.

The insurers, in consideration of the premium of twenty per cent, engage thus: that if the prizes arising against the tickets insured do not, one with another, make in the whole a sum equal to the first cost of the tickets, they will make up the deficiency. They now think it a disadvantageous agreement and have left off insuring, for though they would gain, as you observe, £1000 if they insured the whole at that rate in one lot, yet it will not be so when they insure a number of separate lots, as ten, twenty, or one hundred tickets in a lot, because the prizes falling in one lot do not help to make up the deficiencies in another. The person that insured your one hundred and twenty-five, did the next day give the whole premium to another, with six and a quarter per cent. more, to be reinsured two thirds of them. I have not insured for anybody, so I shall neither lose nor gain that way. I will send the policy, that you may see it, with the book. I am, Sir, &c.,

B. Franklin.

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LVI

TO JAMES LOGAN

Philadelphia, 30 January, 1748.

Sir:—

I send you herewith the book, and enclosed is the policy. Here is no news but what is bad, namely, the taking of Mesnard, an account of which we have by way of Lisbon. He was carried into St. Malo. And just now we have advice from New York, that an express was arrived there from New England to inform the government that two prisoners, who had escaped from different parts of Canada and arrived in New England, agreed in declaring that three thousand men were getting ready to march against Albany, which they intended to besiege and take, and that they were to be joined by a great body of Indians. They write from New York that the advice is credited there. I wish it may not prove too true, the wretched divisions and misunderstandings among the principal men in that government giving the enemy too much encouragement and advantage.

I hope you and your good family continue well, being with sincere respect and affection, &c.,

B. Franklin.

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LVII

TO JAMES LOGAN

Philadelphia, 6 April, 1748.

Sir:—

I have a letter from Mr. Samuel Laurens, of New York, who undertook to ship the guns for us, informing me that two small vessels had been agreed with to bring them round, but a sloop arriving there on Sunday last that had been chased in latitude thirty-six by a ship and brigantine, which were supposed to be the *Don Pedro* with a consort coming on this coast, the Governor and Council thought it more advisable to send them to Brunswick, which we since hear is done. Captain Wallace, a discreet old sea commander of this place, goes to-day or to-morrow to receive them there and provide carriages to bring them to Philadelphia. The postmaster at New York and another correspondent there write me that the ship seen was certainly the *Don Pedro,* the captain of the vessel chased knowing her well, having often seen her at the Havana, where he has been several voyages with a flag of truce. He was very near being taken, but escaped by favor of the night. We are glad to hear the *Don* is come out with one consort only, as by some accounts we apprehended he intended to bring a small fleet with him. It now looks as if his design was more against our trade than our city.

With this I send you a packet from London and a pamphlet from Sweden, both left with me for you by the new Swedish missionary, Mr. Sandin. You must have heard that Mr. James Hamilton is appointed our governor, an event that gives us the more pleasure, as we esteem him a benevolent and upright as well as a sensible man. I hope he will arrive here early in the summer and bring with him some cannon from the Proprietors. I am, Sir, &c.,

B. Franklin.

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LVIII

TO CADWALLADER COLDEN

Philadelphia, 29 September, 1748.

Sir:—

I received your favor of the 12th instant, which gave me the greater pleasure, as it was so long since I had heard from you. I congratulate you on your return to your beloved retirement. I, too, am taking the proper measures for obtaining leisure to enjoy life and my friends more than heretofore, having put my printing-house under the care of my partner, David Hall, absolutely left off bookselling, and removed to a more quiet part of the town, where I am settling my old accounts, and hope soon to be quite master of my own time, and no longer, as the song has it, *at every one's call but my own.* If health continue, I hope to be able in another year to visit the most distant friend I have, without inconvenience.

With the same views I have refused engaging further in public affairs. The share I had in the late Association, &c., having given me a little present run of popularity, there was a pretty general intention of choosing me a representative of the city at the next election of Assembly men; but I have desired all my friends who spoke to me about it, to discourage it, declaring that I should not serve if chosen. Thus you see I am in a fair way of having no other tasks than such as I shall like to give myself, and of enjoying what I look upon as a great happiness, leisure to read, study, make experiments, and converse at large with such ingenious and worthy men as are pleased to honor me with their friendship or acquaintance, on such points as may produce something for the common benefit of mankind, uninterrupted by the little cares and fatigues of business. Among other pleasures I promise myself, that of corresponding more frequently and fully with Dr. Colden is none of the least. I shall only wish that what must be so agreeable to me may not prove troublesome to you.

I thank you for your kind recommending of me to Mr. Osborne. Mr. Read would readily have put the books into my hands, but it being now out of my way to dispose of them, I propose to Mr. Hall the taking of them into his shop; but he, having looked over the invoice, says they are charged so extravagantly high that he cannot sell them for any profit to himself without hurting the character of his shop. He will, however, at my request, take the copies of the Indian

History and put them on sale; but the rest of the cargo must lie, I believe, for Mr. Osborne's further orders. I shall write to him by our next vessels.

I am glad you have had an opportunity of gaining the friendship of Governor Shirley, with whom though I have not the honor of being particularly acquainted, I take him to be a wise, good, and worthy man. He is now a fellow sufferer with you, in being made the subject of some public, virulent, and senseless libels. I hope they give him as little pain.

Mr. Bartram continues well. Here is a Swedish gentleman,[1] a professor of botany, lately arrived, and I suppose will soon be your way, as he intends for Canada. Mr. Collinson and Dr. Mitchell recommend him to me as an ingenious man. Perhaps the enclosed (left at the post-office for you) may be from him. I have not seen him since the first day he came. I delivered yours to Mr. Evans; and when I next see Mr. Bartram I shall acquaint him with what you say.

I Am, With Great Esteem And Respect, Dear Sir, &C.,

B. Franklin.

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LIX

TO JAMES LOGAN

Philadelphia, 30 October, 1748.

Sir:—

I received your favor of the 28th, with the piece on the Generation of Plants, for which I thank you. Mr. Sandin, the Swedish missionary, who gave me Wahlboom's Oration to send you (as he passed through this town from New York, where he just arrived, to Racoon Creek, where he was to be settled), I have never seen since. Mr. Kalm came to see me the day he arrived, and brought me letters from Mr. Collinson and Dr. Mitchell, both recommending him. I invited him to lodge at my house, and offered him any service in my power; but I never saw him afterwards till yesterday, when he told me that he had been much in the country, and at New York, since his arrival, but was now come to settle in town for the winter. To-day he dined with me; and, as I had received yours in the morning, I took occasion to ask him if he had not yet seen Mr. Logan. He said, no; that he had once been out with his countryman, Mr. Kock, proposing to wait on you as they returned; but it proved later in the evening than they had expected, and he thought a visit then would be unseasonable, but proposed soon to pay his respects to you. Possibly he might at that time have the packet for you at Naglee's. I did not ask him about that. Inquiring of him what was become of Mr. Sandin, he told me that soon after he got to Racoon Creek, he was taken with the fever and ague, which was followed by several other disorders, that constantly harassed him, and at length carried him off, just as Kalm arrived here, who, hearing that he was dangerously ill, hurried down to see him, but found him dead.

Sandin had a family with him, and, when here, was in haste to get to his settlement, but might intend to wait on you when he should come again to Philadelphia. Kalm, I suppose, might be in haste to see as much of the country as he could, and make his journey to New York before cold weather came on. I mention these things so particularly, that you may see you have not been purposely avoided by both these gentlemen, as you seem to imagine. I did not let Kalm know that you had mentioned him to me in your letter. I shall write to Mr. Hugh Jones, as you desire. I am, Sir, &c.,

B. Franklin.

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LX

ADVICE TO A YOUNG TRADESMAN

To My Friend, A. B.:

As you have desired it of me, I write the following hints, which have been of service to me, and may, if observed, be so to you.

Remember that *time* is money. He that can earn ten shillings a day by his labor, and goes abroad, or sits idle, one half of that day, though he spends but sixpence during his diversion or idleness, ought not to reckon *that* the only expense; he has really spent, or rather thrown away, five shillings besides.

Remember that *credit* is money. If a man lets his money lie in my hands after it is due, he gives me the interest, or so much as I can make of it during that time. This amounts to a considerable sum where a man has good and large credit, and makes good use of it.

Remember that money is of the prolific, generating nature. Money can beget money, and its offspring can beget more, and so on. Five shillings turned is six, turned again it is seven and three-pence, and so on till it becomes an hundred pounds. The more there is of it, the more it produces every turning, so that the profits rise quicker and quicker. He that kills a breeding sow destroys all her offspring to the thousandth generation. He that murders a crown destroys all that it might have produced, even scores of pounds.

Remember that six pounds a year is but a groat a day. For this little sum (which may be daily wasted either in time or expense unperceived) a man of credit may, on his own security, have the constant possession and use of an hundred pounds. So much in stock, briskly turned by an industrious man, produces great advantage.

Remember this saying: *The good paymaster is lord of another man's purse.* He that is known to pay punctually and exactly to the time he promises, may at any time, and on any occasion, raise all the money his friends can spare. This is sometimes of great use. After industry and frugality, nothing contributes more to the raising of a young man in the world than punctuality and justice in all his dealings; therefore, never keep borrowed money an hour beyond the time you promised, lest a disappointment shut up your friend's purse for ever.

The most trifling actions that affect a man’s credit are to be regarded. The sound of your hammer at five in the morning, or nine at night, heard by a creditor, makes him easy six months longer; but if he sees you at a billiard-table or hears your voice at a tavern when you should be at work, he sends for his money the next day; demands it, before he can receive it, in a lump.

It shows, besides, that you are mindful of what you owe; it makes you appear a careful as well as an honest man, and that still increases your credit.

Beware of thinking all your own that you possess, and of living accordingly. It is a mistake that many people who have credit fall into. To prevent this, keep an exact account for some time, both of your expenses and your income. If you take the pains at first to mention particulars, it will have this good effect: you will discover how wonderfully small, trifling expenses mount up to large sums, and will discern what might have been and may for the future be saved, without occasioning any great inconvenience.

In short, the way to wealth, if you desire it, is as plain as the way to market. It depends chiefly on two words, *industry* and *frugality*—that is, waste neither *time* nor *money,* but make the best use of both. Without industry and frugality nothing will do, and with them every thing. He that gets all he can honestly, and saves all he gets (necessary expenses excepted), will certainly become *rich,* if that Being who governs the world, to whom all should look for a blessing on their honest endeavours, doth not, in his wise providence, otherwise determine.

An Old Tradesman.

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LXI

TO PETER COLLINSON

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.[1]

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.

7. Place two phials equally charged on a table, at five or six inches distance. Let a cork ball, suspended by a silk thread, hang between them. If the phials were both charged through their hooks, the cork, when it has been attracted and repelled by the one, will not be attracted, but equally repelled, by the other. But if the phials were charged, the one through the hook and the other through the coating,[1] the ball, when it is repelled from one hook, will be as strongly attracted by the other, and play vigorously between them, fetching the electric fluid from the one, and delivering it to the other, till both phials are nearly discharged.

8. When we use the terms of *charging* and *discharging* the phial, it is in compliance with custom, and for want of others more suitable. Since we are of opinion that there is really no more electrical fire in the phial after what is called its *charging,* than before, nor less after its *discharging;* excepting only the small spark 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, holding the bottle in one hand, takes the spark by touching the wire hook with the other, the bottle being thereby *discharged,* the man would be *charged;* or whatever fire was lost by one, would be found in the other, since there was no way for its escape; but the contrary is true.

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

10. But suspend two or more phials on the prime conductor, one hanging on the tail of the other, and a wire from the last to the floor, an equal number of turns of the wheel shall charge them all

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

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

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

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

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

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

16. Thus, the whole force of the bottle and power of giving a shock is in the *glass itself;* the non-electrics in contact with the two

surfaces serving only to *give* and *receive* to and from the several parts of the glass; that is, to give on one side and take away from the other.

17. This was discovered here in the following manner: purposing to analyze the electrified bottle, in order to find wherein its strength lay, we placed it on glass, and drew out the cork and wire, which for that purpose had been loosely put in. Then taking the bottle in one hand, and bringing a finger of the other near its mouth, a strong spark came from the water, and the shock was as violent as if the wire had remained in it, which showed that the force did not lie in the wire. Then, to find if it resided in the water, being crowded into and condensed in it, as confined by the glass, which had been our former opinion, we electrified the bottle again, and placing it on glass, drew out the wire and cork as before; then taking up the bottle, we decanted all its water into an empty bottle, which likewise stood on glass; and taking up that other bottle, we expected, if the force resided in the water, to find a shock from it; but there was none. We judged then that it must either be lost in decanting or remain in the first bottle. The latter we found to be true; for that bottle on trial gave the shock, though filled up as it stood with fresh unelectrified water from a tea-pot. To find, then, whether glass had this property merely as glass, or whether the form contributed any thing to it, we took a pane of sash-glass, and laying it on the hand, placed a plate of lead on its upper surface; then electrified that plate, and bringing a finger to it, there was a spark and shock. We then took two plates of lead of equal dimensions, but less than the glass by two inches every way, and electrified the glass between them by electrifying the uppermost lead; then separated the glass from the lead, in doing which what little fire might be in the lead was taken out, and the glass being touched in the electrified parts with a finger, afforded only very small pricking sparks, but a great number of them might be taken from different places. Then dexterously placing it again between the leaden plates, and completing a circle between the two surfaces, a violent shock ensued, which demonstrated the power to reside in glass as glass, and that the non-electrics in contact served only, like the armature of a loadstone, to unite the force of the several parts, and bring them at once to any point desired; it being the property of a non-electric that the whole body instantly receives or gives what electrical fire is given to, or taken from, any one of its parts.

18. Upon this we made what we called an *electrical battery,* consisting of eleven panes of large sash-glass, armed with thin leaden plates, pasted on each side, placed vertically, and supported at two inches distance on silk cords, with thick hooks of leaden wire, one from each side, standing upright, distant from each other,

and convenient communications of wire and chain, from the giving side of one pane to the receiving side of the other, that so the whole might be charged together, and with the same labor as one single pane; and another contrivance to bring the giving sides, after charging, in contact with one long wire, and the receivers with another, which two long wires would give the force of all the plates of glass at once through the body of any animal forming the circle with them. The plates may also be discharged separately, or any number together that is required. But this machine is not much used, as not perfectly answering our intention with regard to the ease of charging, for the reason given, § 10. We made also of large glass panes magical pictures and self-moving animated wheels, presently to be described.

19. I perceive by the ingenious Mr. Watson's last book, lately received, that Dr. Bevis had used, before we had, panes of glass to give a shock[1] ; 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. 185), and, as far as we hitherto know, have carried it farther.

20. The magical picture[2] is made thus. Having a large mezzotinto with a frame and glass, suppose of the King (God preserve him), take out the print and cut a pannel out of it near two inches distant from the frame all round. If the cut is through the picture, it is not the worse. With thin paste or gum-water, fix the border that is cut off on the inside the glass, pressing it smooth and close; then fill up the vacancy by gilding the glass well with leaf-gold or brass. Gild likewise the inner edge of the back of the frame all round, except the top part, and form a communication between that gilding and the gilding behind the glass; then put in the board, and that side is finished. Turn up the glass and gild the fore side exactly over the back gilding, and when it is dry cover it by pasting on the pannel of the picture that hath been cut out, observing to bring the correspondent parts of the border and picture together, by which the picture will appear of a piece, as at first, only part is behind the glass and part before. Hold the picture horizontally by the top, and place a little movable gilt crown on the King's head. If now the picture be moderately electrified, and another person take hold of the frame with one hand, so that his fingers touch its inside gilding, and with the other hand endeavour to take off the crown, he will receive a terrible blow and fail in the attempt. If the picture were highly charged, the consequence might perhaps be as fatal[1] as that of high treason; for when the spark is taken through a quire of paper laid on the picture by means of a wire communication, it makes a fair hole through every sheet, that is, through forty-eight

leaves, though a quire of paper is thought good armour against the push of a sword, or even against a pistol bullet, and the crack is exceedingly loud. The operator, who holds the picture by the upper end, where the inside of the frame is not gilt, to prevent its falling, feels nothing of the shock, and may touch the face of the picture without danger, which he pretends is a test of his loyalty. If a ring of persons take the shock among them, the experiment is called *The Conspirators.*

21. On the principle in § 7 that hooks of bottles differently charged will attract and repel differently, is made an electrical wheel that turns with considerable strength. A small upright shaft of wood passes at right angles through a thin round board of about twelve inches diameter, and turns on a sharp point of iron fixed in the lower end, while a strong wire in the upper end, passing through a small hole in a thin brass plate, keeps the shaft truly vertical. About thirty *radii* 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 has 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 with a glass salt-cellar. The upper end of its axis passes through a hole in a thin brass plate cemented to a long strong piece of glass, which keeps it six or eight inches distant from any non-electric, and has a small ball of wax or metal on its top to keep in the fire. In a circle on the table which supports the wheel, are fixed twelve small pillars of glass, at about four inches distance, with a thimble on the top of each. On the edge of the wheel is a small leaden bullet, communicating by a wire with the gilding of the *upper* surface of the wheel; and about six inches from it is another bullet, communicating in like manner with the *under* surface. When the wheel is to be charged by the upper surface, a communication must be made from the under surface to the table. When it is well charged it begins to move; the bullet nearest to a pillar moves towards the thimble on that pillar, and passing by electrifies it, and then pushes itself from it; the succeeding bullet, which communicates with the other surface of the glass, more strongly attracts that thimble, on account of its being before electrified by the other bullet; and thus the wheel increases its motion till it comes to such a height that the resistance of the air regulates it. It will go half an hour, and make, one minute with another, twenty turns in a minute, which is six hundred turns in the whole; the bullet of the upper surface giving in each turn twelve sparks to the thimbles, which makes seven thousand two hundred sparks; and the bullet of the under surface receiving as many from the thimbles; those bullets moving in the time near two thousand five hundred feet. The thimbles are well fixed, and in so exact a circle that the bullets may pass within a very small distance of each of them. If, instead of two bullets, you put eight, four communicating with the upper surface and four with the under surface, placed alternately, which eight at about six inches distance completes the circumference, the force and swiftness will be greatly increased, the wheel making fifty turns in a minute; but then it will not continue moving so long. These wheels may be applied, perhaps, to the ringing of chimes,[1] and moving of light-made orreries.

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

24. Every spark in that manner drawn from the surface of the wheel, makes a round hole in the gilding, tearing off a part of it in

coming out; which shows that the fire is not accumulated on the gilding, but is in the glass itself.

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

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

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

28. We were surprised at the account, given in Mr. Watson's book, of a shock communicated through a great space of dry ground, and suspect there must be some metalline quality in the gravel of that ground; having found that simply dry earth, rammed in a glass tube, open at both ends, and a wire hook inserted in the earth at each end, the earth and wires making part of a circuit, would not conduct the least perceptible shock; and, indeed, when one wire was electrified, the other hardly showed any signs of its being in connexion with it.[1] Even a thoroughly wet packthread sometimes fails of conducting a shock, though it otherwise conducts electricity very well. A dry cake of ice, or an icicle held between two in a circle, likewise prevents the shock, which one would not expect, as water conducts it so perfectly well. Gilding on a new book, though at first it conducts the shock extremely well, yet fails after ten or a dozen experiments, though it appears otherwise in all respects the same, which we cannot account for.[1]

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

Chagrined a little that we have been hitherto able to produce nothing in this way of use to mankind; and the hot weather coming on, when the electrical experiments are not so agreeable, it is proposed to put an end to them for this season, somewhat humorously, in a party of pleasure on the banks of the *Skuylkill.*[1] 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.[2] A turkey is to be killed for our dinner by *electrical shock,* and roasted by the *electrical jack,* before a fire kindled by the *electrified bottle;* when the healths of all the famous electricians in England, Holland, France, and Germany are to be drank in *electrified bumpers,*[1] under the discharge of guns from the *electrical battery.*

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LXII

TO PETER COLLINSON

Sir:—

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

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

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

4. Water being electrified, the vapors arising from it will be equally electrified, and floating in the air, in the form of clouds, or otherwise, will retain that quantity of electrical fire, till they meet with other clouds or bodies not so much electrified, and then will communicate as before mentioned.

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

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

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

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

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

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

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

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

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

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

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

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

17. Particles of water having no fire in them mutually attract each other. Three particles of water, then, being attached to the three particles of a triangle of air, would, by their mutual attraction operating against the air's repulsion, shorten the sides and lessen

the triangle, whereby that portion of air made denser would sink to the earth with its water and not rise to the formation of a cloud.

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

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

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

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

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

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

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

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

26. Hence clouds, formed by vapors raised from fresh waters within land, from growing vegetables, moist earth, &c., more speedily and easily deposit their water, having but little electrical fire to repel and keep the particles separate. So that the greatest part of the water raised from the land is let fall on the land again; and winds blowing from the land to the sea are dry, there being

little use for rain on the sea, and to rob the land of its moisture, in order to rain on the sea, would not appear reasonable.

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

28. How these ocean clouds, so strongly supporting their water, are made to deposit 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 deposit its own water, the first cloud again flashing into the mountains; the third approaching cloud, and all succeeding ones, acting in the same manner as far back as they extend, which may be over many hundred miles of country.

31. Hence the continual storms of rain, thunder, and lightning on the east side of the Andes, which, running north and south, and being vastly high, intercept all the clouds brought against them from the Atlantic ocean by the trade winds, and oblige them to deposit 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 deposit 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 deposit water.

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

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

35. Thus, when the sea and land clouds would pass at too great a distance for the flash, they are attracted towards each other till within that distance; for the sphere of electrical attraction is far beyond the distance of flashing.

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

37. When the gun-barrel (in electrical experiments) has but little electrical fire in it, you must approach it very near with your knuckle before you can draw a spark. Give it more fire, and it will give a spark at a greater distance. Two gun-barrels united, and as

highly electrified, will give a spark at a still greater distance. But if two gun-barrels electrified will strike at two inches distance, and make a loud snap, to what a great distance may ten thousand acres of electrified cloud strike and give its fire, and how loud must be that crack?

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

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

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

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

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

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

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

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

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

Hence a wet rat cannot be killed by the exploding electrical bottle, when a dry rat may.[1]

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

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

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

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

50. Thus spirits must be heated before we can fire them by the electrical spark.1 If they are much heated, a small spark will do; if not, the spark must be greater.

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

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

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.1

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

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

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

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LXIII

TO GEORGE WHITEFIELD

Philadelphia, 6 July, 1749.

Dear Sir:—

Since your being in England, I have received two of your favours, and a box of books to be disposed of. It gives me great pleasure to hear of your welfare, and that you purpose soon to return to America.

We have no kind of news here worth writing to you. The affair of the building remains in *statu quo,* there having been no new application to the Assembly about it, or any thing done in consequence of the former.

I have received no money on your account from Mr. Thanklin, or from Boston. Mrs. Read,[1] and your other friends here, in general, are well, and will rejoice to see you again.

I am glad to hear that you have frequent opportunities of preaching among the great. If you can gain them to a good and exemplary life, wonderful changes will follow in the manners of the lower ranks; for *ad exemplum regis,* etc. On this principle, Confucius, the famous Eastern reformer, proceeded. When he saw his country sunk in vice, and wickedness of all kinds triumphant, he applied himself first to the grandees; and having, by his doctrine, won *them* to the cause of virtue, the commons followed in multitudes. The mode has a wonderful influence on mankind; and there are numbers who, perhaps, fear less the being in hell, than out of the fashion. Our most western reformations began with the ignorant mob; and when numbers of them were gained, interest and party views drew in the wise and great. Where both methods can be used, reformations are likely to be more speedy. O that some method could be found to make them lasting! He who discovers that will, in my opinion, deserve more, ten thousand times, than the inventor of the longitude.

My wife and family join in the most cordial salutations to you and good Mrs. Whitefield.

I am, dear Sir, your very affectionate friend, and most obliged humble servant, Benjamin Franklin.

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LXIV

TO MRS. ABIAH FRANKLIN, AT BOSTON

Philadelphia, 7 September, 1749.

Honored Mother:

We received your kind letter by this post, and are glad you still continue to enjoy such a share of health. Cousin Josiah and his spouse arrived hearty and well last Saturday noon. I met them the evening before at Trenton, thirty miles off, and accompanied them to town. They went into their own house on Monday, and I believe will do very well, for he seems bent on industry, and she appears a discreet, notable young woman. My wife has been to see them every day, calling in as she passes by; and I suspect has fallen in love with our new cousin, for she entertains me a deal, when she comes home, with what cousin Sally does, and what cousin Sally says, what a good contriver she is, and the like.

I believe it might be of service to me, in the matter of getting in my debts, if I were to make a voyage to London; but I have not yet determined on it in my own mind, and think I am grown almost too lazy to undertake it.

The Indians are gone homewards loaded with presents. In a week or two the treaty with them will be printed, and I will send you one. My love to brother and sister Mecom, and to all inquiring friends. I am your dutiful son,

B. Franklin.

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LXV

TO MRS. ABIAH FRANKLIN

Philadelphia, 16 October, 1749.

Honored Mother:

This has been a busy day with your daughter, and she is gone to bed much fatigued and cannot write.

I send you enclosed one of our new Almanacs. We print them early, because we send them to many places far distant. I send you also a moidore enclosed, which please to accept towards chaise hire, that you may ride warm to meetings this winter. Pray tell us what kind of a sickness you have had in Boston this summer. Besides the measles and flux, which have carried off many children, we have lost some grown persons, by what we call the *Yellow Fever;* though that is almost, if not quite over, thanks to God, who has preserved all our family in perfect health.

Here are cousins Coleman, and two Folgers, all well. Your granddaughter is the greatest lover of her book and school of any child I ever knew, and is very dutiful to her mistress as well as to us.

I doubt not but brother Mecom will send the collar, as soon as he can conveniently. My love to him, sister, and all the children. I am your dutiful son,

B. Franklin.

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LXVI

TO MRS. ABIAH FRANKLIN

[Date uncertain.]

Honored Mother:

We received your kind letter of the 2d instant, by which we are glad to hear you still enjoy such a measure of health, notwithstanding your great age. We read your writing very easily. I never met with a word in your letters but what I could easily understand; for, though the hand is not always the best, the sense makes every thing plain. My leg, which you inquire after, is now quite well. I shall keep these servants; but the man not in my own house. I have hired him out to the man that takes care of my Dutch printing-office, who agrees to keep him in victuals and clothes, and to pay me a dollar a week for his work. The wife, since that affair, behaves exceeding well; but we conclude to sell them both the first good opportunity, for we do not like negro servants. We got again about half what we lost.

As to your grandchildren, Will is now nineteen years of age, a tall, proper youth, and much of a beau. He acquired a habit of idleness on the Expedition,[1] but begins of late to apply himself to business, and I hope will become an industrious man. He imagined his father had got enough for him, but I have assured him that I intend to spend what little I have myself, if it please God that I live long enough; and, as he by no means wants acuteness, he can see by my going on that I mean to be as good as my word.

Sally grows a fine girl, and is extremely industrious with her needle, and delights in her work. She is of a most affectionate temper, and perfectly dutiful and obliging to her parents, and to all. Perhaps I flatter myself too much, but I have hopes that she will prove an ingenious, sensible, notable, and worthy woman, like her aunt Jenny. She goes now to the dancing-school.

For my own part, at present, I pass my time agreeably enough. I enjoy, through mercy, a tolerable share of health. I read a great deal, ride a little, do a little business for myself, now and then for others, retire when I can, and go into company when I please; so the years roll round, and the last will come, when I would rather have it said, *He lived usefully,* than *He died rich.*

Cousins Josiah and Sally are well, and I believe will do well, for they are an industrious loving young couple; but they want a little more stock to go on smoothly with their business.

My love to brother and sister Mecom, and their children, and to all my relations in general. I am your dutiful son,

B. Franklin.

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LXVII

TO PETER COLLINSON1

Sir:—

According to your request, I now send you the arithmetical curiosity, of which this is the history.

Being one day in the country, at the house of our common friend, the late learned Mr. Logan, he showed me a folio French book filled with magic squares, wrote, if I forget not, by one M. Frenicle, in which, he said, the author had discovered great ingenuity and dexterity in the management of numbers; and though several other foreigners had distinguished themselves in the same way, he did not recollect that any one Englishman had done any thing of the kind remarkable.

I said it was, perhaps, a mark of the good sense of our English mathematicians, that they would not spend their time in things that were merely *difficiles nugæ,* incapable of any useful application. He answered, that many of the arithmetical or mathematical questions publicly proposed and answered in England were equally trifling and useless. “Perhaps the considering and answering such questions,” I replied, “may not be altogether useless, if it produces by practice an habitual readiness and exactness in mathematical disquisitions, which readiness may, on many occasions, be of real use.” “In the same way,” says he, “may the making of these squares be of use.” I then confessed to him that in my younger days, having once some leisure (which I still think I might have employed more usefully), I had amused myself in making this kind of magic squares, and at length had acquired such a knack at it that I could fill the cells of any magic square of reasonable size with a series of numbers as fast as I could write them, disposed in such a manner as that the sums of every row, horizontal, perpendicular, or diagonal, should be equal; but not being satisfied with these, which I looked on as common and easy things, I had imposed on myself more difficult tasks, and succeeded in making other magic squares, with a variety of properties, and much more curious. He then showed me several in the same book of an uncommon and more curious kind; but as I thought none of them equal to some I remembered to have made, he desired me to let him see them; and, accordingly, the next time I visited him I carried him a square of eight, which I found among my old papers, and which I will now give you, with an account of its properties. (See Plate IV., Fig. 1.)

Fig. 2.

200	217	232	249	8	25	40	57	72	89	104	121	136	153	168	185
58	39	26	7	250	231	218	199	186	167	154	135	122	103	90	71
198	219	230	251	6	27	38	59	70	91	102	123	134	155	166	187
60	37	28	5	252	229	220	197	188	165	156	133	124	101	92	69
201	216	233	248	9	24	41	56	73	88	105	120	137	152	169	184
55	42	23	10	247	234	215	202	183	170	151	138	119	106	87	74
203	214	235	246	11	22	43	54	75	86	107	118	139	150	171	182
53	44	21	12	245	236	213	204	181	172	149	140	117	108	85	76
205	212	237	244	13	20	45	52	77	84	109	116	141	148	173	180
51	46	19	14	243	238	211	206	179	174	147	142	115	110	83	78
207	210	239	242	15	18	47	50	79	82	111	114	143	146	175	178
49	48	17	16	241	240	209	208	177	176	145	144	113	112	81	80
196	221	228	253	4	29	36	61	68	93	100	125	132	157	164	189
62	35	30	3	254	227	222	195	190	163	158	131	126	99	94	67
194	223	226	255	2	31	34	63	66	95	98	127	130	159	162	191
64	33	32	1	256	225	224	193	192	161	160	129	128	97	96	65

Fig. 1.

52	61	4	13	20	29	36	45
14	3	62	51	46	35	30	19
53	60	5	12	21	28	37	44
11	6	59	54	43	38	27	22
55	58	7	10	23	26	39	42
9	8	57	56	41	40	25	24
50	63	2	15	18	31	34	47
16	1	64	49	48	33	32	17

Plate IV Vol. II, 273

MAGICAL SQUARES.

The properties are:

1. That every straight row (horizontal or vertical) of eight numbers added together makes 260, and half each row half 260.

2. That the bent row of eight numbers, ascending and descending diagonally, viz., from 16 ascending to 10, and from 23 descending to 17; and every one of its parallel bent rows of eight numbers, make 260. Also the bent row from 52 descending to 54, and from 43, ascending to 45, and every one of its parallel bent rows of eight numbers, make 260. Also the bent row from 45 to 43, descending to the left, and from 23 to 17, descending to the right, and every one of its parallel bent rows of eight numbers, make 260. Also the

bent row from 52 to 54, descending to the right, and from 10 to 16, descending to the left, and every one of its parallel bent rows of eight numbers, make 260. Also the parallel bent rows next to the above-mentioned, which are shortened to three numbers ascending and three descending, &c., as from 53 to 4 ascending, and from 29 to 44 descending, make, with the two corner numbers, 260. Also the two numbers, 14, 61, ascending, and 36, 19, descending, with the lower four numbers situated like them, viz., 50, 1, descending, and 32, 47, ascending, make 260. And, lastly, the four corner numbers, with the four middle numbers, make 260.

So this magical square seems perfect in its kind. But these are not all its properties; there are five other curious ones, which, at some other time, I will explain to you.

Mr. Logan then showed me an old arithmetical book, in quarto, wrote, I think, by one Stifelius, which contained a square of sixteen, that he said he should imagine must have been a work of great labor; but, if I forget not, it had only the common properties of making the same sum, viz., 2056, in every row, horizontal, vertical, and diagonal. Not willing to be outdone by Mr. Stifelius, even in the size of my square, I went home and made that evening the following magical square of sixteen, which, besides having all the properties of the foregoing square of eight—that is, it would make the 2056 in all the same rows and diagonals, had this added, that a four-square hole being cut in a piece of paper of such a size as to take in and show through it just sixteen of the little squares, when laid on the greater square, the sum of the sixteen numbers, so appearing through the hole, wherever it was placed on the greater square, should likewise make 2056. This I sent to our friend the next morning, who, after some days, sent it back in a letter with these words: “I return to thee thy astonishing or most stupendous piece of the magical square, in which”—but the compliment is too extravagant, and therefore, for his sake, as well as my own, I ought not to repeat it. Nor is it necessary; for I make no question but you will readily allow this square of sixteen to be the most magically magical of any magic square ever made by any magician. (See Plate IV., Fig. 2.)

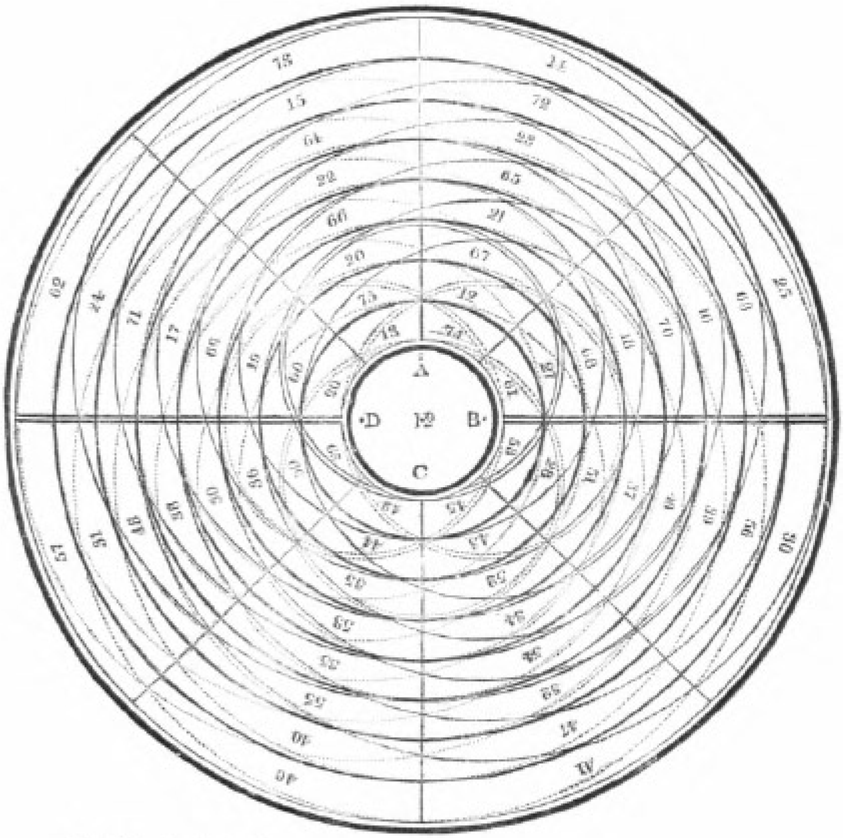

PLATE V. VOL. II., P. 275.

MAGIC CIRCLE OF CIRCLES.

I did not, however, end with squares, but composed also a magic circle, consisting of eight concentric circles and eight radial rows, filled with a series of numbers from 12 to 75 inclusive, so disposed as that the numbers of each circle, or each radial row, being added to the central number 12, they make exactly 360, the number of degrees in a circle, and this circle had, moreover, all the properties of the square of eight. If you desire it I will send it, but at present I believe you have enough on this subject.

I Am, &C.,

B. Franklin.

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LXVIII

TO PETER COLLINSON

Magical Circle

Sir:—

I am glad the perusal of the magical squares afforded you any amusement. I now send you the magical circle. (See Plate V.)

Its properties, besides those mentioned in my former, are these:

Half the numbers in any radial row added with half the central number, make 180, equal to the number of degrees in a semicircle.

Also half the numbers in any one of the concentric circles, taken either above or below the horizontal double line, with half the central number, make 180.

And if any four adjoining numbers, standing nearly in a square, be taken from any part and added with half the central number, they make 180.

There are, moreover, included four other sets of circular spaces, eccentric with respect to the first, each of these sets containing five spaces. The centres of the circles that bound them, are at *A, B, C,* and *D.* Each set, for the more easy distinguishing them from the first, are drawn with a different colored ink, red, blue, green, and yellow.[1]

These sets of eccentric circular spaces intersect those of the concentric, and each other, and yet the number contained in each of the twenty eccentric spaces, taken all around, make, with the central number, the same sum as those in each of the eight concentric, viz., 360. The halves also of those drawn from the centres *A* and *C,* taken above or below the double horizontal line, and of those drawn from centres *B* and *D* taken to the right or left of the vertical line, do, with half the central number, make just 180.

It may be observed, that there is not one of the numbers but what belongs at least to two of the different circular spaces; some to three, some to four, some to five; and yet they are all so placed as never to break the required number 360, in any of the twenty-eight circular spaces within the primitive circle.

These interwoven circles make so perplexed an appearance, that it is not easy for the eye to trace every circle of numbers one would examine, through all the maze of circles intersected by it; but if you fix one foot of the compasses in either of the centres, and extend the other to any number in the circle you would examine belonging to that centre, the moving foot will point the others out, by passing round over all the numbers of that circle successively. I am, &c.,

B. Franklin.

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LXIX

TO JARED ELIOT

Philadelphia, 13 February, 1750.

Dear Sir:

You desire to know my thoughts about the northeast storms beginning to leeward. Some years since, there was an eclipse of the moon at nine o'clock in the evening, which I intended to observe; but before night a storm blew up at northeast, and continued violent all night and all next day; the sky thick-clouded, dark, and rainy, so that neither moon nor stars could be seen. The storm did a great deal of damage all along the coast, for we had accounts of it in the newspapers from Boston, Newport, New York, Maryland, and Viriginia; but what surprised me was to find in the Boston newspapers an account of an observation of that eclipse made there; for I thought, as the storm came from the northeast, it must have begun sooner at Boston than with us, and consequently have prevented such observation. I wrote to my brother about it, and he informed me, that the eclipse was over there an hour before the storm began. Since which I have made inquiries from time to time of travellers, and of my correspondents northeastward and southwestward, and observed the accounts in the newspapers from New England, New York, Maryland, Virginia, and South Carolina; and I find it to be a constant fact, that northeast storms begin to leeward, and are often more violent there than farther to windward. Thus the last October storm, which with you was on the 8th, began on the 7th in Virginia and North Carolina, and was most violent there.1

As to the reason of this, I can only give you my conjectures. Suppose a great tract of country, land and sea, to wit, Florida and the Bay of Mexico, to have clear weather for several days, and to be heated by the sun, and its air thereby exceedingly rarefied. Suppose the country northeastward, as Pennsylvania, New England, Nova Scotia, and Newfoundland, to be at the same time covered with clouds, and its air chilled and condensed. The rarefied air being lighter must rise, and the denser air next to it will press into its place; that will be followed by the next denser air, that by the next, and so on. Thus, when I have a fire in my chimney, there is a current of air constantly flowing from the door to the chimney; but the beginning of the motion was at the chimney, where the air being rarefied by the fire rising, its place was supplied by the cooler air that was next to it, and the place of that by the next, and so on to the door. So the water in a long sluice or mill-race, being stopped by a gate, is at rest like the air in a calm; but as soon as you open the gate at one end to let it out, the water next the gate begins first to move, that which is next to it follows; and so, though the water proceeds forward to the gate, the motion which began there runs backwards, if one may so speak, to the upper end of the race, where the water is last in motion. We have on this continent a long ridge of mountains running from northeast to southwest, and the coast runs the same course. These may, perhaps, contribute towards the direction of the winds, or at least influence them in some degree. If these conjectures do not satisfy you, I wish to have yours on the subject.

I doubt not but those mountains which you mention contain valuable mines, which time will discover. I know of but one valuable copper mine in this country, which is that of Schuyler's in the Jerseys. This yields good copper, and has turned out vast wealth to the owners. I was at it last fall, but they were not then at work. The water is grown too hard for them, and they waited for a fire-engine from England to drain their pits. I suppose they will have that at work next summer; it costs them one thousand pounds sterling.

Colonel John Schuyler, one of the owners, has a deer park five miles round, fenced with cedar logs, five logs high, with blocks of wood between. It contains a variety of land, high and low, woodland and clear. There are a great many deer in it, and he expects in a few years to kill two hundred head a year, which will be a very profitable thing. He has likewise six hundred acres of meadow, all within bank. The mine is not far from Passaic Falls, which I went also to see. They are very curious; the water falls seventy feet perpendicularly, as we are told; but we had nothing to measure with.

It will be agreeable to you to hear that our subscription goes on with great success, and we suppose will exceed five thousand pounds of our currency. We have bought for the Academy the house that was built for itinerant preaching, which stands on a large lot of ground capable of receiving more buildings to lodge the scholars, if it should come to be a regular college. The house is one hundred feet long and seventy wide, built of brick, very strong, and sufficiently high for three lofty stories. I suppose the building did not cost less than two thousand pounds but we bought it for seven hundred and seventy-five pounds, eighteen shillings, eleven pence, and three farthings; though it will cost us three and perhaps four hundred more to make the partitions and floors and fit up the rooms. I send you enclosed a copy of our present constitution but we expect a charter from our Proprietaries this summer, when they may probably receive considerable alterations. The paper admonishes me that it is time to conclude.

I Am, Sir, Your Obliged Humble Servant,

B. Franklin.

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LXX

TO CADWALLADER COLDEN

Philadelphia, 28 June, 1750.

Sir:—

I wrote a line to you last post, and sent you some electrical observations and experiments. You formerly had those papers of mine, out of which something has been taken by Mr. Watson and inserted in the *Transactions.* If you have forgot the contents of those papers, I am afraid some things in that I last sent you will hardly be understood, as they depend on what went before. I send you herewith, my essay towards a new hypothesis of the cause and effects of lightning, &c., of which you may remember some hints in my first electrical minutes. I sent this essay above a twelvemonth since to Dr. Mitchell in London, and have since heard nothing of it, which makes me doubt of its getting to hand. In some late experiments, I have not only frequently fired unwarmed spirits by the electrical stroke, but have even melted small quantities of copper, silver, and gold; and not only melted, but vitrified them, so as to incorporate them with common glass; and this without any sensible heat, which strengthens my supposition, that the melting of metals by lightning may be a cold fusion. Of these experiments I shall shortly write a particular account. I wrote to Mr. Collinson, on reading in the *Transactions* the accounts from Italy and Germany, of giving purges, transferring odors, &c., with the electrical effluvia, that I was persuaded they were not true. He since informs me, that Abbé Nollet, of Paris, who had tried the experiments without success, was lately at the pains to make a journey to Turin, Bologna, and Venice, to inquire into the facts, and see the experiments repeated, imagining they had there some knacks of operating that he was unacquainted with; but, to his great disappointment, found little or no satisfaction, the gentleman there having been premature in publishing their imaginations and expectations for real experiments. Please to return me the papers when you have perused them.

My good old friend, Mr. Logan, being about three months since struck with a palsy, continues speechless, though he knows people, and seems in some degree to retain his memory and understanding. I fear he will not recover. Mr. Kalm[1] is gone towards Canada again, and Mr. Evans[2] is about to take a journey to Lake Erie, which he intends next week. Mr. Bartram continues well and hearty. I thank you for what you write concerning celestial observations. We are going on with our building for the Academy, and propose to have an observatory on the top; and, as we shall have a mathematical professor, I doubt not but we shall soon be able to send you some observations accurately made.

I am with great esteem and respect, &c.,

B. Franklin.

P. S.—If you think it would be agreeable to Mr. Alexander, or any other friend in New York, to peruse these electrical papers, you may return them to me through his hands.

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LXXI

TO PETER COLLINSON

Philadelphia, 27 July, 1750.

Sir:—

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

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

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

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

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

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

In these experiments the ends of the needle are sometimes finely blued, like a watch-spring, by the electric flame. This color, given by the flash from two jars only, will wipe off, but four jars fix it, and frequently melt the needles. I send you some that have had their heads and points melted off by our mimic lightning, and a pin that had its point melted off and some part of its head and neck run. Sometimes the surface on the body of the needle is also run, and appears blistered when examined by a magnifying-glass. The jars I make use of, hold seven or eight gallons, and are coated and lined with tin-foil; each of them takes a thousand turns[1] of a globe nine inches diameter to charge it.

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

I have not heard that any of your European electricians have ever been able to fire gunpowder by the electric flame. We do it here in this manner: A small cartridge is filled with dry powder, hard rammed, so as to bruise some of the grains; two pointed wires are then thrust in, one at each end, the points approaching each other in the middle of the cartridge till within the distance of half an inch; then, the cartridge being placed in the circuit, when the four jars are discharged, the electric flame, leaping from the point of one wire to the point of the other within the cartridge amongst the powder, *fires it,* and the explosion of the powder is at the same instant with the crack of the discharge.

Yours, &C.,

B. Franklin.

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LXXII

TO PETER COLLINSON

Philadelphia, 29 July, 1750.

Sir:—

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

I am, sir, your much obliged humble servant,

B. Franklin.

Opinions and Conjectures concerning the Properties and Effects of the Electrical Matter, and the Means of Preserving Buildings, Ships, &c., from Lightning, arising from Experiments and Observations made at Philadelphia, 1749.

§ 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.[1]

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

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

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

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

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

10. The beneficial uses of this electric fluid in the creation we are not yet well acquainted with, though doubtless such there are, and those very considerable; but we may see some pernicious consequences that would attend a much greater proportion of it. For, had this globe we live on as much of it in proportion as we can give to a globe of iron, wood, or the like, the particles of dust and other light matters that get loose from it would, by virtue of their separate electrical atmospheres, not only repel each other, but be repelled from the earth, and not easily be brought to unite with it again; whence our air would continually be more and more clogged with foreign matter and grow unfit for respiration. This affords another occasion of adoring that wisdom which has made all things by weight and measure!

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

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

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

14. To explain this: take two apples, or two balls of wood or other matter, each having its own natural quantity of the electrical fluid. Suspend them by silk lines from the ceiling. Apply the wire of a well-charged phial, held in your hand, to one of them (*A*) Plate III., Fig. 7, and it will receive from the wire a quantity of the electrical fluid, but will not imbibe it, being already full. The fluid, therefore, will flow round its surface and form an electrical atmosphere. Bring *A* into contact with *B,* and half the electrical fluid is communicated, so that each has now an electrical atmosphere, and therefore they repel each other. Take away these atmospheres, by touching the balls, and leave them in their natural state; then, having fixed a stick of sealing-wax to the middle of the phial to hold it by, apply the wire to *A,* at the same time the coating touches *B.* Thus will a

quantity of the electrical fluid be drawn out of *B,* and thrown on *A.* So that *A* will have a redundance of this fluid, which forms an atmosphere round, and *B* an exactly equal deficiency. Now, bring these balls again into contact, and the electrical atmosphere will not be divided between *A* and *B,* into two smaller atmospheres as before; for *B* will drink up the whole atmosphere of *A,* and both will be found again in their natural state.

15. The form of the electrical atmosphere is that of the body it surrounds. This shape may be rendered visible in a still air, by raising a smoke from dry rosin dropt into a hot tea-spoon under the electrified body, which will be attracted, and spread itself equally on all sides, covering and concealing the body.[1] 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 Plate III., Fig. 8, be electrified, or have an electrical atmosphere communicated to it, and we consider every side as a base on which the particles rest, and by which they are attracted, one may see, by imagining a line from *A* to *F,* and another from *E* to *G,* that the portion of the atmosphere included in *F, A, E, G,* has the line *A, E* for its basis. So the portion of atmosphere included in *H, A, B, I,* has the line *A, B* for its basis. And likewise the portion included in *K, B, C, L,* has *B, C* to rest on; and so on the other side of the figure. Now, if you will draw off this atmosphere with any blunt, smooth body, and approach the middle of the side *A, B,* you must come very near, before the force of your attractor exceeds the force or power with which that side holds the atmosphere. But there is a small portion between *I, B, K,* that has less of the surface to rest on, and to be attracted by, than the neighbouring portions, while at the same time there is a mutual repulsion between its particles and the particles of those portions; therefore here you can get it with more ease, or at a greater distance. Between *F, A, H,* there is a larger portion that has yet a less surface to rest on, and to attract it; here, therefore, you can get it away still more easily. But easiest of all, between *L, C, M,* where the quantity is largest, and the surface to attract and keep it back the least. When you have drawn away one of these angular portions of the fluid, another succeeds in its place

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

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

particles at once, but a pointed one, with no greater force, takes them away easily, particle by particle.

18. These explanations of the power and operation of points when they first occurred to me, and while they first floated in my mind, appeared perfectly satisfactory; but now I have written them, and considered them more closely, I must own I have some doubts about them; yet, as I have at present nothing better to offer in their stead, I do not cross them out; for, even a bad solution read, and its faults discovered, has often given rise to a good one, in the mind of an ingenious reader.

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

20. Thus, in the present case, to know this power of points may possibly be of some use to mankind, though we should never be able to explain it. The following experiments, as well as those in my first paper, show this power. I have a large prime conductor, made of several thin sheets of clothier's pasteboard, formed into a tube, near ten feet long and a foot diameter. It is covered with Dutch embossed paper, almost totally gilt. This large metallic surface supports a much greater electrical atmosphere than a rod or iron of fifty times the weight would do. It is suspended by silk lines, and when charged will strike, at near two inches distance, a pretty hard stroke, so as to make one's knuckle ache. Let a person standing on the floor present the point of a needle, at twelve or more inches distance form it, and while the needle is so presented, the conductor cannot be charged, the point drawing off the fire as fast as it is thrown on by the electrical globe. Let it be charged, and then present the point at the same distance, and it will suddenly be discharged. In the dark you may see the light on the point, when the experiment is made. And if the person holding the point stands upon wax, he will be electrified by receiving the fire at that distance. Attempt to draw off the electricity with a blunt body, as a bolt of iron round at the end, and smooth (a silversmith's iron punch, inch thick, is what I use), and you must bring it within the distance of three inches before you can do it, and then it is done with a stroke and crack. As the pasteboard tube hangs loose on silk lines, when you approach it with the punch-iron, it likewise will move towards the punch, being attracted while it is charged; but if, at the same instant, a point be presented as before, it retires again, for the point discharges it. Take a pair of large brass scales, of two or more feet beam, the cords of the scales being silk. Suspend the

beam by a pack-thread from the ceiling, so that the bottom of the scales may be about a foot from the floor; the scales will move round in a circle by the untwisting of the 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 upward, the scale, instead of drawing nigh to the punch and snapping, discharges its fire silently through the point, and rises higher from the punch. Nay, even if the needle be placed upon the floor near the punch, its point upwards, the end of the punch, though so much higher than the needle, will not attract the scale and receive its fire, for the needle will get it and convey it away before it comes nigh enough for the punch to act. And this is constantly observable in these experiments, that the greater quantity of electricity on the pasteboard tube, the farther it strikes or discharges its fire, and the point likewise will draw it off at a still greater distance.

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

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

22. Before I leave this subject of lightning, I may mention some other similarities between the effects of that and those of electricity. Lightning has often been known to strike people blind. A pigeon that we struck dead to appearance by the electrical shock, recovering life, drooped about the yard several days, ate 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. The biggest animal we have yet killed, or tried to kill, with the electrical stroke was a well-grown pullet.

23. Reading in the ingenious Dr. Miles’s account of the thunder-storm at Stretham, the effect of the lightning in stripping off all the paint that had covered a gilt moulding of a pannel of wainscot without hurting the rest of the paint, I had a mind to lay a coat of paint over the filleting of gold on the cover of a book, and try the effect of a strong electrical flash sent through that gold from a charged sheet of glass. But having no paint at hand, I pasted a narrow strip of paper over it, and when dry sent the flash through the gilding, by which the paper was torn off from end to end with such force that it was broken in several places, and in others brought away part of the grain of the Turkey-leather in which it was bound, and convinced me that had it been painted the paint would have been stripped off in the same manner with that on the wainscot at Stretham.

24. Lightning melts metals, and I hinted in my paper on that subject that I suspected it to be a cold fusion; I do not mean a fusion by force of cold, but a fusion without heat. We have also melted gold, silver, and copper in small quantities by the electrical flash. The manner is this: Take leaf-gold, leaf-silver, or leaf-gilt copper, commonly called leaf-brass, or Dutch gold; cut off from the leaf long narrow strips the breadth of a straw. Place one of these strips between two strips of smooth glass that are about the width of your finger. If one strip of gold the length of the leaf be not long enough for the glass, add another to the end of it, so that you may have a little part hanging out loose at each end of the glass. Bind the pieces of glass together from end to end with strong silk thread; then place it so as to be part of an electrical circuit (the ends of gold hanging out being of use to join with the 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 gold-leaf between them, put them between two smoothly-plained pieces of wood, and fixed them tight in a book-binder’s small press: yet, though they were so closely confined, the force of the electrical shock shivered the glass into many pieces. The gold was melted, and stained into the glass, as usual. The circumstances of the breaking of the glass differ much in making the experiment, and sometimes it does not break at all; but this is constant, that the stains in the upper and under pieces are exact counterparts of each other. And though I have taken up the pieces of glass between my fingers immediately after this melting, I never could perceive the least warmth in them.

25. In one of my former papers I mentioned that gilding on a book, though at first it communicated the shock perfectly well, yet failed after a few experiments, which we could not account for. We have since found, that one strong shock breaks the continuity of the gold

in the filleting, and makes it look rather like dust of gold, abundance of its parts being broken and driven off; and it will seldom conduct above one strong shock. Perhaps this may be the reason: when there is not a perfect continuity in the circuit, the fire must leap over the vacancies; there is a certain distance which it is able to leap over according to its strength; if a number of small vacancies, though each be very minute, taken together exceed that distance, it cannot leap over them, and so the shock is prevented.

26. From the before-mentioned law of electricity, that points, as they are more or less acute, draw on and throw off the electrical fluid with more or less power, and at greater or less distances, and in larger or smaller quantities in the same time, we may see how to account for the situation of the leaf of gold suspended between two plates, the upper one continually electrified, the under one in a person's hand standing on the floor. When the upper plate is electrified, the leaf is attracted and raised towards it, and would fly to that plate, were it not for its own points. The corner that happens to be uppermost when the leaf is rising, being a sharp point, from the extreme thinness of the gold, draws and receives at a distance a sufficient quantity of the electric fluid to give itself an electric atmosphere, by which its progress to the upper plate is stopped, and it begins to be repelled from that plate, and would be driven back to the under plate, but that its lowest corner is likewise a point, and throws off or discharges the overplus of the leaf's atmosphere as fast as the upper corner draws it on. Were these two points perfectly equal in acuteness, the leaf would take place exactly in the middle space, for its weight is a trifle compared to the power acting on it; but it is generally nearest the unelectrified plate, because, when the leaf is offered to the electrified plate, at a distance, the sharpest point is commonly first affected and raised towards it; so *that* point, from its greater acuteness, receiving the fluid faster than its opposite can discharge it at equal distances, it retires from the electrified plate and draws nearer to the unelectrified plate, till it comes to a distance where the discharge can be exactly equal to the receipt, the latter being lessened and the former increased; and there it remains as long as the globe continues to supply fresh electrical matter. This will appear plain, when the difference of acuteness in the corners is made very great. Cut a piece of Dutch gold (which is fittest for these experiments on account of its great strength) into the form of Figure 10, the upper corner a right angle, the two next obtuse angles, and the lowest a very acute one; and bring this on your plate, under the electrified plate, in such a manner as that the right-angled part may be first raised (which is done by covering the acute part with the hollow of your hand), and you will see this leaf take place much nearer to the upper than the under plate; because, without being nearer, it cannot receive so fast at its right-angled point as it can discharge

at its acute one. Turn this leaf with the acute part uppermost, and then it takes place nearest the unelectrified plate; because otherwise it receives faster at its acute point than it can discharge at its right-angled one. Thus the difference of distance is always proportioned to the difference of acuteness. Take care, in cutting your leaf, to leave no little ragged particles on the edges, which sometimes form points where you would not have them. You may make this figure so acute below and blunt above, as to need no under plate, it discharging fast enough into the air. When it is made narrower, as the figure between the pricked lines, we call it the *golden fish,* from its manner of acting. For if you take it by the tail, and hold it at a foot or greater horizontal distance from the prime conductor, it will, when let go, fly to it with a brisk but wavering motion, like that of an eel through the water; it will then take place under the prime conductor, at perhaps a quarter or half an inch distance, and keep a continual shaking of the tail like a fish, so that it seems animated. Turn its tail towards the prime conductor, and then it flies to your finger, and seems to nibble it. And if you hold a plate under it at six or eight inches distance, and cease turning the globe, when the electrical atmosphere of the conductor grows small, it will descend to the plate, and swim back again several times, with the same fish-like motion, greatly to the entertainment of spectators. By a little practice in blunting or sharpening the heads or tails of these figures, you may make them take place as desired, nearer or farther from the electrified plate.

27. It is said, in section eighth of this paper, that all kinds of common matter are supposed not to attract the electrical fluid with equal strength; and that those called electrics *per se,* as glass, &c., attract and retain it strongest, and contain the greatest quantity. This latter position may seem a paradox to some, being contrary to the hitherto received opinion; and therefore I shall now endeavour to explain it.

28. In order to this, let it first be considered *that we cannot, by any means we are yet acquainted with, force the electrical fluid through glass.* I know it is commonly thought that it easily pervades glass; and the experiment of a feather suspended by a thread, in a bottle hermetically sealed, yet moved by bringing a rubber tube near the outside of the bottle, is alleged to prove it. But if the electrical fluid so easily pervades glass, how does the phial become *charged* (as we term it), when we hold it in our hands? Would not the fire, thrown in by the wire, pass through to our hands, and so escape into the floor? Would not the bottle in that case be left just as we found it, uncharged, as we know a metal bottle so attempted to be charged would be? Indeed, if there be the least crack, the minutest solution of continuity in the glass, though it remains so tight that nothing else we know of will pass, yet the extremely

subtile electric fluid flies through such a crack with the greatest freedom, and such a bottle we know can never be charged; what then makes the difference between such a bottle and one that is sound, but this, that the fluid can pass through the one and not through the other.[1]

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![1] And therefore the fire that thus leaves the bottle, though the same in quantity, cannot be the very same fire that entered at the wire, for if it were, the bottle would remain uncharged.

30. If the fire that so leaves the bottle be not the same that is thrown in through the wire, it must be fire that subsisted in the bottle (that is, in the glass of the bottle) before the operation began.

31. If so there must be a great quantity in glass, because a great quantity is thus discharged, even from very thin glass.

32. That this electrical fluid or fire is strongly attracted by glass, we know from the quickness and violence with which it is resumed by the part that had been deprived of it when there is an opportunity. And by this, that we cannot from a mass of glass draw a quantity of electric fire, or electrify the whole mass *minus,* as we can a mass of metal. We cannot lessen or increase its whole quantity, for the quantity it has it holds, and it has as much as it can hold. Its pores are filled with it as full as the mutual repellency of the particles will admit, and what is already in refuses, or strongly repels, any additional quantity. Nor have we any way of moving the electrical fluid in glass, but one: that is, by covering part of the two surfaces of thin glass with non-electrics, and then throwing an additional quantity of this fluid on one surface, which, spreading in the non-electric, and being bound by it to that surface, acts by its repelling force on the particles of the electrical fluid contained in the other surface, and drives them out of the glass into the non-electric on that side from whence they are discharged, and then

those added on the charged side can enter. But when this is done there is no more in the glass, nor less, than before, just as much having left it on one side as it received on the other.

33. I feel a want of terms here, and doubt much whether I shall be able to make this part intelligible. By the word *surface,* in this case, I do not mean mere length and breadth without thickness; but, when I speak of the upper or under surface of a piece of glass, the outer or inner surface of the phial, I mean length, breadth, and half the thickness, and beg the favor of being so understood. Now I suppose that glass, in its first principles, and in the furnace, has no more of this electrical fluid than other common matter; that when it is blown, as it cools, and the particles of common fire leave it, its pores become a vacuum; that the component parts of glass are extremely small and fine, I guess from its never showing a rough face when it breaks, but always a polish; and from the smallness of its particles I suppose the pores between them must be exceedingly small, which is the reason that *aqua fortis,* nor any other menstruum we have, can enter to separate them and dissolve the substance; nor is any fluid we know of fine enough to enter, except common fire and the electric fluid. Now the departing fire, leaving a vacuum, as aforesaid, between these pores, which air nor water are fine enough to enter and fill, the electric fluid (which is everywhere ready in what we call the non-electrics, and in the non-electric mixtures that are in the air) is attracted in; yet does not become fixed with the substance of the glass, but subsists there as water in a porous stone, retained only by the attraction of the fixed parts, itself still loose and a fluid. But I suppose farther, that, in the cooling of the glass, its texture becomes closest in the middle, and forms a 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 glass they are condensed or forced near to each other. When the glass has received, and by its attraction forced closer together, so much of this electric fluid, as that the power of attracting and condensing in the one, is equal to the power of expansion in the other, it can imbibe no more, and that remains its constant whole quantity; but each surface would receive more, if the repellency of what is in the opposite surface did not resist its entrance. The quantities of this fluid in each surface being equal, their repelling action on each other is equal; and therefore those of one surface cannot drive out those of the other; but if a greater quantity is forced into one surface than the glass would naturally draw in, this

increases the repelling power on that side, and, overpowering the attraction on the other, drives out part of the fluid that had been imbibed by that surface, if there be any non-electric ready to receive it; such there is in all cases where glass is electrified to give a shock. The surface that has been thus emptied, by having its electrical fluid driven out, resumes again an equal quantity with violence, as soon as the glass has an opportunity to discharge that over quantity more than it could retain by attraction in its other surface, by the additional repellency of which the vacuum had been occasioned. For experiments favoring (if I may not say confirming) this hypothesis, I must, to avoid repetition, beg leave to refer you back to what is said of the electrical phial in my former papers.

34. Let us now see how it will account for several other appearances. Glass, a body extremely elastic (and perhaps its elasticity may be owing in some degree to the subsisting of so great a quantity of this repelling fluid in its pores), must, when rubbed, have its rubbed surface somewhat stretched, or its solid parts drawn a little farther asunder, so that the vacancies, in which the electrical fluid resides, become larger, affording room for more of that fluid, which is immediately attracted into it from the cushion or handrubbing, 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.[1] 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, the opposite inner surface receiving at the same time an equal quantity from the floor. Every electrician knows that a globe wet within will afford little or no fire; but the reason has not before been attempted to be given, that I know of.

35. So, if a tube lined with a non-electric be rubbed,[2] 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; then wrap a sheet of gilt paper close round the outer surface, and grasping it in your hand you may receive a shock by applying the finger of the other hand to the wire; for now the vacant pores in the inner surface resume their quantity, and the overcharged pores in the outer surface discharge their overplus; the equilibrium being restored through your body, which could not be restored through the glass.[1] If the tube be exhausted of air, a non-electric lining in contact with the wire is not necessary; for *in vacuo* the electrical fire will fly freely from the inner surface without a non-electric conductor; but air resists its motion; for being itself an electric *per se,* it does not attract it, having already its quantity. So the air never draws off an electric atmosphere from any body, but in proportion to the non-electrics mixed with it; it rather keeps such an atmosphere confined, which, from the mutual repulsion of its particles, tends to dissipation, and would immediately dissipate *in vacuo.* And thus the experiment of the feather enclosed in a glass vessel hermetically sealed, but moving on the approach of the rubbed tube, is explained. When an additional quantity of the electrical fluid is applied to the side of the vessel by the atmosphere of the tube, a quantity is repelled and driven out of the inner surface of that side into the vessel, and there affects the feather, returning again into its pores when the tube with its atmosphere is withdrawn; not that the particles of that atmosphere did themselves pass through the glass to the feather. And every other appearance I have yet seen, in which glass and electricity are concerned, are, I think, explained with equal ease by the same hypothesis. Yet perhaps it may not be a true one, and I shall be obliged to him that affords me a better.

36. Thus I take the difference between non-electrics and glass, an electric *per se,* to consist in these two particulars. 1st, that a non-electric easily suffers a change in the quantity of the electric fluid it contains. You may lessen its whole quantity by drawing out a part, which the whole body will again resume; but of glass you can only

lessen the quantity contained in one of its surfaces; and not that, but by supplying an equal quantity at the same time to the other surface; so that the whole glass may always have the same quantity in the two surfaces, their two different quantities being added together. And this can only be done in glass that is thin; beyond a certain thickness we have yet no power that can make this change. And 2dly, that the electric fire freely moves from place to place in and through the substance of a non-electric, but not so through the substance of glass. If you offer a quantity to one end of a long rod of metal it receives it, and when it enters every particle that was before in the rod pushes its neighbour quite to the farther end, where the overplus is discharged; and this instantaneously, where the rod is part of the circle in the experiment of the shock. But glass, from the smallness of its pores, or stronger attraction of what it contains, refuses to admit so free a motion; a glass rod will not conduct a shock, nor will the thinnest glass suffer any particle entering one of its surfaces to pass through to the other.

37. Hence we see the impossibility of success in the experiments proposed to draw out the effluvial virtues of a non-electric, as cinnamon, for instance, and mixing them with the electric fluid, to convey them with that into the body by including it in the globe, and then applying friction, &c. For, though the effluvia of cinnamon and the electric fluid should mix within the globe, they would never come out together through the pores of the glass, and so go to the prime conductor, for the electric fluid itself cannot come through, and the prime conductor is always supplied from the cushion, and that from the floor. And besides, when the globe is filled with cinnamon, or other non-electric, no electric fluid can be obtained from its outer surface, for the reason before mentioned. I have tried another way, which I thought more likely to obtain a mixture of the electric and other effluvia together, if such a mixture had been possible. I placed a glass plate under my cushion, to cut off the communication between the cushion and the floor, then brought a small chain from the cushion into a glass of oil of turpentine, and carried another chain from the oil of turpentine to the floor, taking care that the chain from the cushion to the glass should touch no part of the frame of the machine. Another chain was fixed to the prime conductor, and held in the hand of a person to be electrified. The ends of the two chains in the glass were near an inch distant from each other, the oil of turpentine between. Now the globe being turned could draw no fire from the floor through the machine, the communication that way being cut off by the thick glass plate under the cushion; it must then draw it through the chains whose ends were dipped in the oil of turpentine. And as the oil of turpentine, being an electric *per se,* would not conduct, what came up from the floor was obliged to jump from the end of one chain to the end of the other, through the substance of that oil,

which we could see in large sparks, and so it had a fair opportunity of seizing some of the finest particles of the oil in its passage, and carrying them off with it; but no such effect followed, nor could I perceive the least difference in the smell of the electric effluvia thus collected, from what it has when collected otherwise, nor does it otherwise affect the body of a person electrized. I likewise put into a phial, instead of water, a strong purgative liquid, and then charged the phial, and took repeated shocks from it, in which case every particle of the electrical fluid must, before it went through my body, have first gone through the liquid when the phial is charging, and returned through it when discharging, yet no other effect followed than if it had been charged with water. I have also smelled the electric fire when drawn through gold, silver, copper, lead, iron, wood, and the human body, and could perceive no difference; the odor is always the same, where the spark does not burn what it strikes; and therefore I imagine it does not take that smell from any quality of the bodies it passes through. And indeed, as that smell so readily leaves the electric matter, and adheres to the knuckle receiving the sparks, and to other things, I suspect that it never was connected with it, but arises instantaneously from something in the air acted upon by it. For if it was fine enough to come with the electric fluid through the body of one person, why should it stop on the skin of another?

But I shall never have done, if I tell you all my conjectures, thoughts, and imaginations on the nature and operations of this electric fluid, and relate the variety of little experiments we have tried. I have already made this paper too long, for which I must crave pardon, not having now time to abridge it. I shall only add that, as it has been observed here that spirits will fire by the electric spark in the summer-time without heating them, when Fahrenheit's thermometer is above seventy; so, when colder, if the operator puts a small flat bottle of spirits in his bosom, or a close pocket, with the spoon, some little time before he uses them, the heat of his body will communicate warmth more than sufficient for the purpose.

ADDITIONAL EXPERIMENTS

Proving that the Leyden Bottle has no more Electrical Fire in it when charged than before, nor less when discharged; that, in discharging, the Fire does not issue from the Wire and the Coating at the same Time, as some have thought, but that the Coating always receives what is discharged by the Wire, or an equal Quantity; the outer Surface being always in a Negative State of Electricity, when the inner Surface is in a positive State.

Place a thick plate of glass under the rubbing cushion, to cut off the communication of electrical fire from the floor to the cushion; then, if there be no fine points or hairy threads sticking out from the cushion, or from the parts of the machine opposite to the cushion (of which you must be careful), you can get but a few sparks from the prime conductor, which are all the cushion will part with.

Hang a phial then on the prime conductor, and it will not charge, though you hold it by the coating. But—

Form a communication by a chain from the coating to the cushion, and the phial will charge.

For the globe then draws the electric fire out of the outside surface of the phial, and forces it through the prime conductor and wire of the phial into the inside surface.

Thus the bottle is charged with its own fire, no other being to be had while the glass plate is under the cushion.

Hang two cork balls by flaxen threads to the prime conductor; then touch the coating of the bottle, and they will be electrified and recede from each other.

For, just as much fire as you give the coating, so much is discharged through the wire upon the prime conductor, whence the cork balls receive an electrical atmosphere. But—

Take a wire bent in the form of a C, with a stick of wax fixed to the outside of the curve to hold it by; and apply one end of this wire to the coating, and the other at the same time to the prime conductor, the phial will be discharged; and if the balls are not electrified before the discharge, neither will they appear to be so after the discharge, for they will not repel each other.

If the phial really exploded at both ends, and discharged fire from both coating and wire, the balls would be *more* electrified, and recede *farther;* for none of the fire can escape, the wax handle preventing.

But if the fire with which the inside surface is surcharged be so much precisely as is wanted by the outside surface, it will pass round through the wire fixed to the wax handle, restore the equilibrium in the glass, and make no alteration in the state of the prime conductor.

Accordingly we find that if the prime conductor be electrified, and the cork balls in a state of repellency before the bottle is discharged, they continue so afterwards. If not, they are not electrified by that discharge.

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LXXIII

TO SAMUEL JOHNSON1

Philadelphia, 23 August, 1750.

Dear Sir:—

We received your favor of the 16th instant. Mr. Peters will hardly have time to write to you by this post, and I must be short. Mr. Francis spent the last evening with me, and we were all glad to hear that you seriously meditate a visit after the middle of next month, and that you will inform us by a line when to expect you. We drank your health and Mrs. Johnson's, remembering your kind entertainment of us at Stratford.

I think with you, that nothing is of more importance for the public weal, than to form and train up youth in wisdom and virtue. Wise and good men are, in my opinion, the strength of a state; much more so than riches or arms, which, under the management of ignorance and wickedness, often draw on destruction, instead of providing for the safety of the people. And though the culture bestowed on *many* should be successful only with a *few,* yet the influence of those few, and the service in their power may be very great. Even a single woman, that was wise, by her wisdom saved the city.

I think also that general virtue is more probably to be expected and obtained from the education of youth, than from the exhortation of adult persons; bad habits and vices of the mind being, like diseases of the body, more easily prevented than cured. I think, moreover, that talents for the education of youth are the gift of God; and that he on whom they are bestowed, whenever a way is opened for the use of them, is as strongly *called* as if he heard a voice from heaven; nothing more surely pointing out duty in a public service, than ability and opportunity of performing it.

I have not yet discoursed with Dr. Jenney concerning your removal hither. You have reason, I own, to doubt whether your coming on the foot I proposed would not be disagreeable to him, though I think it ought not; for, should his particular interest be somewhat affected by it, that ought not to stand in competition with the *general good;* especially as it cannot be much affected, he being old, and rich, and without children. I will, however, learn his sentiments before the next post. But whatever influence they might have on your determination about removing, they need have none on your intention of visiting; and if you favor us with the visit, it is not necessary that you should previously write to him to learn his disposition about your removal, since you will see him, and when we are all together those things may be better settled in conversation than by letters at a distance.

Your tenderness of the Church’s peace is truly laudable; but methinks to build a new church in a growing place is not properly *dividing* but *multiplying;* and will really be the means of increasing the number of those who worship God in that way. Many who cannot now be accommodated in the church go to other places or stay at home; and if we had another church, many who go to other places or stay at home would go to church. I suppose the interest of the church has been far from suffering in Boston by the building of two churches there in my memory. I had for several years nailed against the wall of my house a pigeon-box that would hold six pair; and though they bred as fast as my neighbours’ pigeons, I never had more than six pair, the old and strong driving out the young and weak, and obliging them to seek new habitations. At length I put up an additional box with apartments for entertaining twelve pair more, and it was soon filled with inhabitants by the overflowing of my first box and of others in the neighbourhood. This I take to be a parallel case with the building a new church here.

Your years I think are not so many as to be an objection of any weight, especially considering the vigor of your constitution. For the smallpox, if it should spread here, you might inoculate with great probability and safety; and I think that distemper generally more favorable here than farther northward. Your objection about the politeness of Philadelphia and your imagined rusticity is mere compliment, and your diffidence of yourself absolutely groundless.

My humble respects, if you please, to your brethren at the Commencement. I hope they will advise you to what is most for the good of the whole, and then I think they will advise you to remove hither. Please to tender my best respects and service to Mrs. Johnson and your son. I am, dear Sir, your obliged and affectionate humble servant,

B. Franklin.

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LXXIV

TO JAMES BOWDOIN,[1] AT BOSTON

Philadelphia, 25 October, 1750.

Sir:—

Enclosed with this I send you all my electrical papers, fairly transcribed, and I have, as you desired, examined the copy, and find it correct. I shall be glad to have your observations on them, and if in any part I have not made myself well understood, I will on notice endeavour to explain the obscure passages by letter. My compliments to Mr. Cooper and the other gentlemen who were with you here. I hope you all got safe home. I am, Sir,

Your Most Humble Servant,

B. Franklin.

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LXXV

TO JARED ELIOT

Philadelphia, 25 October, 1750.

Dear Sir:—

I ought to have informed you sooner, that we got well home, and should have inquired after your health, as we left you in the hands of a fever. I beg you will excuse the delay, and desire you will remember in my favor the old saying, *They who have much business must have much pardon.* Whenever Mr. Francis and I meet of an evening, we drink your health, among our other New England friends, and he desires to be always respectfully remembered to you.

I am glad to hear you are got well again; but I cannot have the pleasure of seeing you again this year. I will write to Colonel Schuyler, and obtain for you a particular account of his manner of improving his banked grounds; and will also procure for you a specimen of our alum earth, with Mr. Syng's observations on it. In return (for you know there is no trade without returns) I request you to procure for me a particular account of the manner of making a new kind of fence we saw at Southhold, on Long Island, which consists of a bank and hedge. I would know every particular relating to the matter, as the best thickness, height and slope of the bank; the manner of erecting it, the best time for the work, the best way of planting the hedge, the price of the work to laborers per rod or perch, and whatever may be of use for our information here, who begin in many places to be at a loss for wood to make fence with. We were told at Southhold, that this kind of fencing had been long practised with success at Southampton and other places, on the south side of the Island, but was new among them. I hear the minister at Southhold is esteemed an ingenious man; perhaps you may know him, and he will at your request favor me with an explicit account of these fences.

The fore part of the summer here was extremely dry, and the grass in many places was burnt up. But we had a good crop of wheat; and, rains coming on about the end of July, we had in August a new spring, the grass sprouting again wonderfully thick and fast, in fields where we thought the very roots had been destroyed. Our grave-diggers said they found the earth hot sensibly at three feet depth, even after these rains; perhaps the great heat below and the moisture above occasioned this sudden and profuse vegetation, the whole country being, as it were, one great hot-bed.

I am, with esteem and affection, dear Sir,

Your Obliged Humble Servant,

B. Franklin.

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LXXVI

TO A FRIEND IN BOSTON1

Philadelphia, 25 December, 1750.

I have lately made an experiment in electricity that I desire never to repeat. Two nights ago, being about to kill a turkey by the shock from two large glass jars, containing as much electrical fire as forty common phials, I inadvertently took the whole through my own arms and body, by receiving the fire from the united top wires with one hand, while the other held a chain connected with the outsides of both jars. The company present (whose talking to me and to one another, I suppose, occasioned my inattention to what I was about) say that the flash was very great, and the crack as loud as a pistol; yet, my senses being instantly gone, I neither saw the one nor heard the other; nor did I feel the stroke on my hand, though I afterwards found it raised a round swelling where the fire entered, as big as half a pistol-bullet, by which you may judge of the quickness of the electrical fire, which by this instance seems to be greater than that of sound, light, or animal sensation.

What I can remember of the matter is that I was about to try whether the bottles or jars were fully charged by the strength and length of the stream issuing to my hand, as I commonly used to do, and which I might safely enough have done if I had not held the chain in the other hand. I then felt what I know not how well to describe—a universal blow throughout my whole body from head to foot, which seemed within as well as without; after which the first thing I took notice of was a violent, quick shaking of my body, which gradually remitting, my sense as gradually returned, and then I thought the bottles must be discharged, but could not conceive how, till at last I perceived the chain in my hand, and recollected what I had been about to do. That part of my hand and fingers which held the chain was left white, as though the blood had been driven out, and remained so eight or ten minutes after, feeling like dead flesh; and I had a numbness in my arms and the back of my neck, which continued till the next morning, but wore off. Nothing remains now of this shock but a soreness in my breast-bone, which feels as if it had been bruised. I did not fall, but suppose I should have been knocked down if I had received the stroke in my head. The whole was over in less than a minute.

You may communicate this to Mr. Bowdoin as a caution to him, but do not make it more public, for I am ashamed to have been guilty of so notorious a blunder; a match for that of the Irishman whom my sister told me of, who, to divert his wife, poured the bottle of gunpowder on the live coal; or of that other, who, being about to steal powder, made a hole in the cask with a hot iron. I am yours, &c.,

B. Franklin.

P. S.—The jars hold six gallons each.

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LXXVII

TO CADWALLADER COLDEN, AT NEW YORK

Philadelphia, ——, 1751.

Sir:—

I enclose you answers, such as my present hurry of business will permit me to make, to the principal queries contained in yours of the 28th instant, and beg leave to refer you to the latter piece in the printed collection of my papers, for further explanation of the difference between what are called *electrics per se* and *non-electrics.* When you have time to read and consider these papers, I will endeavour to make any new experiments you shall propose, that you think may afford farther light or satisfaction to either of us; and shall be much obliged to you for such remarks, objections, &c., as may occur to you.

I forget whether I wrote to you that I have melted brass pins and steel needles, inverted the poles of the magnetic needle, given a magnetism and polarity to needles that had none, and fired dry gunpowder by the electric spark. I have five bottles that contain eight or nine gallons each, two of which charged are sufficient for those purposes; but I can charge and discharge them altogether. There are no bounds (but what expense and labor give) to the force man may raise and use in the electrical way; for bottle may be added to bottle *ad infinitum,* and all united and discharged together as one, the force and effect proportioned to their number and size. The greatest known effects of common lightning may, I think, without much difficulty, be exceeded in this way, which a few years since could not have been believed, and even now may seem to many a little extravagant to suppose. So we are got beyond the skill of Rabelais's devils of two years old, who, he humorously says, had only learned to thunder and lighten a little round the head of a cabbage.

I Am, With Sincere Respect,
Your Most Obliged Humble Servant,

B. Franklin.

Queries And Answers Referred To In The Foregoing Letter

Query.

Wherein consists the difference between an *electric* and a *non-electric* body?

Answer.

The terms *electric per se* and *non-electric* were first used to distinguish bodies, on a mistaken supposition that those called *electrics per se* alone contained electric matter in their substance which was capable of being excited by friction, and of being produced or drawn from them, and communicated to those called *non-electrics,* supposed to be destitute of it; for the glass, &c., being rubbed, discovered signs of having it, by snapping to the finger, attracting, repelling, &c., and could communicate those signs to metals and water. Afterwards it was found that rubbing of glass would not produce the electric matter, unless a communication was preserved between the rubber and the floor; and subsequent experiments proved that the electric matter was really drawn from those bodies that at first were thought to have none in them. Then it was doubted whether glass, and other bodies called *electrics per se,* had really any electric matter in them, since they apparently afforded none but what they first extracted from those which had been called *non-electrics.* But some of my experiments show that glass contains it in great quantity, and I now suspect it to be pretty equally diffused in all the matter of this terraqueous globe. If so, the terms *electric per se* and *non-electric* should be laid aside as improper; and (the only difference being this, that some bodies will conduct electric matter, and others will not) the terms *conductor* and *non-conductor* may supply their place. If any portion of electric matter is applied to a piece of conducting matter, it penetrates and flows through it, or spreads equally on its surafce; 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.[1] This (by the way) shows a new relation between metals and water heretofore unknown.

To illustrate this by a comparison, which, however, can only give a faint resemblance. Electric matter passes through conductors as water passes through a porous stone, or spreads on their surfaces as water spreads on a wet stone; but when applied to non-conductors, it is like water dropped on a greasy stone, it neither penetrates, passes through, nor spreads on the surface, but remains in drops where it falls. See farther on this head, in my last printed piece, entitled *Opinions and Conjectures,* &c. 1749.

Query.

What are the effects of air in electrical experiments?

Answer.

All I have hitherto observed are these. Moist air receives and conducts the electrical matter in proportion to its moisture, quite dry air not at all; air is therefore to be classed with the non-conductors. Dry air assists in confining the electrical atmosphere to the body it surrounds, and prevents its dissipating; for *in vacuo* it quits easily, and points operate stronger—that is, they throw off or attract the electrical matter more freely and at greater distances; so that air intervening obstructs its passage from body to body in some degree. A clean electrical phial and wire, containing air instead of water, will not be charged, nor give a shock, any more than if it was filled with powder of glass; but exhausted of air, it operates as well as if filled with water. Yet an electric atmosphere and air do not seem to exclude each other, for we breathe freely in such an atmosphere, and dry air will blow through it without displacing or driving it away. I question whether the strongest dry north-wester would dissipate it. I once electrified a large cork ball at the end of a silk thread three feet long, the other end of which I held in my fingers, and whirled it round, like a sling, one hundred times in the air, with the swiftest motion I could possibly give it; yet it retained its electric atmosphere, though it must have passed through eight hundred yards of air, allowing my arm in giving the motion to add a foot to the semidiameter of the circle. By quite dry air, I mean the dryest we have; for perhaps we never have any perfectly free from moisture. An electrical atmosphere raised round a thick wire, inserted in a phial of air, drives out none of the air, nor on withdrawing that atmosphere will any air rush in, as I have found by a curious experiment[1] accurately made, whence we concluded that the air's elasticity was not affected thereby.

An Experiment Towards Discovering More Of The Qualities Of The Electric Fluid

From the prime conductor, hang a bullet by a wire hook; under the bullet, at half an inch distance, place a bright piece of silver to receive the sparks; then let the wheel be turned, and in a few minutes (if the repeated sparks continually strike in the same spot) the silver will receive a blue stain, nearly the color of a watch-spring.

A bright piece of iron will also be spotted, but not with that color; it rather seems corroded.

On gold, brass, or tin I have not perceived it makes any impression. But the spots on the silver or iron will be the same, whether the bullet be lead, brass, gold, or silver.

On a silver bullet there will also appear a small spot, as well as on the plate below it.

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LXXVIII

IMPORTANCE OF GAINING AND PRESERVING THE FRIENDSHIP OF THE INDIANS1

[*The author of the foregoing essay, having desired the printer to communicate the manuscript to some of the most judicious of his friends, it produced the following letter from one of them, the publishing whereof, we think, needs no other apology, viz.:*]

Philadelphia, March 20, 1751.

Dear Mr. Parker:

I have, as you desire, read the manuscript you sent me, and am of opinion, with the publick-spirited author, that securing the friendship of the *Indians* is of the greatest consequence to these colonies; and that the surest means of doing it are, to regulate the *Indian* trade, so as to convince them, by experience, that they may have the best and cheapest goods and the fairest dealings from the *English;* and to unite the several governments, so as to form a strength that the *Indians* may depend on for protection in case of a rupture with the *French;* or apprehend great danger from, if they should break with, us.

This union of the colonies, however necessary, I apprehend is not to be brought about by the means that have hitherto been used for that purpose. A governor of one colony, who happens from some circumstances in his own government to see the necessity of such an union, writes his sentiments of the matter to the other governors, and desires them to recommend it to their respective assemblies. They accordingly lay the letters before those assemblies and perhaps recommend the proposal in general words. But governors are often on ill terms with their assemblies, and seldom are the men that have the most influence among them. And perhaps some governors, though they openly recommend the scheme, may privately throw cold water on it, as thinking additional publick charges will make their people less able or less willing to give to them. Or perhaps they do not clearly see the necessity of it, and therefore do not very earnestly press the consideration of it; and no one being present that has the affair at heart to back it, to answer and remove objections, &c., it is easily dropp’d, and nothing is done. Such an union is certainly necessary to us all, but more immediately so to our government. Now if you were to pick out half a dozen men of good understanding and address, and furnish them with a reasonable scheme and proper instructions, and send them in the nature of ambassadors to the other colonies, where they might apply particularly to all the leading men, and by proper management get them to engage in promoting the scheme; where, by being present, they would have the opportunity of pressing the affair both in publick and private, obviating difficulties as they arise, answering objections as soon as they are made, before they spread and gather strength in the minds of the people, &c., &c., I imagine such an union might thereby be made and established; for reasonable, sensible men, can always make a reasonable scheme appear such to other reasonable men, if they take pains, and have time and opportunity for it; unless from some circumstances their honesty and good intentions are suspected. A voluntary union entered into by the colonies themselves, I think, would be preferable to one imposed by parliament; for it would be perhaps not much more difficult to procure, and more easy to alter and improve, as circumstances should require and experience direct. It would be a very strange thing, if *Six Nations* of ignorant savages should be capable of forming a scheme for such an union, and be able to execute it in such a manner, as that it has subsisted ages, and appears indissoluble; and yet that a like union should be impracticable for ten or a dozen *English* colonies, to whom it is more necessary and must be more advantageous, and who cannot be supposed to want an equal understanding of their interests.

Were there a general council form’d by all the colonies, and a general governor appointed by the crown to preside in that council, or in some manner to concur with and confirm their acts, and take care of the execution, every thing relating to Indian affairs and the defence of the colonies might be properly put under their management. Each colony should be represented by as many members as it pays sums of hundred pounds in the common treasury for the common expence; which treasury would perhaps be best and most equitably supply’d by an equal excise on strong liquors in all the colonies, the produce never to be apply’d to the private use of any colony, but to the general service. Perhaps if the council were to meet successively at the capitals of the several colonies, they might thereby become better acquainted with the circumstances, interests, strength, or weakness, &c., of all, and thence be able to judge better of measures proposed from time to time: at least it might be more satisfactory to the colonies if this were proposed as a part of the scheme, for a preference might create jealousy and dislike.

I believe the place mentioned is a very suitable one to build a fort on. In times of peace, parties of the garrisons of all frontier forts might be allowed to go out on hunting expeditions, with or without Indians, and have the profit to themselves of the skins they got; by this means a number of wood-runners would be formed, well acquainted with the country, and of great use in the war time as guides of parties and scouts, &c. Every Indian is a hunter; and as their manner of making war, *viz.,* by skulking, surprising, and killing particular persons and families, is just the same as their hunting, only changing the object, every Indian is a disciplined soldier. Soldiers of this kind are always wanted in the colonies in an Indian war, for the European military discipline is of little use in these woods.

Publick trading houses would certainly have a good effect towards regulating the private trade, and preventing the impositions of the private traders, and therefore such should be established in suitable places all along the frontiers; and the superintendent of the trade, proposed by the author, would, I think, be a useful officer.

The observation concerning the importation of Germans in too great numbers into Pennsylvania is, I believe, a very just one. This will in a few years become a German colony; instead of their learning our language, we must learn theirs, or live as in a foreign country. Already the English begin to quit particular neighborhoods surrounded by Dutch, being made uneasy by the disagreeableness of disonant manners; and, in time, numbers will probably quit the province for the same reason. Besides, the Dutch under-live, and are thereby enabled to under-work and under-sell the English, who are thereby extremely incommoded, and consequently disgusted, so that there can be no cordial affection or unity between the two nations. How good subjects they may make, and how faithful to the British interest, is a question worth considering. And, in my opinion, equal numbers might have been spared from the British islands without being missed there, and on proper encouragement would have come over. I say without being missed, perhaps I might say without lessening the number of people at home. I question, indeed, whether there be a man the less in Britain for the establishment of the colonies. An island can support but a certain number of people; when all employments are full, multitudes refrain from marriage, till they can see how to maintain a family. The number of Englishmen in England cannot by their present common increase be doubled in a thousand years; but if half of them were taken away and planted in America, where there is room for them to increase, and sufficient employment and subsistence, the number of Englishmen would be doubled in a hundred years;

for those left at home would multiply in that time so as to fill up the vacancy, and those here would at least keep pace with them.

Every one must approve the proposal of encouraging a number of sober discreet smiths to reside among the Indians. They would doubtless be of great service. The whole subsistence of Indians depends on keeping their guns in order, and if they are obliged to make a journey of two or three hundred miles to an English settlement to get a lock mended, it may, besides the trouble, occasion the loss of their hunting season. They are people that think much of their temporal, but little of their spiritual, interests; and therefore, as he would be a most useful and necessary man to them, a smith is more likely to influence them than a Jesuit; provided he has a good common understanding, and is from time to time well instructed.

I wish I could offer any thing for the improvement of the author’s piece, but I have little knowledge and less experience in these matters. I think it ought to be printed; and should be glad to see there were a more general communication of the sentiments of judicious men, on subjects so generally interesting; it would certainly produce good effects. Please to present my respects to the gentleman, and thank him for the perusal of the manuscript.

I Am, Yours Affectionately.

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LXXIX

OBSERVATIONS CONCERNING THE INCREASE OF MANKIND AND THE PEOPLING OF COUNTRIES

1. Tables of the proportion of marriages to births, of deaths to births, of marriages to the number of inhabitants, &c., formed on observations made upon the bills of mortality, christenings, &c. of populous cities, will not suit countries; nor will tables formed on observations made on full-settled old countries as Europe, suit new countries as America.[1]

2. For people increase in proportion to the number of marriages, and that is greater in proportion to the ease and convenience of supporting a family. When families can be easily supported, more persons marry, and earlier in life.

3. In cities, where all trades, occupations, and offices are full, many delay marrying till they can see how to bear the charges of a family; which charges are greater in cities, as luxury is more common; many live single during life and continue servants to families, journeymen to trades; hence cities do not, by natural generation, supply themselves with inhabitants; the deaths are more than the births.

4. In countries full settled the case must be nearly the same; all lands being occupied and improved to the height, those who cannot get land must labor for others that have it; when laborers are plenty their wages will be low; by low wages a family is supported with difficulty; this difficulty deters many from marriage, who therefore long continue servants and single. Only as the cities take supplies of people from the country, and thereby make a little more room in the country, marriage is a little more encouraged there, and the births exceed the deaths.

5. Europe is generally full settled with husbandmen, manufacturers, &c., and therefore cannot now much increase in people. America is chiefly occupied by Indians, who subsist mostly by hunting. The hunter, of all men, requires the greatest quantity of land from whence to draw his subsistence (the husbandman subsisting on much less, the gardener on still less, and the manufacturer requiring least of all). The Europeans found America as fully settled as it well could be by hunters; yet these, having large tracts, were easily prevailed on to part with portions of

territory to the new comers, who did not much interfere with the natives in hunting, and furnished them with many things they wanted.

6. Land being thus plenty in America, and so cheap as that a laboring man that understands husbandry can in a short time save money enough to purchase a piece of new land sufficient for a plantation, whereon he may subsist a family, such are not afraid to marry; for, if they even look far enough forward to consider how their children, when grown up, are to be provided for, they see that more land is to be had at rates equally easy, all circumstances considered.

7. Hence, marriages in America are more general, and more generally early than in Europe. And if it is reckoned there that there is but one marriage per annum among one hundred persons, perhaps we may here reckon two; and if in Europe they have but four births to a marriage (many of their marriages being late), we may here reckon eight, of which, if one half grow up, and our marriages are made, reckoning one with another, at twenty years of age, our people must at least be doubled every twenty years.

8. But, notwithstanding this increase, so vast is the territory of North America, that it will require many ages to settle it fully, and, till it is fully settled, labor will never be cheap here, where no man continues long a laborer for others, but gets a plantation of his own; no man continues long a journeyman to a trade, but goes among those new settlers and sets up for himself, &c. Hence labor is no cheaper now in Pennsylvania than it was thirty years ago, though so many thousand laboring people have been imported.

9. The danger, therefore, of these colonies interfering with their mother country in trades that depend on labor, manufactures, &c., is too remote to require the attention of Great Britain.

10. But in proportion to the increase of the colonies, a vast demand is growing for British manufactures, a glorious market wholly in the power of Britain, in which foreigners cannot interfere, which will increase in a short time even beyond her power of supplying, though her whole trade should be to her colonies; therefore, Britain should not too much restrain manufactures in her colonies. A wise and good mother will not do it. To distress is to weaken, and weakening the children weakens the whole family.

11. Besides, if the manufactures of Britain (by reason of the American demands) should rise too high in price, foreigners who can sell cheaper will drive her merchants out of foreign markets; foreign manufactures will thereby be encouraged and increased,

and consequently foreign nations, perhaps her rivals in power, grow more populous and more powerful; while her own colonies, kept too low, are unable to assist her, or add to her strength.

12. It is an ill-grounded opinion that, by the labor of slaves, America may possibly vie in cheapness of manufactures with Britain. The labor of slaves can never be so cheap here as the labor of workingmen is in Britain. Any one may compute it. Interest of money is in the colonies from six to ten per cent. Slaves, one with another, cost thirty pounds sterling per head. Reckon then the interest of the first purchase of a slave, the insurance or risk on his life, his clothing and diet, expenses in his sickness and loss of time, loss by his neglect of business (neglect is natural to the man who is not to be benefited by his own care or diligence), expense of a driver to keep him at work, and his pilfering from time to time, almost every slave being by nature a thief, and compare the whole amount with the wages of a manufacturer of iron or wool in England, you will see that labor is much cheaper there than it ever can be by negroes here. Why, then, will Americans purchase slaves? Because slaves may be kept as long as a man pleases, or has occasion for their labor; while hired men are continually leaving their masters (often in the midst of his business) and setting up for themselves (sec. 8).

13. As the increase of people depends on the encouragement of marriages, the following things must diminish a nation, viz.: 1. *The being conquered;* for the conquerors will engross as many offices and exact as much tribute or profit on the labor of the conquered as will maintain them in their new establishment; and this, diminishing the subsistence of the natives, discourages their marriages, and so gradually diminishes them, while the foreigners increase. 2. *Loss of territory.* Thus, the Britons being driven into Wales, and crowded together in a barren country, insufficient to support such great numbers, diminished till the people bore a proportion to the produce, while the Saxons increased on their abandoned lands till the island became full of English. And were the English now driven into Wales by some foreign nation, there would in a few years be no more Englishmen in Britain than there are now people in Wales. 3. *Loss of trade.* Manufactures exported, draw subsistence from foreign countries for numbers, who are thereby enabled to marry and raise families. If the nation be deprived of any branch of trade, and no new employment is found for the people occupied in that branch, it will also be soon deprived of so many people. 4. *Loss of food.* Suppose a nation has a fishery, which not only employs great numbers, but makes the food and subsistence of the people cheaper. If another nation becomes master of the seas, and prevents the fishery, the people will diminish in proportion as the loss of employ and dearness of

provision make it more difficult to subsist a family. 5. *Bad government and insecurity of property.* People not only leave such a country, and, settling abroad, incorporate with other nations, lose their native language, and become foreigners, but the industry of those that remain being discouraged, the quantity of subsistence in the country is lessened, and the support of a family becomes more difficult. So heavy taxes tend to diminish a people. 6. *The introduction of slaves.* The negroes brought into the English sugar islands have greatly diminished the whites there; the poor are by this means deprived of employment, while a few families acquire vast estates, which they spend on foreign luxuries, and in educating their children in the habit of those luxuries. The same income is needed for the support of one that might have maintained one hundred. The whites who have slaves, not laboring are enfeebled, and therefore not so generally prolific; the slaves being worked too hard and ill fed, their constitutions are broken, and the deaths among them are more than the births; so that a continual supply is needed from Africa. The northern colonies, having few slaves, increase in whites. Slaves also pejorate the families that use them; the white children become proud, disgusted with labor, and being educated in idleness, are rendered unfit to get a living by industry.

14. Hence, the prince that acquires new territory, if he finds it vacant, or removes the natives to give his own people room; the legislator that makes effectual laws for promoting of trade, increasing employment, improving of land by more or better tillage, providing more food by fisheries, securing property, &c.; and the man that invents new trades, arts, or manufactures, or new improvements in husbandry, may be properly called fathers of their nation, as they are the cause of the generation of multitudes by the encouragement they afford to marriage.

15. As to privileges granted to the married (such as the *jus trium liberorum* among the Romans), they may hasten the filling of a country that has been thinned by war or pestilence, or that has otherwise vacant territory, but cannot increase a people beyond the means provided for their subsistence.

16. Foreign luxuries and needless manufactures, imported and used in a nation, do, by the same reasoning, increase the people of the nation that furnishes them, and diminish the people of the nation that uses them. Laws, therefore, that prevent such importations, and on the contrary promote the exportation of manufactures to be consumed in foreign countries, may be called (with respect to the people that make them) *generative laws,* as, by increasing subsistence, they encourage marriage. Such laws likewise strengthen a country doubly, by increasing its own people and diminishing its neighbours.

17. Some European nations prudently refuse to consume the manufactures of East India; they should likewise forbid them to their colonies; for the gain to the merchant is not to be compared with the loss, by this means, of people to the nation.

18. Home luxury in the great increases the nation's manufacturers employed by it, who are many, and only tends to diminish the families that indulge in it, who are few. The greater the common fashionable expense of any rank of people, the more cautious they are of marriage. Therefore luxury should never be suffered to become common.

19. The great increase of offspring in particular families is not always owing to greater fecundity of nature, but sometimes to examples of industry in the heads, and industrious education; by which the children are enabled to provide better for themselves, and their marrying early is encouraged from the prospect of good subsistence.

20. If there be a sect therefore in our nation that regard frugality and industry as religious duties, and educate their children therein, more than others commonly do, such sect must consequently increase more by natural generation than any other sect in Britain.

21. The importation of foreigners into a country that has as many inhabitants as the present employments and provisions for subsistence will bear, will be in the end no increase of people, unless the new comers have more industry and frugality than the natives, and then they will provide more subsistence, and increase in the country; but they will gradually eat the natives out. Nor is it necessary to bring in foreigners to fill up any occasional vacancy in a country, for such vacancy (if the laws are good, sec. 14, 16) will soon be filled by natural generation. Who can now find the vacancy made in Sweden, France, or other warlike nations, by a plague of heroism forty years ago; in France, by the expulsion of the Protestants; in England, by the settlement of her colonies; or in Guinea, by one hundred years' exportation of slaves, that has blackened half America? The thinness of inhabitants in Spain is owing to national pride and idleness, and other causes, rather than to the expulsion of the Moors, or to the making of new settlements.

22. There is, in short, no bound to the prolific nature of plants or animals, but what is made by their crowding and interfering with each other's means of subsistence. Were the face of the earth vacant of other plants, it might be gradually sowed and overspread with one kind only, as, for instance, with fennel; and were it empty of other inhabitants, it might in a few ages be replenished from one nation only, as, for instance, with Englishmen. Thus, there are

supposed to be now upwards of one million English souls in North America (though it is thought scarce eighty thousand has been brought over sea), and yet perhaps there is not one the fewer in Britain, but rather many more, on account of the employment the colonies afford to manufacturers at home. This million doubling, suppose but once in twenty-five years, will in another century be more than the people of England, and the greatest number of Englishmen will be on this side the water.[1] What an accession of power to the British empire by sea as well as land! What increase of trade and navigation! What numbers of ships and seamen! We have been here but little more than one hundred years, and yet the force of our privateers in the late war, united, was greater, both in men and guns, than that of the whole British navy in Queen Elizabeth’s time. How important an affair then to Britain is the present treaty for settling the bounds between her colonies and the French, and how careful should she be to secure room enough, since on the room depends so much the increase of her people.

23. In fine, a nation well regulated is like a polypus. Take away a limb, its place is soon supplied; cut it in two, and each deficient part shall speedily grow out of the part remaining. Thus, if you have room and substance enough, as you may by dividing make ten polypuses out of one, you may of one make ten nations, equally populous and powerful, or rather increase a nation ten fold in numbers and strength.

And since detachments of English from Britain, sent to America, will have their places at home so soon supplied and increase so largely here, why should the Palatine boors be suffered to swarm into our settlements, and, by herding together, establish their language and manners, to the exclusion of ours? Why should Pennsylvania, founded by the English, become a colony of aliens, who will shortly be so numerous as to Germanize us, instead of our Anglifying them, and will never adopt our language or customs any more than they can acquire our complexion?

24. Which leads me to add one remark, that the number of purely white people in the world is proportionably very small. All Africa is black or tawny; Asia chiefly tawny; America (exclusive of the new comers) wholly so. And in Europe, the Spaniards, Italians, French, Russians, and Swedes are generally of what we call a swarthy complexion; as are the Germans also, the Saxons only excepted, who, with the English, make the principal body of white people on the face of the earth. I could wish their numbers were increased. And while we are, as I may call it, scouring our planet, by clearing America of woods, and so making this side of our globe reflect a brighter light to the eyes of inhabitants in Mars or Venus, why should we, in the sight of superior beings, darken its people? Why

increase the sons of Africa by planting them in America, where we have so fair an opportunity, by excluding all blacks and tawnys, of increasing the lovely white and red? But perhaps I am partial to the complexion of my country, for such kind of partiality is natural to mankind.

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LXXX

TO JARED ELIOT

Philadelphia, 12 September, 1751.

Dear Sir:—

I received your favor of last month, with the twelve essays. The Collinson you mention is the same gentleman I correspond with. He is a most benevolent, worthy man, very curious in botany and other branches of natural history, and fond of improvements in agriculture, etc. He will be pleased with your acquaintance. In the late *Philosophical Transactions* you may see frequently papers of his, or letters that were directed to him, on various subjects. He is a member of the Royal Society.

An ingenious acquaintance of mine here, Mr. Hugh Roberts, one of our most eminent farmers, tells me that it appears by your writings that your people are yet far behind us in the improvement of swamps and meadows. I am persuading him to send you such hints as he thinks may give you farther insight into that matter. But in other respects he greatly esteems your pieces. He says they are preferable to any thing of late years published on that subject in England. The late writers there chiefly copy from one another, and afford very little new or useful; but you have collected experiences and facts, and make propositions, that are reasonable and serviceable. You have taught him, he says, to clear his meadows of elder (a thing very pernicious to banks), which was before beyond the art of all our farmers; and given him several other useful informations.

I am exceedingly obliged to you for the plan and directions concerning ditching. It is very satisfactory, and I hope will be useful here.

Our Academy flourishes beyond expectation. We have now above one hundred scholars, and the number is daily increasing. We have excellent masters at present; and, as we give pretty good salaries, I hope we shall always be able to procure such. We pay the

Rector, who teaches Latin and Greek, per annum	£200
The English master	£150
The Mathematical professor	£125
Three assistant tutors, each £60 =	£180
Total per annum	£655

Our currency is something better than that of New York. The scholars pay each £4 per annum.

The changes of the barometer are most sensible in high latitudes. In the West India Islands the mercury continues at the same height with very little variation the year round. In these latitudes, the alterations are not frequently so great as in England. Thermometers are often badly made. I had three that differed widely from each other, though hung in the same place. As to hygrometers, there is no good one yet invented. The cord is as good as any; but, like the rest, it grows continually less sensible by time, so that the observations of one year cannot be compared with those of another by the same instrument. I will think of what you hint concerning the hydrostatic balance.

What you mention concerning the love of praise is indeed very true; it reigns more or less in every heart; though we are generally hypocrites in that respect, and pretend to disregard praise, and our nice, modest ears are offended, forsooth, with what one of the ancients calls *the sweetest kind of music.* This hypocrisy is only a sacrifice to the pride of others, or to their envy; both which, I think, ought rather to be mortified. The same sacrifice we make when we forbear to *praise ourselves,* which naturally we are all inclined to; and I suppose it was formerly the fashion, or Virgil, that courtly writer, would not have put a speech into the mouth of his hero, which now-a-days we should esteem so great an indecency:

> "Sum pius Æneas, ...
> . . . . famâ super æthera notus."

One of the Romans, I forget who, justified speaking in his own praise by saying: *Every freeman had a right to speak what he thought of himself, as well as of others.* That this is a natural inclination appears in that all children show it, and say freely: *I am a good boy; Am I not a good girl?* and the like, till they have been frequently chid, and told their trumpeter is dead, and that it is unbecoming to sound their own praise, &c. But *naturam expellas furcâ, tamen usque recurret.* Being forbid to praise themselves, they learn instead of it to censure others, which is only a roundabout way of praising themselves; for condemning the conduct of another, in any particular, amounts to as much as saying: *I am so honest, or wise, or good, or prudent, that I could* *not do or approve of such an action.* This fondness for ourselves, rather than malevolence to others, I take to be the general source of censure and backbiting; and I wish men had not been taught to dam up natural currents, to the overflowing and damage of their neighbours' grounds.

Another advantage, methinks, would arise from freely speaking our good thoughts of ourselves, viz.: if we were wrong in them, somebody or other would readily set us right; but now, while we conceal so carefully our vain, erroneous self-opinions, we may carry them to our grave, for who would offer physic to a man that seems to be in health? And the privilege of recounting freely our own good actions might be an inducement to the doing of them, that we might be enabled to speak of them without being subject to be justly contradicted or charged with falsehood; whereas now, as we are not allowed to mention them, and it is an uncertainty whether others will take due notice of them or not, we are perhaps the more indifferent about them; so that, upon the whole, I wish the out-of-fashion practice of praising ourselves would, like other old fashions, come round into fashion again. But this I fear will not be in our time, so we must even be contented with what little praise we can get from one another. And I will endeavour to make you some amends for the trouble of reading this long scrawl, by telling you that I have the sincerest esteem for you, as an ingenious man and a good one, which together make the valuable member of society. As such, I am with great respect and affection, dear Sir, your obliged humble servant,

B. Franklin.

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LXXXI

TO MRS. JANE MECOM

Philadelphia, 24 October, 1751.

Dear Sister:—

My son waits upon you with this, whom I heartily recommend to your motherly care and advice. He is indeed a sober and discreet lad of his years, but he is young and unacquainted with the ways of your place. My compliments to my new niece, Miss Abiah, and pray her to accept the enclosed piece of gold, to cut her teeth; it may afterwards buy nuts for them to crack.

Some time since I sent a letter to your care for our cousin at Casco Bay. Have you had an opportunity to forward it? My love to brother Mecom and your children; and to brother and sister Davenport and children; and respects to Mrs. Billings and her daughter, and all other friends, from, dear sister, your affectionate brother,

B. Franklin.

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LXXXII

TO JARED ELIOT

Philadelphia, 10 December, 1751.

Dear Sir:—

The rector of our Academy, Mr. Martin, came over to this country on a scheme for making potash, in the Russian method. He promised me some written directions for you, which expecting daily I delayed writing, and now he lies dangerously ill of a kind of quinsy. The surgeons have been obliged to open his windpipe, and introduce a leaden pipe for him to breathe through. I fear he will not recover.

I thank you for the merino wool. It is a curiosity. Mr. Roberts promises me some observations on husbandry for you. It is one Mr. Masters that makes manure of leaves, and not Mr. Roberts. I hope to get the particulars from him soon.

I have a letter from Mr. Collinson, of July 19th, in which he says: "Pray, has Mr. Eliot published any addition to his work? I have Nos. 1 and 2. If I can get ready, I will send some improvements made in the sandy parts of the county of Norfolk. By the way, *it is a great secret,* but it is Mr. Jackson's own drawing up, being experiments made on some of his father's estates in that county; but his name must not be mentioned. I thank you for the foul meadow grass. I sowed it June 7th, as soon as I received it, but none is yet come up. I don't know how it is, but I never could raise any of your native grasses; and I have had a variety from J. Bartram of curious species."

In another, of September 26th, he says: "I am much obliged to thee for Mr. Eliot's Third Essay. I have sent Maxwell's *Select Transactions in Husbandry.* If Mr. Eliot has not seen them, they may be very useful to him. I have prevailed on our worthy, learned, and ingenious friend Mr. Jackson to give some dissertations on the husbandry of Norfolk, believing it may be very serviceable to the colonies. He has great opportunities of doing this, being a gentleman of leisure and fortune, being the only son, whose father has great riches and possessions, and resides every year, all the long vacation, at his father's seat in Norfolk. After J. Bartram has perused it, I shall submit how it may be further disposed of, only our friend Eliot should see it soon; for Jackson admires his little

Tracts of Husbandry, as well as myself, and it may be of greater service to him and his colony, than to yours. The foul meadow grass has at last made its appearance. Another year we shall judge better of it.” Thus far friend Collinson. You may expect the papers in a post or two.

If you make any use of them, you will take care not to mention any thing of the author.

The bearer is my son, who desired an opportunity of paying his respects to you in his return from Boston. He went by sea.

They have printed all my electrical papers in England, and sent me a few copies, of which I design to send you one per next post, after having corrected a few errata. I am, dear Sir,

Your Most Humble Servant,

B. Franklin.

P. S.—Mr. Martin is dead.

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LXXXIII

TO JARED ELIOT

Philadelphia, 24 December, 1751.

Dear Sir:—

I wrote you at large by my son, in answer to your former favors, and sent you an extract from Mr. Collinson's letter, who much admires your Tracts on Husbandry. Herewith you will receive a manuscript of a friend of Mr. Collinson's, and a printed book; which you may keep till spring, and then return it to me. I believe they will afford you pleasure.

I send you also enclosed a letter from my friend John Bartram, whose Journal you have read. He corresponds with several of the greatest naturalists in Europe, and will be proud of an acquaintance with you. I make no apologies for introducing him to you; for, though a plain and illiterate man, you will find he has merit. And since for want of skill in agriculture I cannot converse with you pertinently on that valuable subject, I am pleased that I have procured you two correspondents who can.

I am glad you have introduced English declamation into your college. It will be of great service to the youth, especially if care is taken to form their pronounciation on the best models. Mr. Whittlesey, who was lately here, will tell you that we have little boys under seven, who can deliver an oration with more propriety than most preachers. It is a matter that has been too much neglected.

I Am, Dear Sir, Yours Affectionately,

B. Franklin.

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LXXXIV

TO JAMES BOWDOIN

read at the royal society, may 27, 1756

Philadelphia, 24 January, 1752.

Sir:—

I am glad to learn by your favor of the 21st past, that Mr. Kinnersley's lectures have been acceptable to the gentlemen of Boston, and are like to prove serviceable to himself.

I thank you for the countenance and encouragement you have so kindly afforded my fellow-citizen.

I send you enclosed an extract of a letter containing the substance of what I observed concerning the communication of magnetism to needles by electricity. The minutes I took at the time of the experiments are mislaid. I am very little acquainted with the nature of magnetism. Dr. Gawin Knight, inventor of the steel magnets, has wrote largely on that subject; but I have not yet had leisure to peruse his writings with the attention necessary to become master of his doctrine.

Your explication of the crooked direction of lightning[1] appears to me both ingenious and solid. When we can account as satisfactorily for the electrification of clouds, I think that branch of natural philosophy will be nearly complete.

The air undoubtedly obstructs the motion of the electric fluid. Dry air prevents the dissipation of an electric atmosphere, the denser the more, as in cold weather. I question whether such an atmosphere can be retained by a body *in vacuo.* A common electrical phial requires a non-electric communication from the wire to every part of the charged glass; otherwise, being dry and clean, and filled with air only, it charges slowly and discharges gradually by sparks, without a shock; but, exhausted of air, the communication is so open and free between the inserted wire and surface of the glass, that it charges as readily, and shocks as smartly, as if filled with water; and I doubt not but that in the experiment you propose the sparks would not only be near straight *in vacuo,* but strike at a greater distance than in the open air, though perhaps there would not be a loud explosion. As soon as I have a little leisure, I will make the experiment and send you the result.

My supposition, that the sea might possibly be the grand source of lightning, arose from the common observation of its luminous appearance in the night, on the least motion; an appearance never observed in fresh water. Then I knew that the electric fluid may be pumped up out of the earth by the friction of a glass globe on a non-electric cushion; and that notwithstanding the surprising activity and swiftness of that fluid and the non-electric communication between all parts of the cushion and the earth, yet quantities would be snatched up by the revolving surface of the globe, thrown on the prime conductor, and dissipated in air. How this was done, and why that subtile, active spirit did not immediately return again from the globe into some part or other of the cushion, and so into the earth was difficult to conceive; but whether from its being opposed by a current setting upwards to the cushion, or from whatever other cause, that it did not so return was an evident fact. Then I considered the separate particles of water as so many hard spherules, capable of touching the salt only in points, and imagined a particle of salt could therefore no more be wet by a particle of water, than a globe by a cushion; that there might therefore be such a friction between these originally constituent particles of salt and water, as in a sea of globes and cushions; that each particle of water on the surface might obtain, from the common mass, some particles of the universally diffused, much finer, and more subtile electric fluid, and, forming to itself an atmosphere of those particles, be repelled from the then generally electrified surface of the sea, and fly away with them into the air. I thought, too, that possibly the great mixture of particles *electric per se* in the ocean water might, in some degree, impede the swift motion and dissipation of the electric fluid through it to the shores, &c. But having since found, that salt in the water of an electric phial does not lessen the shock; and having endeavoured in vain to produce that luminous appearance from a mixture of salt and water agitated; and observed, that even the sea-water will not produce it after some hours' standing in a bottle; I suspect it to proceed from some principle yet unknown to us (which I would gladly make some experiments to discover, if I lived near the sea), and I grow more doubtful of my former supposition, and more ready to allow weight to that objection (drawn from the activity of the electric fluid, and the readiness of water to conduct), which you have indeed stated with great strength and clearness.

In the mean time, before we part with this hypothesis, let us think what to substitute in its place. I have sometimes queried, whether the friction of the air, an *electric per se,* in violent winds, among trees, and against the surface of the earth, might not pump up, as so many glass globes, quantities of the electric fluid, which the rising vapors might receive from the air, and retain in the clouds they form; on which I should be glad to have your sentiments. An ingenious friend of mine supposes the land clouds more likely to be electrified than the sea clouds. I send his letter for your perusal, which please to return to me.

I have wrote nothing lately on electricity, nor observed any thing new that is material, my time being much taken up with other affairs. Yesterday I discharged four jars through a fine wire, tied up between two strips of glass; the wire was in part melted, and the rest broke into small pieces, from half an inch long to half a quarter of an inch. My globe raises the electric fire with greater ease, in much greater quantities, by the means of a wire extended from the cushion to the iron pin of a pump-handle behind my house, which communicates by the pump-spear with the water in the well.

By this post I send to Dr. Perkins, who is curious in that way, some meteorological observations and conjectures, and desire him to communicate them to you, as they may afford you some amusement, and I know you will look over them with a candid eye. By throwing our occasional thoughts on paper, we more readily discover the defects of our opinions, or we digest them better, and find new arguments to support them. This I sometimes practise; but such pieces are fit only to be seen by friends.

I Am, With Great Respect, &C.,

B. Franklin.

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LXXXV

TO E. KINNERSLEY, AT BOSTON[1]

Philadelphia, 2 March, 1752.

Sir:—

I thank you for the experiments communicated.[2] I sent immediately for your brimstone globe, in order to make the trials you desired, but found it wanted centres, which I have not time now to supply; but, the first leisure, I will get it fitted for use, try the experiments, and acquaint you with the result.

In the mean time I suspect that the different attractions and repulsions you observed, proceeded rather from the greater or smaller quantities of the fire you obtained from different bodies, than from its being of a different *kind,* or having a different *direction.* In haste, I am, &c.,

B. Franklin.

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LXXXVI

TO E. KINNERSLEY, AT BOSTON

Philadelphia, 16 March, 1752.

Sir:—

Having brought your brimstone globe to work, I tried one of the experiments you proposed, and was agreeably surprised to find that the glass globe being at one end of the conductor, and the sulphur globe at the other end, both globes in motion, no spark could be obtained from the conductor, unless when one globe turned slower, or was not in so good order as the other; and then the spark was only in proportion to the difference, so that turning equally, or turning that slowest which worked best, would again bring the conductor to afford no spark.

I found also that the wire of a phial charged by the glass globe, attracted a cork ball that had touched the wire of a phial charged by the brimstone globe, and *vice versâ,* so that the cork continued to play between the two phials, just as when one phial was charged through the wire, the other through the coating, by the glass globe alone. And two phials charged, the one by the brimstone globe, the other by the glass globe, would be both discharged by bringing their wires together, and shock the person holding the phials.

From these experiments one may be certain that your second, third, and fourth proposed experiments would succeed exactly as you suppose, though I have not tried them, wanting time. I imagine it is the glass globe that charges positively, and the sulphur negatively, for these reasons. 1. Though the sulphur globe seems to work equally well with the glass one, yet it can never occasion so large and distant a spark between my knuckle and the conductor, when the sulphur one is working, as when the glass one is used; which, I suppose, is occasioned by this, that bodies of a certain bigness cannot so easily part with a quantity of electrical fluid they have and hold attracted *within* their substance, as they can receive an additional quantity *upon* their surface by way of atmosphere. Therefore so much cannot be drawn *out* of the conductor, as can be thrown *on* it. 2. I observe that the stream or brush of fire appearing at the end of a wire connected with the conductor, is long, large, and much diverging, when the glass globe is used, and makes a snapping (or rattling) noise; but when the sulphur one is used, it is short, small, and makes a hissing noise; and just the reverse of both happens, when you hold the same wire in your hand, and the globes are worked alternately: the brush is large, long, diverging, and snapping (or rattling), when the sulphur globe is turned; short, small, and hissing, when the glass globe is turned. When the brush is long, large, and much diverging, the body to which it joins seems to me to be throwing the fire out; and when the contrary appears, it seems to be drinking in. 3. I observe that when I hold my knuckle before the sulphur globe, while turning, the stream of fire between my knuckle and the globe seems to spread on its surface, as if it flowed from the finger; on the glass globe it is otherwise. 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.[1] I think I can conceive how it may be done; but have not time to add more than that I am,

Yours, &C.,

B. Franklin.

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LXXXVII

TO CADWALLADER COLDEN

read at the royal society, november 11, 1756

Philadelphia, 23 April, 1752.

Sir:—

In considering your favor of the 16th past, I recollected my having wrote you answers to some queries concerning the difference between *electrics per se* and *non-electrics,* and the effects of air in electrical experiments, which, I apprehend, you may not have received. The date I have forgotten.

We have been used to call those bodies *electrics per se,* which would not conduct the electric fluid. We once imagined that only such bodies contained that fluid; afterwards that they had none of it, and only educed it from other bodies; but further experiments showed our mistake. It is to be found in all matter we know of; and the distinction of *electrics per se* and *non-electrics* should now be dropped as improper, and that of *conductors* and *non-conductors* assumed in its place, as I mentioned in those answers.

I do not remember any experiment by which it appeared that high-rectified spirit will not conduct; perhaps you have made such. This I know, that wax, rosin, brimstone, and even glass, commonly reputed *electrics per se,* will, when in a fluid state, conduct pretty well. Glass will do it when only red-hot. So that my former position, that only metals and water were conductors, and other bodies more or less such as they partook of metal or moisture, was too general.

Your conception of the electric fluid, that it is incomparably more subtile than air, is undoubtedly just. It pervades dense matter with the greatest ease; but it does not seem to mix or incorporate willingly with mere air, as it does with other matter. It will not quit common matter to join with air. Air obstructs, in some degree, its motion. An electric atmosphere cannot be communicated at so great a distance, by far, through intervening air as through a vacuum. Who knows, then, but there may be, as the ancients thought, a region of this fire above our atmosphere, prevented by our air and its own too great distance for attraction, from joining our earth? Perhaps where the atmosphere is rarest this fluid may be densest, and nearer the earth, where the atmosphere grows denser, this fluid may be rarer, yet some of it be low enough to attach itself to our highest clouds, and thence they, becoming electrified may be attracted by and descend towards the earth and discharge their watery contents, together with that ethereal fire. Perhaps the *auroræ boreales* are currents of this fluid in its own region, above our atmosphere, becoming from their motion, visible. There is no end to conjectures. As yet we are but novices in this branch of natural knowledge.

You mention several differences of salts in electrical experiments. Were they all equally dry? Salt is apt to acquire moisture from a moist air, and some sorts more than others. When perfectly dried by lying before a fire, or on a stove, none that I have tried will conduct any better than so much glass.

New flannel, if dry and warm, will draw the electric fluid from *non-electrics,* as well as that which has been worn.

I wish you had the convenience of trying the experiments you seem to have such expectations from, upon various kinds of spirits, salts, earth, &c. Frequently, in a variety of experiments, though we miss what we expected to find, yet something valuable turns out, something surprising and instructing, though unthought of.

I thank you for communicating the illustration of the theorem concerning light. It is very curious. But I must own I am much in the *dark* about *light.* I am not satisfied with the doctrine that supposes particles of matter, called light, continually driven off from the sun’s surface, with a swiftness so prodigious! Must not the smallest particle conceivable have, with such a motion, a force exceeding that of a twenty-four pounder discharged from a cannon? Must not the sun diminish exceedingly by such a waste of matter; and the 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 ancient dimensions, and his attendants move in their ancient orbits.

May not all the phenomena of light be more conveniently solved, by supposing universal space filled with a subtile elastic fluid, which, when at rest, is not visible, but whose vibrations affect that fine sense in the eye, as those of air do the grosser organs of the ear? We do not, in the case of sound, imagine that any sonorous particles are thrown off from a bell, for instance, and fly in straight lines to the ear; why must we believe that luminous particles leave the sun and proceed to the eye? Some diamonds, if rubbed, shine in the dark, without losing any part of their matter. I can make an electrical spark as big as the flame of a candle, much brighter, and therefore, visible farther; yet this is without fuel; and I am persuaded no part of the electric fluid flies off in such case to distant places, but all goes directly, and is to be found in the place to which I destine it. May not different degrees of the vibration of the above-mentioned universal medium occasion the appearances of different colors? I think the electric fluid is always the same; yet I find that weaker and stronger sparks differ in apparent color; some white, blue, purple, red; the strongest, white; weak ones, red. Thus different degrees of vibration given to the air produce the seven different sounds in music, analogous to the seven colors, yet the medium, air, is the same.

If the sun is not wasted by expense of light, I can easily conceive that he shall otherwise always retain the same quantity of matter; though we should suppose him made of sulphur constantly flaming. The action of fire only *separates* the particles of matter; it does not *annihilate* them. Water, by heat raised in vapor, returns to the earth in rain; and if we could collect all the particles of burning matter that go off in smoke, perhaps they might, with the ashes, weigh as much as the body before it was fired; and if we could put them into the same position with regard to each other, the mass would be the same as before, and might be burnt over again. The chemists have analyzed sulphur, and find it composed, in certain proportions, of oil, salt, and earth; and having by the analysis discovered those proportions, they can, of those ingredients, make sulphur. So we have only to suppose, that the parts of the sun’s sulphur, separated by fire, rise into his atmosphere, and there, being freed from the immediate action of the fire, they collect into cloudy masses, and growing by degrees too heavy to be longer supported, they descend to the sun and are burnt over again. Hence the spots appearing on his face, which are observed to diminish daily in size, their consuming edges being of particular brightness.

It is well we are not, as poor Galileo was, subject to the Inquisition for *philosophical heresy.* My whispers against the orthodox doctrine, in private letters, would be dangerous; but your writing and printing would be highly criminal. As it is, you must expect some censure; but one heretic will surely excuse another.

I am heartily glad to hear more instances of the success of the poke-weed in the cure of that horrible evil to the human body, a cancer. You will deserve highly of mankind for the communication. But I find in Boston they are at a loss to know the right plant, some asserting it is what they call *mechoachan,* others other things. In one of their late papers it is publicly requested that a perfect description may be given of the plant, its places of growth, &c. I have mislaid the paper, or would send it to you. I thought you had described it pretty fully. I am, Sir, &c.,

B. Franklin.

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LXXXVIII

TO CADWALLADER COLDEN

Philadelphia, 14 May, 1752.

Sir:—

I find P—— has been indiscreet enough to print a piece in his paper which has brought him into a great deal of trouble. I cannot conceive how he was prevailed on to do it, as I know him to be a thorough believer himself, and averse to every thing that is commonly called *freethinking.* He is now much in his penitentials, and requests me to intercede with you, to procure from the governor a *Nol. Pros.* in his favor, promising to be very circumspect and careful for the future, not to give offence either in religion or politics, to you or any of your friends, in which, I believe, he is very sincere.

I have let him know that I pretend to no interest with you, and I fear he has behaved to the governor and to you in such a manner as not to deserve your favor. Therefore I only beg leave to recommend the poor man's case to your consideration; and if you could, without inconvenience to your own character, interest yourself a little in his behalf, I shall, as I am much concerned for him, esteem it a very great obligation.

As to the cause of religion, I really think it will be best served by stopping the prosecution; for, if there be any evil tendency apprehended from the publication of that piece, the trial and punishment of the printer will certainly make it a thousand times more public,—such is the curiosity of mankind in these cases. It is, besides, an old thing, has been printed before both in England and by Andrew Bradford here; but, no public notice being taken of it, it died and was forgotten, as I believe it would now be, if treated with the same indifference. I am with great respect, &c.,

B. Franklin.

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LXXXIX

TO EDWARD AND JANE MECOM

Philadelphia, 21 May, 1752.

Dear Brother And Sister:

I received yours with the affecting news of our dear good mother's death. I thank you for your long continued care of her in her old age and sickness. Our distance made it impracticable for us to attend her, but you have supplied all. She has lived a good life, as well as a long one, and is happy.

Since I sent you the order on Mr. Huske, I have received his account, and find he thinks he has money to receive, and though I endeavour by this post to convince him he is mistaken, yet possibly he may not be immediately satisfied, so as to pay that order; therefore, lest the delay should be inconvenient to you, I send the six pistoles enclosed. But if the order is paid, give those to brother John, and desire him to credit my account with them. Your affectionate brother,

B. Franklin.

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XC

TO JOHN PERKINS[1]

Philadelphia, 13 August, 1752.

Sir:—

I received your favor of the 3d instant. Some time last winter I procured from one of our physicians an account of the number of persons inoculated during the five visitations of the small-pox we have had in twenty-two years; which account I sent to Mr. W. V., of your town, and have no copy. If I remember rightly, the number exceeded eight hundred, and the deaths were but four. I suppose Mr. V. will show you the account, if he ever received it. These four were all that our doctors allow to have died of the small-pox by inoculation, though I think there were two more of the inoculated who died of the distemper; but the eruptions appearing soon after the operation, it is supposed they had taken the infection before in the common way.

I shall be glad to see what Dr. Douglass may write on the subject. I have a French piece printed at Paris, 1724, entitled *Observations sur la Saignée duPied, et sur la Purgation, au Commencement de la Petite Vérole, et Raisons de doubte contre l'Inoculation.* A letter of the Doctor's is mentioned in it. If he or you have it not, and desire to see it, I will send it. Please to favor me with the particulars of your purging method, to prevent the secondary fever.

I am indebted for your preceding letter, but business sometimes obliges one to postpone philosophical amusements. Whatever I have wrote of that kind are really, as they are entitled, but *Conjectures* and *Suppositions;* which ought always to give place, when careful observation militates against them. I own I have too strong a *penchant* to the building of hypotheses; they indulge my natural indolence. I wish I had more of your patience and accuracy in making observations, on which alone true philosophy can be founded. And, I assure you, nothing can be more obliging to me than your kind communication of those you make, however they may disagree with my preconceived notions.

I am sorry to hear, that the number of your inhabitants decreases. I some time since wrote a small paper of *Thoughts on the Peopling of Countries,*[1] which, if I can find, I will send you, to obtain your sentiments. The favorable opinion you express of my writings may, you see, occasion you more trouble than you expected from,

Sir, Yours, &C.,

B. Franklin.

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XCI

TO CADWALLADER COLDEN

Philadelphia, 14 September, 1752.

Dear Sir:—

When I had read your favor of May the 20th, I resolved to read and consider more carefully Sir Isaac Newton's *Optics,* which I have not looked at these many years. I delayed answering till I should have an opportunity of doing this, but one thing or other has hitherto hindered. In the winter I may possibly have more leisure.

In the mean time I would just mention that the interposition of a hill between a bell and the ear does interrupt a great part of the sound, though not all; and we cannot be certain that an opaque body placed between the eye and a luminous object intercepts all the light, since, as you observe, it does not follow that where we see no light there is therefore none existing. What you say of the separation of the distinct parts of light, which, once separated, remain always the same, has more weight with me, and indeed seems conclusive; at least, I see at present nothing to object.

I congratulate you on the prospect you have, of passing the remainder of life in philosophical retirement. I wish for the same, but it seems too distant. I might then more punctually perform my part in the correspondence you honor me with; than which I have none more instructive or agreeable.

Send me, if you please, the translation of your piece into High Dutch. I understand a little of the German language, and will peruse and return it. At present I cannot guess the meaning of the passage you mention. Unless perhaps, as your twentieth section speaks of "a power that neither resists nor moves, and exerts no kind of action of itself, without the concurrence of some other power; so that in the absence of other powers it must be in a perfect inaction," &c., it may be some kind of Dutch wit, and intended to joke that *quietism* which in Germany is supposed to be very prevalent in Pennsylvania, many of their Quietists[1] having removed hither.

I see by Cave's *Magazine* for May that they have translated my electrical papers into French, and printed them in Paris. I hope our friend Collinson will procure and send me a copy of the translation.

Such things should be done by men skilled in the subject as well as in the language, otherwise great mistakes are easily made, and the clearest matters rendered obscure and unintelligible.

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XCII

TO PETER COLLINSON

read at the royal society, december 21, 1752

Philadelphia, 19 October, 1752.

Sir:—

As frequent mention is made in publick papers from Europe of the success of the Philadelphia experiment for drawing the electric fire from clouds by means of pointed rods of iron erected on high buildings, &c., it may be agreeable to the curious to be informed that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner, which is as follows.

Make a small cross of two light strips of cedar, the arms so long as to reach to the four corners of a large thin silk handkerchief when extended; tie the corners of the handkerchief to the extremities of the cross, so you have the body of a kite; which, being properly accommodated with a tail, loop, and string, will rise in the air, like those made of paper; but this being of silk is fitter to bear the wet and wind of a thunder-gust without tearing. To the top of the upright stick of the cross is to be fixed a very sharp-pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon, and where the silk and twine join, a key may be fastened. This kite is to be raised when a thunder-gust appears to be coming on, and the person who holds the string most 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 thunderclouds come over the kite, the pointed wire will draw the electric fire from them, and the kite, with all the twine, will be electrified, and the loose filaments of the twine will stand out every way, and be attracted by an approaching finger. And when the rain has wetted the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle. At this key the phial may be charged; and from electric fire thus obtained spirits may be kindled, and all the other electric experiments be performed which are usually done by the help of a rubbed glass globe or tube, and thereby the sameness of the electric matter with that of lightning completely demonstrated.

B. Franklin.

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XCIII

TO EDWARD AND JANE MECOM

Philadelphia, 14 November, 1752.

Dear Brother And Sister:

Benny sailed from hence this day two weeks, and left our Capes the Sunday following. They are seldom above three weeks on the voyage to Antigua.

That island is reckoned one of the healthiest in the West Indies. My late partner there enjoyed perfect health for four years, till he grew careless, and got to sitting up late in taverns, which I have cautioned Benny to avoid, and have given him all other necessary advice I could think of, relating both to his health and conduct, and I hope for the best.

He will find the business settled to his hand: a newspaper established, no other printing-house to interfere with him, or beat down his prices, which are much higher than we get on the continent. He has the place on the same terms with his predecessor, who, I understand, cleared from five to six hundred pistoles during the four years he lived there. I have recommended him to some gentlemen of note for their patronage and advice.

Mr. Parker, though he looked on Benny as one of his best hands, readily consented to his going, on the first mention of it. I told him Benny must make him satisfaction for his time. He would leave that to be settled by me, and Benny as readily agreed with me to pay Mr. Parker as much as would hire a good journeyman in his room. He came handsomely provided with apparel, and I believe Mr. Parker has, in every respect, done his duty by him, and in this affair has really acted a generous part; therefore I hope, if Benny succeeds in the world, he will make Mr. Parker a return beyond what he has promised. I suppose you will not think it amiss to write Mr. and Mrs. Parker a line or two of thanks; for, notwithstanding some little differences, they have on the whole been very kind to Benny.

We have vessels going very frequently from this port to Antigua. You have some too from your port. What letters you send this way I will take care to forward. Antigua is the seat of government for all the Leeward Islands, to wit, St. Christopher's, Nevis, and

Montserrat. Benny will have the business of all those islands, there being no other printer.

After all, having taken care to do *what appears to be for the best,* we must submit to God’s providence, which orders all things really for the best.

While Benny was here, and since, our Assembly was sitting, which took up my time, and I could not before write you so fully.

With love to your children, I am, dear brother and sister, your affectionate brother,

B. Franklin.

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XCIV

TO CADWALLADER COLDEN

Philadelphia, 1 January, 1753.

Dear Sir:—

I have your favor of the third past, with your son's remarks on the Abbé Nollet's *Letters.* I think the experiments and observations are judiciously made and so well expressed that, with your and his leave, I would transmit them to Mr. Collinson for publication. I have repeated all the Abbé's experiments *in vacuo,* and find them answer exactly as they should do on my principles, and in the material part quite contrary to what he has related of them; so that he has laid himself extremely open by attempting to impose false accounts of experiments on the world to support his doctrine.

M. Dalibard wrote to me that he was preparing an answer that would be published the beginning of this winter; but as he seems to have been imposed on by the Abbé's confident assertion, that a charged bottle set down on an *electric per se* is deprived of its electricity, and in his letter to me attempts to account for it, I doubt he is not yet quite master of the subject to do the business effectually. So I conclude to write a civil letter to the Abbé myself, in which, without resenting any thing in his letters, I shall endeavour to set the disputed matters in so clear a light as to satisfy every one who will take the trouble of reading it. Before I send it home, I shall communicate it to you, and take your friendly advice on it. I set out to-morrow on a journey to Maryland, where I expect to be some weeks, but shall have some leisure when I return. At present I can only add my thanks to your ingenious son, and my hearty wishes of a happy new year to you and him, and all yours. I am, Sir, &c.,

B. Franklin.

P. S.—I wrote to you last post, and sent my paper on the *Increase of Mankind.* I send the Supplemental Electrical Experiments in several fragments of letters, of which Cave[1] has made the most, by printing some of them twice over.

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XCV

TO JOHN PERKINS

read at the royal society, june 24, 1756

Philadelphia, 4 February, 1753.

Sir:—

I ought to have written to you long since, in answer to yours of October 16th concerning the water-spout; but business partly, and partly a desire of procuring further information by inquiry among my sea-faring acquaintance, induced me to postpone writing from time to time, till I am now almost ashamed to resume the subject, not knowing but you may have forgot what has been said upon it.

Nothing certainly can be more improving to a searcher into nature than objections judiciously made to his opinion, taken up, perhaps, too hastily; for such objections oblige him to re-study the point, consider every circumstance carefully, compare facts, make experiments, weigh arguments, and be slow in drawing conclusions. And hence a sure advantage results; for he either confirms a truth, before too slightly supported, or discovers an error, and receives instruction from the objector.

In this view I consider the objections and remarks you sent me, and thank you for them sincerely; but how much soever my inclinations lead me to philosophical inquiries, I am so engaged in business, public and private, that those more pleasing pursuits are frequently interrupted, and the chain of thought, necessary to be closely continued in such disquisitions, is so broken and disjointed that it is with difficulty I satisfy myself in any of them; and I am now not much nearer a conclusion in this matter of the spout than when I first read your letter.

Yet, hoping we may in time sift out the truth between us, I will send you my present thoughts, with some observations on your reasons on the accounts in the *Transactions,* and on other relations I have met with. Perhaps while I am writing some new light may strike me, for I shall now be obliged to consider the subject with a little more attention.

I agree with you that, by means of a vacuum in a whirlwind, water cannot be supposed to rise in large masses to the region of the clouds; for the pressure of the surrounding atmosphere could not force it up in a continued body or column to a much greater height than thirty feet. But if there really is a vacuum in the centre, or near the axis of whirlwinds, then, I think, water may rise in such vacuum to that height, or to a less height, as the vacuum may be less perfect.

I had not read Stuart's account in the *Transactions* for many years before the receipt of your letter, and had quite forgot it; but now, on viewing his drafts and considering his descriptions, I think they seem to favor *my hypothesis;* for he describes and draws columns of water, of various heights, terminating abruptly at the top, exactly as water would do when forced up by the pressure of the atmosphere into an exhausted tube.

I must, however, no longer call it *my hypothesis,* since I find Stuart had the same thought, though some what obscurely expressed, where he says, "he imagines this phenomenon may be solved by suction (improperly so called), or rather pulsion, as in the application of a cupping-glass to the flesh, the air being first voided by the kindled flax."

In my paper, I supposed a whirlwind and a spout to be the same thing, and to proceed from the same cause; the only difference between them being that the one passes over land, the other over water. I find also in the *Transactions* that M. de la Pryme was of the same opinion; for he there describes two spouts, as he calls them, which were seen at different times, at Hatfield, in Yorkshire, whose appearances in the air were the same with those of the spouts at sea, and effects the same with those of real whirlwinds.

Whirlwinds have generally a progressive as well as a circular motion; so had what is called the spout, at Topsham (see the account of it in the *Transactions*), which also appears, by its effects described, to have been a real whirlwind. Water-spouts have, also, a progressive motion; this is sometimes greater and sometimes less; in some violent, in others barely perceivable. The whirlwind at Warrington continued long in Acrement Close.

Whirlwinds generally arise after calms and great heats; the same is observed of water-spouts, which are therefore most frequent in the warm latitudes. The spout that happened in cold weather, in the Downs, described by Mr. Gordon in the *Transactions,* was, for that reason, thought extraordinary; but he remarks withal, that the weather, though cold when the spout appeared, was soon after much colder; as we find it, commonly, less warm after a whirlwind.

You agree, that the wind blows every way towards a whirlwind, from a large space round. An intelligent whaleman, of Nantucket, informed me, that three of their vessels, which were out in search of whales, happening to be becalmed, lay in sight of each other, at about a league distance, if I remember right, nearly forming a triangle; after some time a water-spout appeared near the middle of the triangle, when a brisk breeze of wind sprung up, and every vessel made sail; and then it appeared to them all, by the setting of the sails, and the course each vessel stood, that the spout was to the leeward of every one of them; and they all declared it to have been so, when they happened afterwards in company, and came to confer about it. So that in this particular likewise, whirlwinds and water-spouts agree.

But if that which appears a water-spout at sea does sometimes, in its progressive motion, meet with and pass over land, and there produce all the phenomena and effects of a whirlwind, it should thence seem still more evident, that a whirlwind and a spout are the same. I send you herewith a letter from an ingenious physician of my acquaintance, which gives one instance of this, that fell within his observation.

A fluid, moving from all points horizontally toward a centre, must at that centre either ascend or descend. Water being in a tub, if a hole be opened in the middle of the bottom, will flow from all sides to the centre, and there descend in a whirl. But air, flowing on and near the surface of land or water, from all sides towards the centre, must at the centre ascend, the land or water hindering its descent.

If these concentring currents of air be in the upper region, they may indeed descend in the spout or whirlwind; but then, when the united current reached the earth or water, it would spread, and probably blow every way from the centre. There may be whirlwinds of both kinds, but from the commonly observed effects I suspect the rising one to be the most common; when the upper air descends, it is perhaps in a greater body extended wider, as in our thunder-gusts, and without much whirling; and when air descends in a spout or whirlwind, I should rather expect it would press the roof of a house *inwards,* or force *in* the tiles, shingles, or thatch, force a boat down into the water, or a piece of timber into the earth, than that it would lift them up and carry them away.

It has so happened that I have not met with any accounts of spouts that certainly descended; I suspect they are not frequent. Please to communicate those you mention. The apparent dropping of a pipe from the clouds towards the earth or sea, I will endeavour to explain hereafter.

The augmentation of the cloud, which, as I am informed, is generally if not always the case during a spout, seems to show an ascent, rather than a descent, of the matter of which such cloud is composed; for a descending spout, one would expect, should diminish a cloud. I own, however, that cold air descending may, by condensing the vapors in a lower region, form and increase clouds; which, I think, is generally the case in our common thunder-gusts, and therefore do not lay great stress on this argument.

Whirlwinds and spouts are not always, though most commonly, in the day time. The terrible whirlwind which damaged a great part of Rome, June 11, 1749, happened in the night of that day. The same was supposed to have been first a spout, for it is said to be beyond doubt, that it gathered in the neighbouring sea, as it could be tracked from Ostia to Rome. I find this in Père Boscovich's account of it, as abridged in the *Monthly Review* for December, 1750.

In that account, the whirlwind is said to have appeared as a very black, long, and lofty cloud, discoverable, notwithstanding the darkness of the night, by its continually lightning or emitting flashes on all sides, pushing along with a surprising swiftness, and within three or four feet of the ground. Its general effects on houses were, stripping off the roofs, blowing away chimneys, breaking doors and windows, *forcing up the floors, and unpaving the rooms,* (some of these effects seem to agree well with a supposed vacuum in the centre of the whirlwind,) and the very rafters of the houses were broken and dispersed, and even hurled against houses at a considerable distance, &c.

It seems, by an expression of Père Boscovich's, as if the wind blew from all sides towards the whirlwind; for, having carefully observed its effects, he concludes of all whirlwinds, "that their motion is circular, and their action attractive."

He observes, on a number of histories of whirlwinds, &c., "that a common effect of them is to carry up into the air tiles, stones, and animals themselves, which happened to be in their course, and all kinds of bodies unexceptionably, throwing them to a considerable distance, with great impetuosity."

Such effects seem to show a rising current of air.

I will endeavour to explain my conceptions of this matter by figures, representing a plan, and an elevation of a spout or whirlwind.

I would only first beg to be allowed two or three positions, mentioned in my former paper.

1. That the lower region of air is often more heated, and so more rarefied, than the upper; consequently, specifically lighter. The coldness of the upper region is manifested by the hail, which sometimes falls from it in a hot day.

2. That heated air may be very moist and yet the moisture so equally diffused and rarefied as not to be visible till colder air mixes with it when it condenses and becomes visible. Thus our breath, invisible in summer, becomes visible in winter.

Now let us suppose a tract of land, or sea, of perhaps sixty miles square, unscreened by clouds, and unfanned by winds, during great part of a summer’s day, or, it may be, for several days successively, till it is violently heated, together with the lower region of air in contact with it, so that the said lower air becomes specifically lighter than the superincumbent higher region of the atmosphere, in which the clouds commonly float; let us suppose, also, that the air surrounding this tract has not been so much heated during those days, and therefore remains heavier. The consequence of this should be, as I conceive, that the heated, lighter air, being pressed on all sides, must ascend, and the heavier descend; and as this rising cannot be in all parts, or the whole area, of the tract at once, for that would leave too extensive a vacuum, the rising will begin precisely in that column that happens to be the lightest or most rarefied; and the warm air will flow horizontally from all points to this column, where the several currents meeting, and joining to rise, a whirl is naturally formed, in the same manner as a whirl is formed in the tub of water, by the descending fluid flowing from all sides of the tub to the hole in the centre.

And as the several currents arrive at this central rising column with a considerable degree of horizontal motion, they cannot suddenly change it to a vertical motion; therefore as they gradually, in approaching the whirl, decline from right to curve or circular lines, so, having joined the whirl, they *ascend* by a spiral motion, in the same manner as the water *descends* spirally through the hole in the tub before-mentioned.

Lastly, as the lower air, and nearest the surface, is most rarefied by the heat of the sun, that air is most acted on by the pressure of the surrounding cold and heavy air, which is to take its place; consequently its motion towards the whirl is swiftest, and so the force of the lower part of the whirl, or trump, strongest, and the centrifugal force of its particles greatest; and hence the vacuum round the axis of the whirl should be greatest near the earth or sea, and be gradually diminished as it approaches the region of the clouds, till it ends in a point, as at *P,* in Figure 2, Plate VI., forming a long and sharp cone.

In Figure 1, which is a plan or ground-plat of a whirlwind, the circle *V* represents the central vacuum.

Between *a a a a* and *b b b b,* I suppose a body of air, condensed strongly by the pressure of the currents moving towards it from all sides without, and by its centrifugal force from within, moving round with prodigious swiftness (having, as it were, the momenta of all the currents, ——> ——> ——> ——>, united in itself), and with a power equal to its swiftness and density.

It is this whirling body of air between *a a a a* and *b b b b* that rises spirally; by its force it tears buildings to pieces, twists up great trees by the roots, &c., and by its spiral motion raises the fragments so high, till the pressure of the surrounding and approaching currents, diminishing, can no longer confine them to the circle, or their own centrifugal force, increasing, grows too strong for such pressure, when they fly off in tangent lines, as stones out of a sling, and fall on all sides and at great distances.

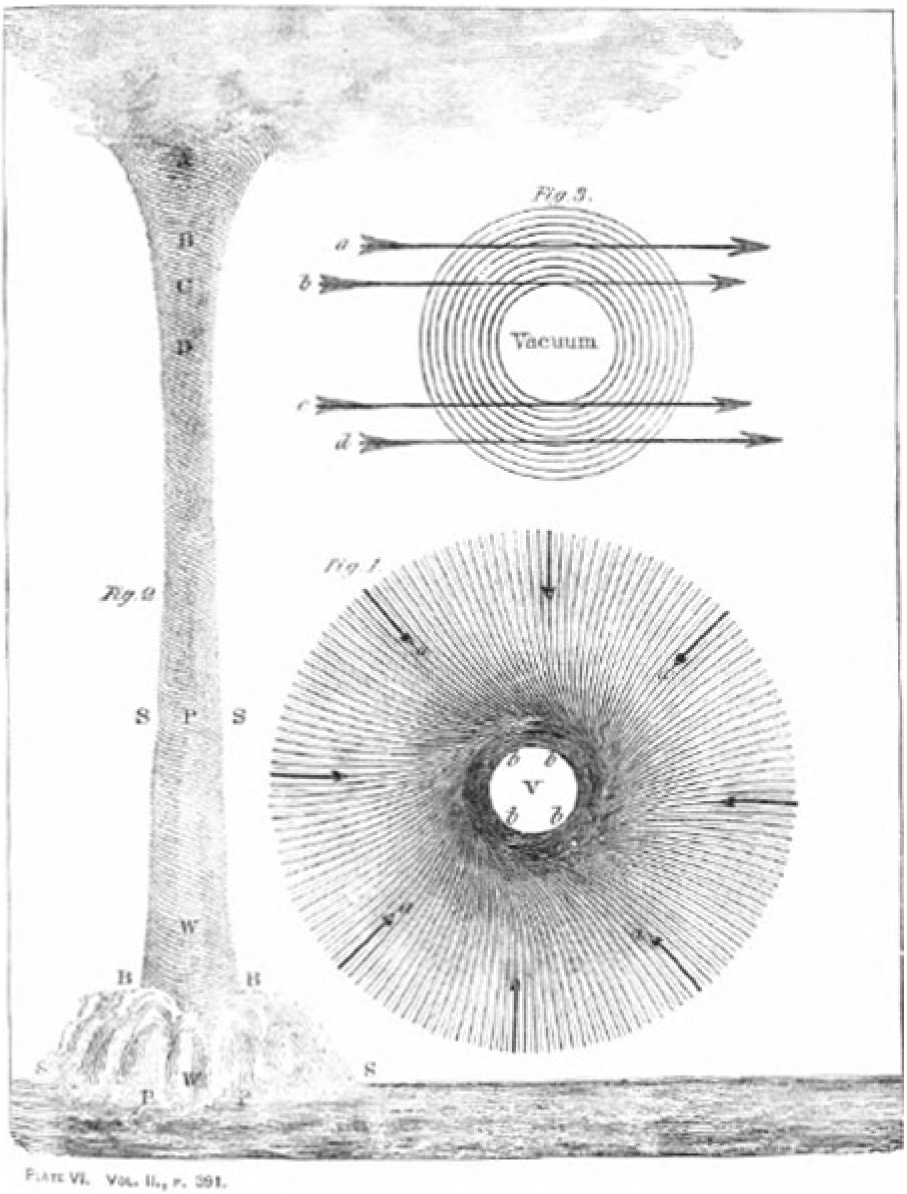
If it happens at sea, the water under and between *a a a a* and *b b b b* will be violently agitated and driven about, and parts of it raised with the spiral current, and thrown about so as to form a bush-like appearance.

This circle is of various diameters, sometimes very large.

If the vacuum passes over water, the water may rise in it, in a body or column, to near the height of thirty-two feet.

If it passes over houses, it may burst their windows or walls outwards, pluck off the roofs, and pluck up the floors, by the sudden rarefaction of the air contained within such buildings; the outward pressure of the atmosphere being suddenly taken off. So the stopped bottle of air bursts under the exhausted receiver of the air-pump.

Figure 2 is to represent the elevation of a water-spout, wherein I suppose *P P P* to be the cone, at first a vacuum, till *W W,* the rising column of water, has filled so much of it; *S S S S,* the spiral whirl of air, surrounding the vacuum, and continued higher in a close column after the vacuum ends in the point *P,* till it reaches the cool region of the air. *B B,* the bush, described by Stuart, surrounding the foot of the column of water.



WATER SPOUT.

Now, I suppose, this whirl of air will, at first, be as invisible as the air itself, though reaching in reality from the water to the region of cool air, in which our low summer thunder-clouds commonly float; but presently it will become visible at its extremities. *At its lower end,* by the agitation of the water under the whirling part of the circle, between *P* and *S,* forming Stuart's bush, and by the welling and rising of the water in the beginning vacuum, which is at first a small, low, broad cone, whose top gradually rises and sharpens as the force of the whirl increases. *At its upper end* it becomes visible, by the warm air brought up to the cooler region, where its moisture begins to be condensed into thick vapor by the cold, and is seen first at *A,* the highest part, which, being now cooled, condenses what rises next at *B,* which condenses that at *C,* and that condenses what is rising at *D,* the cold operating by the contact of the vapors faster in a right line downwards than the vapors themselves can climb in a spiral line upwards; they climb, however, and, as by continual addition they grow denser, and consequently their centrifugal force greater, and being risen above the concentrating currents that compose the whirl, fly off, spread, and form a cloud.

It seems easy to conceive how, by this successive condensation from above, the spout appears to drop or descend from the cloud, though the materials of which it is composed are all the while ascending.

The condensation of the moisture contained in so great a quantity of warm air as may be supposed to rise in a short time in this prodigiously rapid whirl, is, perhaps, sufficient to form a great extent of cloud, though the spout should be over land, as those at Hatfield; and if the land appears not to be very dusty, perhaps the lower part of the spout will scarce become visible at all, though the upper, or what is commonly called the descending, part be very distinctly seen.

The same may happen at sea, in case the whirl is not violent enough to make a high vacuum, and raise the column, &c. In such case, the upper part *A B C D* only will be visible, and the bush perhaps below.

But if the whirl be strong, and there be much dust on the land, and the column *W W* be raised from the water, then the lower part becomes visible, and sometimes even united to the upper part. For the dust may be carried up in the spiral whirl, till it reach the region where the vapor is condensed, and rise with that even to the clouds; and the friction of the whirling air, on the sides of the column *W W,* may detach great quantities of its water, break it into drops, and carry them up in the spiral whirl, mixed with the air; the heavier drops may indeed fly off, and fall in a shower, round the spout; but much of it will be broken into vapor, yet visible; and thus, in both cases, by dust at land, and by water at sea, the whole tube may be darkened and rendered visible.

As the whirl weakens, the tube may (in appearance) separate in the middle, the column of water subsiding, and the superior condensed part drawing up to the cloud. Yet still the tube or whirl of air may remain entire, the middle only becoming invisible, as not containing visible matter.

Dr. Stuart says: “It was observable of all the spouts he saw, but more perceptible of the great one, that towards the end it began to appear like a hollow canal, only black in the borders but white in the middle; and though at first it was altogether black and opake, yet now one could very distinctly perceive the sea water to fly up along the middle of this canal, as smoke up a chimney."

And Dr. Mather, describing a whirlwind, says: "A thick, dark, small cloud arose, with a pillar of light in it, of about eight or ten feet diameter, and passed along the ground in a tract not wider than a street, horribly tearing up trees by the roots, blowing them up in the air like feathers, and throwing up stones of great weight to a considerable height in the air," &c.

These accounts, the one of water-spouts, the other of a whirlwind, seem in this particular to agree; what one gentleman describes as a tube, black in the borders and white in the middle, the other calls a black cloud with a pillar of light in it; the latter expression has only a little more of the *marvellous,* but the thing is the same; and it seems not very difficult to understand. When Dr. Stuart's spouts were full charged—that is, when the whirling pipe of air was filled between *a a a a* and *b b b b,* Figure 1, with quantities of drops, and vapor torn off from the column *W W,* Figure 2, the whole was rendered so dark as that it could not be seen through, nor the spiral ascending motion discovered; but when the quantity ascending lessened, the pipe became more transparent, and the ascending motion visible. For, by inspection of the figure (Fig. 3) representing a section of our spout, with the vacuum in the middle, it is plain that if we look at such a hollow pipe in the direction of the arrows, and suppose opake particles to be equally mixed in the space between the two circular lines, both the part between the arrows *a* and *b* and that between the arrows *c* and *d* will appear much darker than that between *b* and *c,* as there must be many more of those opake particles in the line of vision across the sides than across the middle. It is thus, that a hair in a microscope evidently appears to be a pipe, the sides showing darker than the middle. Dr. Mather's whirl was probably filled with dust, the sides were very dark, but the vacuum within rendering the middle more transparent, he calls it a pillar of light.

It was in this more transparent part between *b* and *c* that Stuart could see the spiral motion of the vapors, whose lines on the nearest and farthest side of the transparent part crossing each other, represented smoke ascending in a chimney; for, the quantity being still too great in the line of sight through the sides of the tube, the motion could not be discovered there, and so they represented the solid sides of the chimney.

When the vapors reach in the pipe from the clouds near to the earth, it is no wonder now to those who understand electricity, that flashes of lightning should descend by the spout, as in that of Rome.

But you object: If water may be thus carried into the clouds, why have we not salt rains? The objection is strong and reasonable, and I know not whether I can answer it to your satisfaction. I never heard but of one salt rain, and that was where a spout passed pretty near a ship; so I suppose it to be only the drops thrown off from the spout by the centrifugal force (as the birds were at Hatfield), when they had been carried so high as to be above, or to be too strongly centrifugal for the pressure of the concurring winds surrounding it. And indeed I believe there can be no other kind of salt rain; for it has pleased the goodness of God so to order it, that the particles of air will not attract the particles of salt, though they strongly attract water.

Hence, though all metals, even gold, may be united with air, and rendered volatile, salt remains fixed in the fire, and no heat can force it up to any considerable height, or oblige the air to hold it. Hence, when salt rises, as it will a little way, into air with water, there is instantly a separation made; the particles of water adhere to the air, and the particles of salt fall down again, as if repelled and forced off from the water by some power in the air; or as some metals, dissolved in a proper menstruum, will quit the solvent when other matter approaches, and adhere to that, so the water quits the salt and embraces the air, but air will not embrace the salt and quit the water, otherwise our rains would indeed be salt, and every tree and plant on the face of the earth be destroyed, with all the animals that depend on them for subsistence. He who hath proportioned and given proper qualities to all things, was not unmindful of this. Let us adore Him with praise and thanksgiving!

By some accounts of seamen, it seems the column of water, *W W,* sometimes falls suddenly; and if it be, as some say, fifteen or twenty yards diameter, it must fall with great force, and they may well fear for their ships. By one account, in the *Transactions,* of a spout that fell at Colne, in Lancashire, one would think the column is sometimes lifted off from the water and carried over land, and there let fall in a body; but this, I suppose, happens rarely.

Stuart describes his spouts as appearing no bigger than a mast, and sometimes less; but they were seen at a league and a half distance.

I think I formerly read in Dampier, or some other voyager, that a spout, in its progressive motion, went over a ship becalmed on the coast of Guinea, and first threw her down on one side, carrying away her foremast, then suddenly whipped her up and threw her down on the other side, carrying away her mizenmast, and the whole was over in an instant. I suppose the first mischief was done by the fore side of the whirl, the latter by the hinder side, their motion being contrary.

I suppose a whirlwind, or spout, may be stationary, when the concurring winds are equal; but if unequal, the whirl acquires a progressive motion, in the direction of the strongest pressure.

When the wind that gives the progressive motion becomes stronger below than above, or above than below, the spout will be bent, and, the cause ceasing, straighten again.

Your queries, towards the end of your paper, appear judicious and worth considering. At present I am not furnished with facts sufficient to make any pertinent answer to them; and this paper has already a sufficient quantity of conjecture.

Your manner of accommodating the accounts to your hypothesis of descending spouts is, I own, ingenious, and perhaps that hypothesis may be true. I will consider it farther; but as yet I am not satisfied with it, though hereafter I may be.

Here you have my method of accounting for the principal phenomena, which I submit to your candid examination.

And as I now seem to have almost written a book instead of a letter, you will think it high time I should conclude, which I beg leave to do, with assuring you that I am, Sir, &c.,

B. Franklin.

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XCVI

TO JAMES BOWDOIN

Philadelphia, 28 February, 1753.

Dear Sir:—

The enclosed is a copy of a letter and some papers I received lately from a friend, of which I have struck off fifty copies by the press to distribute among my ingenious acquaintance in North America, hoping some of them will make the observations proposed. The improvement of geography and astronomy is the common concern of all polite nations, and I trust our country will not miss the opportunity of sharing in the honor to be got on this occasion. The French originals are despatched by express overland to Quebec. I doubt not but you will do what may lie in your power to promote the making these observations in New England, and that we may not be excelled by the American French either in diligence or accuracy. We have here a three-foot reflecting telescope and other proper instruments, and intend to observe at our Academy, if the weather permit. You will see by our Almanac that we have had this transit under consideration before the arrival of these French letters.[1]

Dr. Colden's book was printed in England last summer, but not to be published till the meeting of Parliament. I have one copy, however, which I purpose shortly to send you.

With great esteem and respect, I am, Sir,

Your Most Humble Servant,

B. Franklin.

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XCVII

TO JARED ELIOT

Philadelphia, 12 April, 1753.

Dear Sir:—

I received your favor of March 26th, and thank you for communicating to me the very ingenious letter from your friend, Mr. Todd, with whom, if it may be agreeable to him, I would gladly entertain a correspondence. I shall consider his objections till next post.

I thank you for your hint concerning the word *adhesion,* which should be defined. When I speak of particles of water *adhering* to particles of air, I mean not a firm adhesion, but a loose one, like that of a drop of water to the end of an icicle before freezing. The firm adhesion is after it is frozen.

I conceive that the original constituent particles of water are perfectly *hard, round,* and *smooth.* If so, there must be interstices, and yet the mass incompressible. A box filled with small shot has many interstices, and the shot may be compressed, because they are not perfectly hard. If they were, the interstices would remain the same, notwithstanding the greatest pressure, and would admit sand, as water admits salt.

Our vessel, named the *Argo,* is gone for the northwest passage; and the captain has borrowed my Journals of the last voyage, except one volume of a broken set, which I send you. I enclose a letter from our friend, Mr. Collinson, and am promised some speltz, which I shall send per next post.

The *Tatler* tells us of a girl who was observed to grow suddenly proud, and none could guess the reason, till it came to be known that she had got on a pair of new silk garters. Lest you should be puzzled to guess the cause, when you observe any thing of the kind in me, I think I will not hide my new garters under my petticoats, but take the freedom to show them to you, in a paragraph of our friend Collinson's last letter, viz.—But I ought to mortify, and not indulge, this vanity; I will not transcribe the paragraph, yet I cannot forbear.

"If any of thy friends," says Peter, "should take notice that thy head is held a little higher up than formerly, let them know: when the grand monarch of France strictly commands the Abbé Mazéas to write a letter in the politest terms to the Royal Society, to return the King's thanks and compliments in an express manner to Mr. Franklin of Pennsylvania, for his useful discoveries in electricity, and application of the pointed rods to prevent the terrible effects of thunder-storms, I say, after all this, is not some allowance to be made, if thy crest is a little elevated? There are four letters containing very curious experiments on thy doctrine of points and its verification, which will be printed in the new *Transactions.* I think, now I have stuck a feather in thy cap, I may be allowed to conclude in wishing thee long to wear it. Thine, P. Collinson."

On reconsidering this paragraph, I fear I have not so much reason to be proud as the girl had; for a feather in the cap is not so useful a thing, or so serviceable to the wearer, as a pair of good silk garters. The pride of man is very differently gratified; and had his Majesty sent me a marshal's staff, I think I could scarce have been so proud of it as I am of your esteem, and of subscribing myself, with sincerity, dear Sir,

Your affectionate friend and humble servant,

B. Franklin.

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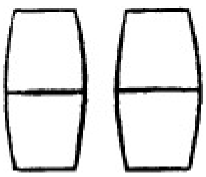
XCVIII

TO JAMES BOWDOIN

Philadelphia, 12 April, 1753.

Sir:—

I have shipped eighteen glass jars in casks well packed, on board Captain Branscombe for Boston; six of them are for you, the rest I understand are for the College. Leaf tin, such as they use in silvering looking-glasses, is best to coat them with; they should be coated to within about four or five inches of the brim. Cut the tin into pieces of the form here represented, and they will comply better with the bellying of the glass; one piece only should be round to cover the bottom; the same shapes will serve the inside. I had not conveniency to coat them for you, and feared to trust anybody else, Mr. Kinnersley being abroad in the West Indies. To make the pieces comply the better, they may be cut in two where the cross lines are. They reach from the top to the edge of the round piece which covers the bottom. I place them in loose rims of scabboard, something like a small sieve, in which they stand very well. If you charge more than one or two together, pray take care how you expose your head to an accidental stroke; for, I can assure you from experience, one is sufficient to knock a stout man down; and I believe a stroke from two or three, in the head, would kill him.



Has Dr. Colden's new book reached you in Boston? If not, I will send it to you.

With great respect, I am, Sir,

Your Most Humble Servant,

B. Franklin.

P. S.—The glass-maker being from home, I cannot now get the account. The tin is laid on with common paste, made of flour and water boiled together, and the pieces may lap over each other a little.

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XCIX

TO WILLIAM SMITH[1]

Philadelphia, 19 April, 1753.

Sir:—

I received your favor of the 11th instant, with your new piece on *Education,*[2] 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,[1] who was educated at Glasgow, has been long accustomed to teach the latter, and Mr. Grew[2] 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,[3] 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 purpose 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 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 convenience to visit Philadelphia before your 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 enclosed. 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.

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C

TO WILLIAM SMITH

Philadelphia, 3 May, 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 Aratus[1] 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*,[1] 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 purposed 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 Philadelphia agreeable to you. I am, &c.,

B. Franklin.

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CI

TO PETER COLLINSON

Philadelphia, 9 May, 1753.

Sir:—

I thank you for the kind and judicious remarks you have made on my little piece. I have often observed with wonder that temper of the poorer English laborers which you mention, and acknowledge it to be pretty general. When any of them happen to come here, where labor is much better paid than in England, their industry seems to diminish in equal proportion. But it is not so with the German laborers; they retain the habitual industry and frugality they bring with them, and receiving higher wages, an accumulation arises that makes them all rich. When I consider that the English are the offspring of Germans; that the climate they live in is much of the same temperature, and when I see nothing in nature that should create this difference, I am tempted to suspect it must arise from the constitution; and I have sometimes doubted whether the laws peculiar to England, which *compel the rich to maintain the poor;* have not given the latter a dependence that very much lessens the care of providing against the wants of old age.

I have heard it remarked that the poor in Protestant countries, on the continent of Europe, are generally more industrious than those of Popish countries. May not the more numerous foundations in the latter for relief of the poor have some effect towards rendering them less provident? To relieve the misfortunes of our fellow creatures is concurring with the Deity; it is godlike; but if we provide encouragement for laziness, and support for folly, may we not be found fighting against the order of God and nature, which perhaps has appointed want and misery as the proper punishments for, and cautions against, as well as necessary consequences of, idleness and extravagance? Whenever we attempt to amend the scheme of Providence, and to interfere with the government of the world, we had need be very circumspect, lest we do more harm than good. In New England they once thought blackbirds useless, and mischievous to the corn. They made efforts to destroy them. The consequence was, the blackbirds were diminished; but a kind of worm, which devoured their grass, and which the blackbirds used to feed on, increased prodigiously; then, finding their loss in grass much greater than their saving in corn, they wished again for their blackbirds.

We had here some years since a Transylvanian Tartar, who had travelled much in the East, and came hither merely to see the West, intending to go home through the Spanish West Indies, China, &c. He asked me one day, what I thought might be the reason that so many and such numerous nations, as the Tartars in Europe and Asia, the Indians in America, and the Negroes in Africa, continued a wandering, careless life, and refused to live in cities, and cultivate the arts they saw practised by the civilized parts of mankind? While I was considering what answer to make him he said, in his broken English: "God make man for Paradise. He make him for live lazy. Man make God angry. God turn him out of Paradise, and bid workee. Man no love workee; he want to go to Paradise again; he want to live lazy. So all mankind love lazy." However this may be, it seems certain that the hope of becoming at some time of life free from the necessity of care and labor, together with fear of penury, are the main springs of most people's industry. To those, indeed, who have been educated in elegant plenty, even the provision made for the poor may appear misery; but to those who have scarce ever been better provided for, such provision may seem quite good and sufficient. These latter, then, have nothing to fear worse than their present condition, and scarce hope for any thing better than a parish maintenance. So that there is only the difficulty of getting that maintenance allowed while they are able to work, or a little shame they suppose attending it, that can induce them to work at all; and what they do will only be from hand to mouth.

The proneness of human nature to a life of ease, of freedom from care and labor, appears strongly in the little success that has hitherto attended every attempt to civilize our American Indians. In their present way of living, almost all their wants are supplied by the spontaneous productions of nature, with the addition of very little labor, if hunting and fishing may indeed be called labor, where game is so plenty. They visit us frequently, and see the advantages that arts, sciences, and compact societies procure us. They are not deficient in natural understanding; and yet they have never shown any inclination to change their manner of life for ours, or to learn any of our arts. When an Indian child has been brought up among us, taught our language, and habituated to our customs, yet if he goes to see his relatives, and makes one Indian ramble with them, there is no persuading him ever to return. And that this is not natural to them merely as Indians, but as men, is plain from this, that when white persons, of either sex, have been taken prisoners by the Indians, and lived awhile with them, though ransomed by their friends, and treated with all imaginable tenderness to prevail with them to stay among the English, yet in a short time they become disgusted with our manner of life, and the care and pains that are necessary to support it, and take the first opportunity of escaping again into the woods, from whence there is no redeeming them. One instance I remember to have heard, where the person was brought home to possess a good estate; but, finding some care necessary to keep it together, he relinquished it to a younger brother, reserving to himself nothing but a gun and a match-coat, with which he took his way again into the wilderness.

So that I am apt to imagine that close societies, subsisting by labor and art, arose first not from choice but from necessity, when numbers being driven by war from their hunting grounds, and prevented by seas, or by other nations, from obtaining other hunting grounds, were crowded together into some narrow territories, which without labor could not afford them food. However, as matters now stand with us, care and industry seem absolutely necessary to our well-being. They should therefore have every encouragement we can invent, and not one motive to diligence be subtracted; and the support of the poor should not be by maintaining them in idleness, but by employing them in some kind of labor suited to their abilities of body, as I am informed begins to be of late the practice in many parts of England, where workhouses are erected for that purpose. If these were general, I should think the poor would be more careful, and work voluntarily to lay up something for themselves against a rainy day, rather than run the risk of being obliged to work at the pleasure of others for a bare subsistence, and that too under confinement.

The little value Indians set on what we prize so highly, under the name of learning, appears from a pleasant passage that happened some years since, at a treaty between some colonies and the Six Nations. When every thing had been settled to the satisfaction of both sides, and nothing remained but a mutual exchange of civilities, the English Commissioners told the Indians that they had in their country a college for the instruction of youth, who were there taught various languages, arts, and sciences; that there was a particular foundation in favor of the Indians to defray the expense of the education of any of their sons who should desire to take the benefit of it; and said, if the Indians would accept the offer, the English would take half a dozen of their brightest lads, and bring them up in the best manner. The Indians, after consulting on the proposals, replied, that it was remembered that some of their youths had formerly been educated at that college, but that it had been observed that for a long time after they returned to their friends *they were absolutely good for nothing;* being neither acquainted with the true method of killing deer, catching beavers, or surprising an enemy. The proposition they looked on, however, as a mark of kindness and good will of the English to the Indian nations, which merited a grateful return; and therefore, if the English gentlemen would send a dozen or two of their children to

Onondaga, the Great Council would take care of their education, bring them up in what was really the best manner, and make men of them.

I am perfectly of your mind, that measures of great temper are necessary with the Germans; and am not without apprehensions, that, through their indiscretion, or ours, or both, great disorders may one day arise among us. Those who come hither are generally the most stupid of their own nation, and, as ignorance is often attended with credulity when knavery would mislead it, and with suspicion when honesty would set it right; and as few of the English understand the German language, and so cannot address them either from the press or the pulpit, it is almost impossible to remove any prejudices they may entertain. Their clergy have very little influence on the people, who seem to take a pleasure in abusing and discharging the minister on every trivial occasion. Not being used to liberty, they know not how to make a modest use of it. And as Kolben says of the young Hottentots, that they are not esteemed men until they have shown their manhood by *beating their mothers,* so these seem not to think themselves free, till they can feel their liberty in abusing and insulting their teachers. Thus they are under no restraint from ecclesiastical government; they behave, however, submissively enough at present to the civil government, which I wish they may continue to do, for I remember when they modestly declined intermeddling in our elections, but now they come in droves and carry all before them, except in one or two counties.

Few of their children in the country know English. They import many books from Germany; and of the six printing-houses in the province, two are entirely German, two half German half English, and but two entirely English. They have one German newspaper, and one half-German. Advertisements, intended to be general, are now printed in Dutch and English. The signs in our streets have inscriptions in both languages, and in some places only German. They begin of late to make all their bonds and other legal instruments in their own language, which (though I think it ought not to be) are allowed good in our courts, where the German business so increases that there is continued need of interpreters; and I suppose in a few years they will also be necessary in the Assembly, to tell one half of our legislators what the other half say.

In short, unless the stream of their importation could be turned from this to other colonies, as you very judiciously propose, they will soon so outnumber us that all the advantages we have will, in my opinion, be not able to preserve our language, and even our government will become precarious. The French, who watch all advantages, are now themselves making a German settlement, back of us, in the Illinois country, and by means of these Germans they may in time come to an understanding with ours; and, indeed, in the last war, our Germans showed a general disposition, that seemed to bode us no good. For, when the English, who were not Quakers, alarmed by the danger arising from the defenceless state of our country, entered unanimously into an association, and within this government and the Lower Counties raised, armed, and disciplined near ten thousand men, the Germans, except a very few in proportion to their number, refused to engage in it, giving out, one amongst another, and even in print, that, if they were quiet, the French, should they take the country, would not molest them; at the same time abusing the Philadelphians for fitting out privateers against the enemy, and representing the trouble, hazard, and expense of defending the province, as a greater inconvenience than any that might be expected from a change of government. Yet I am not for refusing to admit them entirely into our colonies. All that seems to me necessary is, to distribute them more equally, mix them with the English, establish English schools where they are now too thick settled, and take some care to prevent the practice, lately fallen into by some of the ship-owners, of sweeping the German gaols to make up the number of their passengers. I say I am not against the admission of Germans in general, for they have their virtues. Their industry and frugality are exemplary. They are excellent husbandmen, and contribute greatly to the improvement of a country.

I pray God to preserve long to Great Britain the English laws, manners, liberties, and religion. Notwithstanding the complaints so frequent in your public papers, of the prevailing corruption and degeneracy of the people, I know you have a great deal of virtue still subsisting among you; and I hope the constitution is not so near a dissolution as some seem to apprehend. I do not think you are generally become such slaves to your vices, as to draw down the *justice* Milton speaks of, when he says, that——[1]

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CII

TO PETER COLLINSON

the sea and lightning

Philadelphia, — September, 1753.

Sir:—

In my former paper on this subject, written first in 1747, enlarged and sent to England in 1749, I considered the sea as the grand source of lightning, imagining its luminous appearance to be owing to electric fire, produced by friction between the particles of water and those of salt.

Living far from the sea, I had then no opportunity of making experiments on the sea water, and so embraced this opinion too hastily. For, in 1750 and 1751, being occasionally on the seacoast, I found, by experiments, that sea water in a bottle, though at first it would by agitation appear luminous, yet in a few hours it lost that virtue; *hence and from this,* that I could not by agitating a solution of sea salt in water produce any light, I first began to doubt of my former hypothesis, and to suspect that the luminous appearance in sea water must be owing to some other principles.

I then considered whether it were not possible that the particles of air, being *electrics per se,* might, in hard gales of wind, by their friction against trees, hills, buildings, &c., as so many minute electric globes, rubbing against non-electric cushions, draw the electric fire from the earth, and that the rising vapors might receive that power from the air, and by such means the clouds become electrified.

If this were so, I imagined that by forcing a constant violent stream of air against my prime conductor, by bellows, I should electrify it *negatively;* the rubbing particles of air drawing from it part of its natural quantity of the electric fluid. I accordingly made the experiment, but it did not succeed.

In September, 1752, I erected an iron rod to draw the lightning down into my house, in order to make some experiments on it, with two bells to give notice when the rod should be electrified; a contrivance obvious to every electrician.

I found the bells rang sometimes when there was no lightning or thunder, but only a dark cloud over the rod; that sometimes, after a flash of lightning they would suddenly stop; and, at other times, when they had not rung before, they would, after a flash, suddenly begin to ring; that the electricity was sometimes very faint, so that, when a small spark was obtained, another could not be got for some time after; at other times the sparks would follow extremely quick, and once I had a continual stream from bell to bell, the size of a crow-quill; even during the same gust there were considerable variations.

In the winter following I conceived an experiment, to try whether the clouds were electrified *positively* or *negatively;* but my pointed rod, with its apparatus, becoming out of order, I did not refit it till towards the spring, when I expected the warm weather would bring on more frequent thunder-clouds.

The experiment was this; to take two phials; charge one of them with lightning from the iron rod, and give the other an equal charge by the electric glass globe, through the prime conductor; when charged, to place them on a table within three or four inches of each other, a small cork ball being suspended by a fine silk thread from the ceiling so as it might play between the wires. If both bottles then were electrified *positively,* the ball, being attracted and repelled by one, must be also repelled by the other. If the one *positively,* and the other *negatively,* then the ball would be attracted and repelled alternately by each, and continue to play between them as long as any considerable charge remained.

Being very intent on making this experiment, it was no small mortification to me that I happened to be abroad during two of the greatest thunder-storms we had early in the spring; and though I had given orders in the family that if the bells rang when I was from home they should catch some of the lightning for me in electrical phials, and they did so, yet it was mostly dissipated before my return; and in some of the other gusts, the quantity of lightning I was able to obtain was so small, and the charge so weak, that I could not satisfy myself; yet I sometimes saw what heightened my suspicions and inflamed my curiosity.

At last, on the 12th of April, 1753, there being a smart gust of some continuance, I charged one phial pretty well with lightning, and the other equally, as near as I could judge, with electricity from my glass globe; and, having placed them properly, I beheld, with great surprise and pleasure, the cork ball play briskly between them, and was convinced that one bottle was electrized *negatively.*

I repeated this experiment several times during the gust, and in eight succeeding gusts, always with the same success; and being of opinion (for reasons I formerly gave in my letter to Mr. Kinnersley, since printed in London), that the glass globe electrizes *positively,* I concluded that the clouds are *always* electrized *negatively,* or have always in them less than their natural quantity of the electric fluid.

Yet, notwithstanding so many experiments, it seems I concluded too soon; for at last, June the 6th, in a gust which continued from five o'clock P.M., to seven, I met with one cloud that was electrized *positively,* though several that passed over my rod before, during the same gust, were in the *negative* state. This was thus discovered.

I had another concurring experiment, which I often repeated, to prove the negative state of the clouds, viz., while the bells were ringing, I took the phial, charged from the glass globe, and applied its wire to the erected rod, considering that if the clouds were electrized *positively,* the rod, which received its electricity from them, must be so too; and then the additional *positive* electricity of the phial would make the bells ring faster; but if the clouds were in a *negative* state, they must exhaust the electric fluid from my rod, and bring that into the same negative state with themselves, and then the wire of a positively charged phial, supplying the rod with what is 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 the experiment, my bells of themselves stopped ringing, and, after some pause, began to ring again. But now, when I approached the wire of the charged phial to the rod, instead of the usual stream that I expected from the wire to the rod, there was no spark—not even when I brought the wire and the rod to touch; yet the bells continued ringing vigorously, which proved to me that the rod was then *positively* electrified, as well as the wire of the phial, and equally so; and, consequently, that the particular cloud then over the rod was in the same positive state. This was near the end of the gust.

But this was a single experiment, which, however, destroys my first too general conclusion, and reduces me to this: *That the clouds of a thunder-gust are most commonly in a negative state of electricity, but sometimes in a positive state.*

The latter I believe is rare; for, though I, soon after the last experiment, set out on a journey to Boston, and was from home most part of the summer, which prevented my making further trials and observations, yet Mr. Kinnersley, returning from the Islands just as I left home, pursued the experiments during my absence, and informs me that he always found the clouds in the *negative* state.

So that, for the most part, in thunder-strokes, *it is the earth that strikes into the clouds, and not the clouds that strike into the earth.*

Those who are versed in electric experiments will easily conceive that the effects and appearances must be nearly the same in either case: the same explosion and the same flash between one cloud and another, and between the clouds and mountains, &c.; the same rending of trees, walls, &c., which the electric fluid meets with in its passage; and the same fatal shock to animal bodies; and that pointed rods fixed on buildings or masts of ships, and communicating with the earth or sea, must be of the same service in restoring the equilibrium silently between the earth and clouds, or in conducting a flash or stroke, if one should be, so as to save harmless the house or vessel; for points have equal power to throw off, as to draw on, the electric fire, and rods will conduct up as well as down.

But though the light gained from these experiments makes no alteration in the practice, it makes a considerable one in the theory. And now we as much need an hypothesis to explain by what means the clouds become negatively, as before to show how they become 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 meantime be of some use, by stirring up the curious to make more experiments, and occasion more exact disquisitions.

I conceive, then, that this globe of earth and water, with its plants, animals, and buildings, have, diffused throughout their substance, a quantity of the electric fluid, just as much as they can contain, which I call the *natural quantity.*

That this natural quantity is not the same in all kinds of common matter under the same dimensions, nor in the same kind of common matter in all circumstances; but a solid foot, for instance, of one kind of common matter may contain more of the electric fluid than a solid foot of some other kind of common matter; and a pound weight of the same kind of common matter may, when in a rarer state, contain more of the electric fluid than when in a denser state.

For the electric fluid being attracted by any portion of common matter, the parts of that fluid (which have among themselves a mutual repulsion) are brought so near to each other, by the attraction of the common matter that absorbs them, as that their repulsion is equal to the condensing power of attraction in common matter; and then such portion of common matter will absorb no more.

Bodies of different kinds, having thus attracted and absorbed what I call their *natural quantity,* that is, just as much of the electric fluid as is suited to their circumstances of density, rarity, and power of attracting, do not then show any signs of electricity among each other.

And if more electric fluid be added to one of these bodies, it does not enter, but spreads on the surface, forming an atmosphere; and then such body shows signs of electricity.

I have, in a former paper, compared common matter to a sponge, and the electric fluid to water; I beg leave once more to make use of the same comparison, to illustrate farther my meaning in this particular.

When a sponge is somewhat condensed by being squeezed between the fingers, it will not receive and retain so much water as when in its more loose and open state.

If *more* squeezed and condensed, some of the water will come out of its inner parts, and flow on the surface.

If the pressure of the fingers be entirely removed, the sponge will not only resume what was lately forced out, but attract an additional quantity.

As the sponge in its rarer state will *naturally* attract and absorb *more* water, and in its denser state will *naturally* attract and absorb *less* water, we may call the quantity it attracts and absorbs in either state its *natural quantity,* the state being considered.

Now what the sponge is to water, the same is water to the electric fluid.

When a portion of water is in its common dense state, it can hold no more electric fluid than it has; if any be added, it spreads on the surface.

When the same portion of water is rarefied into vapor, and forms a cloud, it is then capable of receiving and absorbing a much greater quantity; there is room for each particle to have an electric atmosphere.

Thus water, in its rarefied state, or in the form of a cloud, will be in a negative state of electricity; it will have less than its *natural quantity*—that is, less than it is naturally capable of attracting and absorbing in that state.

Such a cloud, then, coming so near the earth as to be within the striking distance, will receive from the earth a flash of the electric fluid, which flash, to supply a great extent of cloud, must sometimes contain a very great quantity of that fluid.

Or such a cloud, passing over woods of tall trees, may, from the points and sharp edges of their moist top leaves, receive silently some supply.

A cloud, being by any means supplied from the earth, may strike into other clouds that have not been supplied, or not so much supplied; and those to others, till an equilibrium is produced among all the clouds that are within striking distance of each other.

The cloud thus supplied, having parted with much of what it first received, may require and receive a fresh supply from the earth, or from some other cloud which by the wind is brought into such a situation as to receive it more readily from the earth.

Hence repeated and continual strokes and flashes, till the clouds have all got nearly their natural quantity as clouds, or till they have descended in showers, and are united again with this terraqueous globe, their original.

Thus thunder-clouds are generally in a negative state of electricity compared with the earth, agreeable to most of our experiments; yet, as by one experiment we found a cloud electrized positively, I conjecture that in that case such cloud, after having received what was, in its rare state, only its *natural quantity,* became compressed by the driving winds, or some other means, so that part of what it had absorbed was forced out, and formed an electric atmosphere around it in its denser state. Hence it was capable of communicating positive electricity to my rod.

To show that a body in different circumstances of dilatation and contraction is capable of receiving and retaining more or less of the electric fluid on its surface, I would relate the following experiment: I placed a clean wine-glass on the floor, and on it a small silver can. In the can I put about three yards of brass chain; to one end of which I fastened a silk thread, which went right up to the ceiling, where it passed over a pulley, and came down again to my hand, that I might at pleasure draw the chain up out of the can, extending it till within a foot of the ceiling, and let it gradually sink into the can again. From the ceiling, by another thread of fine raw silk, I suspended a small light lock of cotton, so as that when it hung perpendicularly it came in contact with the side of the can. Then, approaching the wire of a charged phial to the can, I gave it a spark which flowed round in an electric atmosphere; and the lock of cotton was repelled from the side of the can to the distance of about nine or ten inches. The can would not then receive another spark from the wire of the phial; but as I gradually drew up the chain, the atmosphere of the can diminished by flowing over the rising chain, and the lock of cotton accordingly drew nearer and nearer to the can; and then, if I again brought the phial wire near the can, it would receive another spark, and the cotton fly off again to its first distance; and thus, as the chain was drawn higher, the can would receive more sparks; because the can and extended chain were capable of supporting a greater atmosphere than the can with the chain gathered up into its belly. And that the atmosphere round the can was diminished by raising the chain, and increased again by lowering, is not only agreeable to reason, since the atmosphere of the chain must be drawn from that of the can, when it rose, and returned to it again when it fell; but was also evident to the eye, the lock of cotton always approaching the can when the chain was drawn up, and receding when it was let down again.

Thus we see that increase of surface makes a body capable of receiving a greater electric atmosphere; but this experiment does not, I own, fully demonstrate my new hypothesis; for the brass and silver still continue in their solid state, and are not rarefied into vapor, as the water is in clouds. Perhaps some future experiments on vaporized water may set this matter in a clearer light.

One seemingly material objection arises to the new hypothesis, and it is this: if water in its rarefied state, as a cloud, requires and will absorb more of the electric fluid than when in its dense state as water, why does it not require from the earth all its wants at the instant of its leaving the surface, while it is yet near, and but just rising in vapor? To this difficulty I own I cannot at present give a solution satisfactory to myself. I thought, however, that I ought to state it in its full force, as I have done, and submit the whole to examination.

And I would beg leave to recommend it to the curious in this branch of natural philosophy, to repeat with care and accurate observation, the experiments I have reported in this and former papers relating to *positive* and *negative* electricity, with such other relative ones as shall occur to them, that it may be certainly known whether the electricity communicated by a glass globe be *really positive.* And also I would request all who may have the opportunity of observing the recent effects of lightning on buildings, trees, &c., that they would consider them particularly with a view to discover the direction. But in these examinations this one thing is always to be understood, viz., that a stream of the electric fluid passing through wood, brick, metal, &c., while such fluid passes in *small quantity,* the mutually repulsive power of its parts is confined and overcome by the cohesion of the parts of the body it passes through, so as to prevent an explosion; but when the fluid comes in a quantity too great to be confined by such cohesion, it explodes, and rends or fuses the body that endeavoured to confine it. If it be wood, brick, stone, or the like, the splinters will fly off on that side where there is least resistance. And thus, when a hole is struck through pasteboard by the electrified jar, if the surfaces of the pasteboard are not confined or compressed, there will be a bur raised all round the hole on both sides the pasteboard; but if one side be confined, so that the bur cannot be raised on that side, it will be all raised on the other, which way soever the fluid was directed. For the bur round the outside of the hole is the effect of the explosion every way from the centre of the stream, and not an effect of the direction.

In every stroke of lightning, I am of opinion that the stream of the electric fluid, moving to restore the equilibrium between the cloud and the earth, does always previously find its passage, and mark out, as I may say, its own course, taking in its way all the conductors it can find, such as metals, damp walls, moist wood, &c., and will go considerably out of a direct course for the sake of the assistance of good conductors; and that, in this course, it is actually moving, though silently and imperceptibly, before the explosion, in and among the conductors; which explosion happens only when the conductors cannot discharge it as fast as they receive it, by reason of their being incomplete, disunited, too small, or not of the best materials for conducting. Metalline rods, therefore, of sufficient thickness, and extending from the highest part of an edifice to the ground, being of the best materials and complete conductors, will, I think, secure the building from damage, either by restoring the equilibrium so fast as to prevent a stroke, or by conducting it in the substance of the rod as far as the rod goes, so that there shall be no explosion but what is above its point, between that and the clouds.

If it be asked, What thickness of a metalline rod may be supposed sufficient? in answer, I would remark, that five large glass jars, such as I have described in my former papers, discharge a very great quantity of electricity, which, nevertheless, will be all conducted round the corner of a book, by the fine filleting of gold on the cover, it following the gold the farthest way about rather than take the shorter course through the cover, that not being so good a conductor. Now, in this line of gold, the metal is so extremely thin as to be little more than the color of gold, and on an octavo book is not in the whole an inch square, and, therefore, not the thirty-sixth part of a grain, according to M. Réaumur; yet it is sufficient to conduct the charge of five large jars, and how many more I know not. Now, I suppose a wire of a quarter of an inch diameter, to contain about five thousand times as much metal as there is in that gold line; and, if so, it will conduct the charge of twenty-five thousand such glass jars, which is a quantity, I imagine, far beyond what was ever contained in any one stroke of natural lightning. But a rod of half an inch diameter would conduct four times as much as one of a quarter.

And with regard to conducting, though a certain thickness of metal be required to conduct a great quantity of electricity, and at the same time keep its own substance firm and unseparated, and a less quantity, as a very small wire, for instance, will be destroyed by the explosion; yet such small wire will have answered the end of conducting that stroke, though it become incapable of conducting another. And, considering the extreme rapidity with which the electric fluid moves without exploding, when it has a free passage, or complete metal communication, I should think a vast quantity would be conducted in a short time, either to or from a cloud, to restore its equilibrium with the earth, by means of a very small wire, and, therefore, thick rods should seem not so necessary. However, as the quantity of lightning discharged in one stroke cannot well be measured, and in different strokes is certainly very various, in some much greater than in others; and as iron (the best metal for the purpose, being least apt to fuse) is cheap, it may be well enough to provide a larger canal to guide that impetuous blast than we imagine necessary; for, though one middling wire may be sufficient, two or three can do no harm. And time, with careful observations well compared, will at length point out the proper size to greater certainty.

Pointed rods erected on edifices may likewise often prevent a stroke in the following manner: An eye so situated as to view horizontally the under side of a thunder-cloud, will see it very ragged, with a number of separate fragments, or petty clouds, one under another, the lowest sometimes not far from the earth. These, as so many stepping-stones, assist in conducting a stroke between the 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 electrized clouds, whose equilibrium with the earth is soon restored by the point, rise up to the main body, and by that means occasion so large a vacancy as that the grand cloud cannot strike in that place?

These thoughts, my dear friend, are many of them crude and hasty; and if I were merely ambitious of acquiring some reputation in philosophy, I ought to keep them by me till corrected and improved by time and farther experience. But since even short hints and imperfect experiments in any new branch of science, being communicated, have oftentimes a good effect in exciting the attention of the ingenious to the subject, and so become the occasion of more exact disquisition and more complete discoveries, you are at liberty to communicate this paper to whom you please; it being of more importance that knowledge should increase than that your friend should be thought an accurate philosopher.

B. Franklin.

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CIII

TO JAMES BOWDOIN

Philadelphia, 18 October, 1753.

Dear Sir:—

I recollect that I promised to send you Dr. Brownrigg's *Treatise on Common Salt.* You will receive it herewith. I hope it may be of use in the affair of your fishery. Please to communicate it to Captain Erwin, Mr. Pitts, Mr. Boutineau, or any other of your friends who may be desirous of seeing it.

Since my return from Boston, I have been to our western frontiers on a treaty with the Ohio Indians. They complained much of the abuses they suffer from our traders, and earnestly requested us to put the trade under some regulation. If you can procure and send me your truckhouse law, and a particular account of the manner of executing it, with its consequences, &c., so that we may have the benefit of your experience, you will much oblige me; and if you have found it a useful law, I am in hopes we shall be induced to follow your good example.[1]

My compliments to Mrs. Bowdoin and all inquiring friends. With much respect and esteem, I am, dear Sir, &c.,

B. Franklin.

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CIV

TO CADWALLADER COLDEN

Philadelphia, 25 October, 1753.

Sir:—

This last summer I have enjoyed very little of the pleasure of reading or writing. I made a long journey to the eastward, which consumed ten weeks, and two journeys to our western frontier; one of them, to meet and hold a treaty with the Ohio Indians, in company with Mr. Peters and Mr. Norris.1 I shall send you a copy of that treaty as soon as it is published. I should be glad to know whether the Act, mentioned in your *History of the Five Nations,* to prevent the people of New York from supplying the French with Indian goods, still subsists, and is duly executed.2

I left your book with Mr. Bowdoin, in Boston. I hope you will hear from him this winter. I observed extracts from it in all the Magazines, and in the *Monthly Review,* but I see no observations on it. I send you herewith Nollet's book. M. Dalibard writes me that he is just about to publish an answer to it, which, perhaps, may save me the trouble.

I hope soon to find time to finish my new Hypothesis of Thunder and Lightning, which I shall immediately communicate to you. I sent you, by our friend Bartram, some meteorological conjectures for your amusement. When perused, please to return them, as I have no copy. With sincere esteem and respect, I am, dear Sir, &c.,

B. Franklin.

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CV

TO THOMAS CLAP1

Philadelphia, 8 November, 1753.

Dear Sir:—

The first intimation I find of the new air-pump is in a piece of Mr. Watson’s read to the Royal Society, February 20th, 1752, where, describing some experiments he made *in vacuo,* he says: ‘The more complete the vacuum, *cæteris paribus,* the more considerable were the effects; and here I should not do justice to real merit were I silent in regard to Mr. Smeaton. This gentleman, with a genius truly mechanical, which enables him to give to such philosophical instruments as he executes a degree of perfection scarce to be found elsewhere; this gentleman, I say, has constructed an air-pump by which we are empowered to make Boyle’s vacuum much more perfect than heretofore. By a well conducted experiment, which admits of no doubt as to its truth, I have seen by this pump the air rarefied to one thousand times its natural state; whereas, commonly, we seldom arrive at above one hundred and fifty. As the promotion of the mechanic arts is a considerable object of our excellent institution, if this gentleman could be prevailed upon to communicate to the Royal Society that particular construction of his air-pump which enables it to execute so much more than those commonly in use, it would not fail to be an acceptable present.”

So far Mr. Watson. In April following, was read a letter from Mr. Smeaton, in which he describes his improvement, and gives a draft of his pump; the whole too long to transcribe; but it appears to me that the machine, being rather simplified than made more complex, can scarce cost more than one of the old sort, though the price is not mentioned. By only turning a cock it is at pleasure made a condensing engine; an advantage the others have not.

I have seen nothing of your searchers. Mr. Parker has received Bower, but writes me that he is at a loss how to send it, and desires you would order somebody to call for it.

I shall send the dollars for Mr. Mix per next post; for I fancy you will not now buy this apparatus here, but choose the new air-pump from England.

With my respects to all friends, I am, &c.,

B. Franklin.

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CVI

TO PETER COLLINSON

Philadelphia, 23 November, 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.

B. Franklin.

Proposal of an Experiment to measure the Time taken up by an Electric Spark in moving through any given Space. By James Alexander, of New York.

read at the royal society, december 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 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 straight lines through the water the shortest course possible back to the bottle?

If the last, then suppose one brook that falls into Delaware doth head very near to a brook that falls into Schuylkill; and let a wire be stretched and supported as before, from the head of one brook to the head of the other; and let the one end communicate with the water; and let one person stand in the other brook, holding the Leyden bottle; and let another person hold that end of the wire not in the water, and touch the ring of the bottle. If the electric fire will go as in the last question, then will it go down the one brook to Delaware or Schuylkill, and down one of them to their meeting, and up the other and the other brook; the time of its doing this may possibly be observable, and the farther upwards the brooks are chosen the more observable it would be.

Should this be not observable, then suppose the two brooks falling into Susquehanna and Delaware, and proceeding as before, the electric fire may, by that means, make a circuit round the North Cape of Virginia, and go many hundreds of miles, and in doing that, it would seem it must take some observable time.

If still no observable time is found in that experiment, then suppose the brooks falling the one into the Ohio and the other into Susquehanna or Potomac; in that the electric fire would have a circuit of some thousands of miles to go down Ohio to Mississippi, to the Bay of Mexico, round Florida, and round the South Cape of Virginia; which, I think, would give some observable time, and discover exactly the velocity.

But if the electric fire dissipates or weakens in the water, as I fear it does, these experiments will not answer.

Answer To The Foregoing

read at the royal society, december 26, 1756

Suppose a tube of any length, open at both ends, and containing a movable wire of just the same length that fills its bore. If I attempt to introduce the end of another wire into the same tube it must be done by pushing forward the wire it already contains, and the instant I press and move one end of that wire, the other end is also moved; and in introducing one inch of the same wire, I extrude, at the same time, an inch of the first from the other end of the tube.

If the tube be filled with water, and I inject an additional inch of water at one end, I force out an equal quantity at the other in the very same instant.

And the water forced out at one end of the tube is not the very same water that was forced in at the other end at the same time; it was only in motion at the same time.

The long wire, made use of in the experiment to discover the velocity of the electric fluid, is itself filled with what we call its natural quantity of that fluid, before the hook of the Leyden bottle is applied to one end of it.

The outside of the bottle being, at the time of such application, in contact with the other end of the wire, the whole quantity of electric fluid contained in the wire is, probably, put in motion at once.

For at the instant the hook connected with the inside of the bottle *gives out,* the coating, or outside of the bottle, *draws in* a portion of that fluid.

If such long wire contains precisely the quantity that the outside of the bottle demands, the whole will move out of the wire to the outside of the bottle, and the over quantity which the inside of the bottle contained, being exactly equal, will flow into the wire and remain there in the place of the quantity the wire had just parted with to the outside of the bottle.

But if the wire be so long as that one tenth (suppose) of its natural quantity is sufficient to supply what the outside of the bottle demands, in such case the outside will only receive what is contained in one tenth of the wire’s length, from the end next to it; though the whole will move so as to make room at the other end for an equal quantity issuing, at the same time, from the inside of the bottle.

So that this experiment only shows the extreme facility with which the electric fluid moves in metal; it can never determine the velocity.

And, therefore, the proposed experiment (though well imagined and very ingenious) of sending the spark round through a vast length of space, by the waters of Susquehanna, or Potomac, and Ohio, would not afford the satisfaction desired, though we could be sure that the motion of the electric fluid would be in that tract, and not under ground in the wet earth by the shortest way.

B. Franklin.

Physical And Meteorological Observations, Conjectures, And Suppositions

read at the royal society, june 3, 1756

The particles of air are kept at a distance from each other by their mutual repulsion.

Every three particles, mutually and equally repelling each other, must form an equilateral triangle.

All the particles of air gravitate towards the earth, which gravitation compresses them, and shortens the sides of the triangles; otherwise their mutual repellency would force them to greater distances from each other.

Whatever particles of other matter (not endued with that repellency) are supported in air must adhere to the particles of air, and be supported by them; for in the vacancies there is nothing they can rest on.

Air and water mutually attract each other. Hence water will dissolve in air, as salt in water.

The specific gravity of matter is not altered by dividing the matter, though the superficies be increased. Sixteen leaden bullets, of an ounce each, weigh as much in water as one of a pound, whose superficies is less.

Therefore the supporting of salt in water is not owing to its superficies being increased.

A lump of salt, though laid at rest at the bottom of a vessel of water, will dissolve therein, and its parts move every way, till equally diffused in the water; therefore there is a mutual attraction between water and salt. Every particle of water assumes as many of salt as can adhere to it; when more is added, it precipitates, and will not remain suspended.

Water, in the same manner, will dissolve in air, every particle of air assuming one or more particles of water. When too much is added, it precipitates in rain.

But there not being the same contiguity between the particles of air as of water, the solution of water in air is not carried on without a motion of the air, so as to cause a fresh accession of dry particles.

Part of a fluid, having more of what it dissolves, will communicate to other parts that have less. Thus, very salt water, coming in contact with fresh, communicates its saltness till all is equal, and the sooner, if there is a little motion of the water.

Even earth will dissolve or mix with air. A stroke of a horse's hoof on the ground in a hot, dusty road will raise a cloud of dust that shall, if there be a light breeze, expand every way, till, perhaps, near as big as a common house. It is not by mechanical motion communicated to the particles of dust by the hoof that they fly so far, nor by the wind that they spread so wide; but the air near the ground, more heated by the hot dust struck into it, is rarefied and rises, and in rising mixes with the cooler air, and communicates of its dust to it, and it is at length so diffused as to become invisible. Quantities of dust are thus carried up in dry seasons; showers wash it from the air, and bring it down again. For, water attracting it stronger, it quits the air and adheres to the water.

Air, suffering continual changes in the degrees of its heat from various causes and circumstances, and, consequently, changes in its specific gravity, must therefore be in continual motion.

A small quantity of fire mixed with water (or degree of heat therein) so weakens the cohesion of its particles that those on the surface easily quit it, and adhere to the particles of air.

A greater degree of heat is required to break the cohesion between water and air.

Air moderately heated will support a greater quantity of water invisibly than cold air; for its particles being by heat repelled to a greater distance from each other, thereby more easily keep the particles of water that are annexed to them from running into cohesions that would obstruct, refract, or reflect the light.

Hence, when we breathe in warm air, though the same quantity of moisture may be taken up from the lungs, as when we breathe in cold air, yet that moisture is not so visible.

Water being extremely heated, that is, to the degree of boiling, its particles in quitting it so repel each other, as to take up vastly more space than before, and by that repellency support themselves, expelling the air from the space they occupy. That degree of heat being lessened, they again mutually attract; and having no air particles mixed to adhere to, by which they might be supported and kept at a distance, they instantly fall, coalesce, and become water again.

The water commonly diffused in our atmosphere never receives such a degree of heat from the sun, or other cause, as water has when boiling; it is not therefore supported by such heat, but by adhering to air.

Water being dissolved in and adhering to air, that air will not readily take up oil, because of the mutual repellency between water and oil.

Hence cold oils evaporate but slowly, the air having generally a quantity of dissolved water.

Oil being heated extremely, the air that approaches its surface will be also heated extremely; the water then quitting it, it will attract and carry off oil, which can now adhere to it. Hence the quick evaporation of oil heated to a great degree.

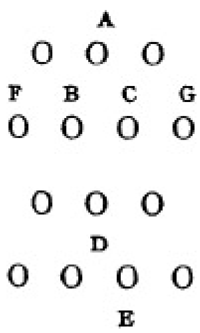
Oil being dissolved in air, the particles to which it adheres will not take up water.

Hence the suffocating nature of air impregnated with burnt grease, as from snuffs of candles and the like. A certain quantity of moisture should be every moment discharged and taken away from the lungs; air that has been frequently breathed is already overloaded, and for that reason can take no more, so will not answer the end. Greasy air refuses to touch it. In both cases suffocation for want of the discharge.

Air will attract and support many other substances.

A particle of air loaded with adhering water, or any other matter is heavier than before, and would descend.

The atmosphere supposed at rest, a loaded descending particle must act with a force on the particles it passes between, or meets with, sufficient to overcome, in some degree, their mutual repellency, and push them nearer to each other.



Thus, supposing the particles *A, B, C, D,* and the other near them, to be at the distance caused by their mutual repellency (confined by their common gravity), if *A* would descend to *E,* it must pass between *B* and *C;* when it comes between *B* and *C,* it will be nearer to them than before, and must either have pushed them nearer to *F* and *G,* contrary to their mutual repellency, or pass through by a force exceeding its repellency with them. It then approaches *D,* and, to move it out of the way, must act on it with a force sufficient to overcome its repellency with the two next lower particles, by which it is kept in its present situation.

Every particle of air, therefore, will bear any load inferior to the force of these repulsions.

Hence the support of fogs, mists, clouds.

Very warm air, clear, though supporting a very great quantity of moisture, will grow turbid and cloudy on the mixture of a colder air, as foggy, turbid air will grow clear by warming.

Thus the sun, shining on a morning fog, dissipates it; clouds are seen to waste in a sunshiny day.

But cold condenses and renders visible the vapor; a tankard or decanter filled with cold water will condense the moisture of warm, clear air on its outside, where it becomes visible as dew, coalesces into drops, descends in little streams.

The sun heats the air of our atmosphere most near the surface of the earth; for there, besides the direct rays, there are many reflections. Moreover the earth, itself being heated, communicates of its heat to the neighbouring air.

The higher regions, having only the direct rays of the sun passing through them, are comparatively very cold. Hence the cold air on the tops of mountains, and snow on some of them all the year, even in the torrid zone. Hence hail in summer.

If the atmosphere were all of it (both above and below) always of the same temper as to cold or heat, then the upper air would always be *rarer* than the lower, because the pressure on it is less; consequently lighter, and therefore would keep its place.

But the upper air may be more condensed by cold than the lower air by pressure; the lower more expanded by heat than the upper, for want of pressure. In such case the upper air will become the heavier, the lower the lighter.

The lower region of air being heated and expanded heaves up and supports for some time the colder, heavier air above, and will continue to support it while the equilibrium is kept. Thus water is supported in an inverted open glass, while the equilibrium is maintained by the equal pressure upwards of the air below; but the equilibrium by any means breaking, the water descends on the heavier side and the air rises into its place.

The lifted heavy, cold air over a heated country, becoming by any means unequally supported, or unequal in its weight, the heaviest part descends first, and the rest follows impetuously. Hence gusts after heats, and hurricanes in hot climates. Hence the air of gusts and hurricanes cold, though in hot climates and seasons; it coming from above.

The cold air descending from above, as it penetrates our warm region full of watery particles, condenses them, renders them visible, forms a cloud thick and dark, overcasting sometimes, at once large and extensive; sometimes, when seen at a distance, small at first, gradually increasing; the cold edge or surface of the cloud condensing the vapors next it, which form smaller clouds that join it, increase its bulk, it descends with the wind and its acquired weight, draws nearer the earth, grows denser with continual additions of water, and discharges heavy showers.

Small black clouds thus appearing in a clear sky, in hot climates, portend storms, and warn seamen to hand their sails.

The earth turning on its axis in about twenty-four hours, the equatorial parts must move about fifteen miles in each minute; in northern and southern latitudes this motion is gradually less to the poles, and there nothing.

If there was a general calm over the face of the globe, it must be by the air’s moving in every part as fast as the earth or sea it covers.

He that sails or rides has insensibly the same degree of motion as the ship or coach with which he is connected. If the ship strikes the shore, or the coach stops suddenly, the motion continuing in the man, he is thrown forward. If a man were to jump from the land into a swift-sailing ship, he would be thrown backward (or towards the stern), not having at first the motion of the ship.

He that travels by sea or land towards the equinoctial, gradually acquires motion; from it, loses.

But if a man were taken up from latitude 40 (where suppose the earth’s surface to move twelve miles per minute) and immediately set down at the equinoctial, without changing the motion he had, his heels would be struck up, he would fall westward. If taken up from the equinoctial and set down in latitude 40, he would fall eastward.

The air under the equator, and between the tropics, being constantly heated and rarefied by the sun, rises. Its place is supplied by air from northern and southern latitudes, which, coming from parts where the earth and air had less motion, and not suddenly acquiring the quicker motion of the equatorial earth,1 appears an east wind blowing westward, the earth moving from west to east, and slipping under the air.

Thus when we ride in a calm it seems a wind against us; if we ride with the wind, and faster, even that will seem a small wind against us.

The air rarefied between the tropics, and rising, must flow in the higher region north and south. Before it rose, it had acquired the greatest motion the earth's rotation could give it. It retains some degree of this motion, and descending in higher latitudes, where the earth's motion is less, will appear a westerly wind, yet tending towards the equatorial parts, to supply the vacancy occasioned by the air of the lower regions flowing thitherwards.

Hence our general cold winds are about northwest; our summer cold gusts the same.

The air in sultry weather, though not cloudy, has a kind of haziness in it, which makes objects at a distance appear dull and indistinct. This haziness is occasioned by the great quantity of moisture equally diffused in that air. When, by the cold wind blowing down among it, it is condensed into clouds, and falls in rain, the air becomes purer and clearer. Hence, after gusts, distant objects appear distinct, their figures sharply terminated.

Extreme cold winds congeal the surface of the earth, by carrying off its fire. Warm winds, afterwards blowing over that frozen surface, will be chilled by it. Could that frozen surface be turned under, and a warmer turned up from beneath it, those warm winds would not be chilled so much.

The surface of the earth is also sometimes much heated by the sun; and such heated surface, not being changed, heats the air that moves over it.

Seas, lakes, and great bodies of water, agitated by the winds, continually change surfaces; the cold surface in winter is turned under by the rolling of the waves, and a warmer turned up; in summer, the warm is turned under, and colder turned up. Hence the more equal temper of sea water, and the air over it. Hence, in winter, winds from the sea seem warm, winds from the land cold. In summer, the contrary.

Therefore the lakes northwest of us,[1] as they are not so much frozen nor so apt to freeze as the earth, rather moderate than increase the coldness of our winter winds.

The air over the sea being warmer, and therefore lighter in winter than the air over the frozen land, may be another cause of our general northwest winds, which blow off to sea at right angles from our North American coast; the warm, light sea air rising, the heavy, cold land air pressing into its place.

Heavy fluids descending frequently form eddies or whirlpools, as is seen in a funnel where the water acquires a circular motion, receding every way from a centre, and leaving a vacancy in the middle, greatest above, and lessening downwards, like a speaking-trumpet, its big end upwards.

Air descending or ascending may form the same kind of eddies or whirlings, the parts of air acquiring a circular motion, and receding from the middle of the circle by a centrifugal force, and leaving there a vacancy, if descending, greatest above, and lessening downwards; if ascending, greatest below, and lessening upwards, like a speaking-trumpet, standing its big end on the ground.

When the air descends with violence in some places, it may rise with equal violence in others, and form both kinds of whirlwinds.

The air, in its whirling motion receding every way from the centre or axis of the trumpet, leaves there a vacuum, which cannot be filled through the sides, the whirling air, as an arch, preventing; it must then press in at the open ends.

The greatest pressure inwards must be at the lower end, the greatest weight of the surrounding atmosphere being there. The air entering rises within, and carries up dust, leaves, and even heavier bodies that happen in its way as the eddy or whirl passes over land.

If it passes over water, the weight of the surrounding atmosphere forces up the water into the vacuity, part of which, by degrees, joins with the whirling air, and adding weight, and receiving accelerated motion, recedes still farther from the centre or axis of the trump as the pressure lessens, and at last, as the trump widens, is broken into small particles, and so united with air as to be supported by it, and become black clouds at the top of the trump.

Thus these eddies may be whirlwinds at land, water-spouts at sea. A body of water so raised may be suddenly let fall when the motion, &c., has not strength to support it, or the whirling arch is broken so as to admit the air; falling in the sea it is harmless, unless ships happen under it; but if in the progressive motion of the whirl it has moved from the sea over the land, and then breaks, sudden, violent, and mischievous torrents are the consequences.

B. Franklin.

end of vol. ii

[1]From the *Pennsylvania Gazette,* October 30, 1735.

[1]From the *Pennsylvania Gazette,* November 20, 1735.

[1]From the *Pennsylvania Gazette,* April 1, 1736.

[1]Qu'est ce que votre roi? Parlez-moi de notre grand monarque, morbleu! qui peut faire tout ce qu'il veut.

[2]Si antiquus animus plebi Romanæ esset (says one of the tribunes), audaciter se laturum fuisse de abrogando Q Fabii [dictatoris] imperio.—*T. Liv.,* lib. xxii. cap. 25.

[1]Tribunos plebis appello (says an illustrious senator to the dictator), et provoco ad populum, eumque tibi, fugienti senatûs judicium, judicem fero.—*T. Liv.,* lib. viii. cap. 33.

[1]From the *Pennsylvania Gazette,* April 8, 1736.

[2]Bracton: *De Legibus et Consuetudinibus Angliæ;* an author of great weight, contemporary with Henry the Third.

[3]Rex non facit injuriam, quia, si facit injuriam, non est rex.

[1]Dum facit justitiam, vicarius est Regis æterni, minister autem Diaboli, dum declinet ad injuriam.

[1]From the *Pennsylvania Gazette,* October 14, 1736.

[1]Scandinavian literature was less known when this was written than at present. The learned suppose that the Icelandic Sagas have thrown new light upon the history of early discoveries, and that there is good evidence for believing that the American continent was known to the Norwegians more than four hundred years before

the birth of Columbus.—See Wheaton's *History of the Northmen,* chap. ii. The best opportunity was afforded to Mr. Wheaton, during his residence in a public capacity at Copenhagen, of ascertaining the genuineness and authenticity of these ancient records, and he appears to place full confidence in them. His opinion is, however, that "the illustrious Genoese" could not have had the slightest knowledge of the discoveries of those Northern adventurers, and that the colony begun by them was probably cut off at an early period in the same manner as the first establishments in Greenland.—Ed.

[1]From the *Pennsylvania Gazette,* November 18, 1736.

[1]In December of the year 1732 Franklin commenced the publication of what he styled *Poor Richard's Almanac,* price 5 pence. It attained an astonishing popularity at once. Three editions were sold within the month of its appearance. The average sale for twenty-five years was ten thousand a year. He was sometimes obliged to put it to press in October to get a supply of copies to the remote colonies by the beginning of the year. It has been translated into nearly if not quite every written language, and several different translations of it have been made into the French and German. It contains some of the best fun as well as the wisest counsel that ever emanated from his pen.

[1]Parton's *Life of Franklin,* vol. i., 228.

[1]Some parts of this humorous Piece will be explained by the following address, contained in *Poor Richard's Almanac* for the year 1736 "Loving Readers:

"Your kind acceptance of my former labors has encouraged me to continue writing, though the general approbation you have been so good as to favor me with has excited the envy of some, and drawn upon me the malice of others. These ill-willers of mine, despited at the great reputation I gained by exactly predicting another man's death, have endeavoured to deprive me of it all at once in the most effectual manner, by reporting that I myself was never alive. They say in short, *That there is no such man as I am;* and have spread this notion so thoroughly in the country that I have been frequently told it to my face by those that don't know me. This is not civil treatment, to endeavour to deprive me of my very being, and reduce me to a nonentity in the opinion of the public. But so long as I know myself to walk about, eat, drink, and sleep, I am satisfied that *there is really such a man as I am,* whatever they may say to the contrary. And the world may be satisfied likewise; for if there were no such man as I am, how is it possible I should appear publicly to hundreds of people, as I have done for several years past, in print? I need not, indeed, have taken any notice of so idle a report, if it had not been for the sake of my printer, to whom my enemies are pleased to ascribe my productions; and who, it seems, is as unwilling to father my offspring as I am to lose the credit of it. Therefore to clear him entirely, as well as to vindicate my own honor, I make this public and serious declaration, which I desire may be believed, to wit, *that what I have written heretofore, and do now write, neither was nor is written by any other man or men, person or persons, whatsoever.* Those who are not satisfied with this, must needs be very unreasonable.

My performance for this year follows. It submits itself, kind reader, to thy censure, but hopes for thy candor to forgive its faults. It devotes itself entirely to thy service, and will serve thee faithfully. And if it has the good fortune to please its master, 't is gratification enough for the labor of Poor.
R. Saunders."

[1]This paper is contained in Duane's edition of the author's writings, but in no previous collection. It is taken from the newspaper published by Franklin (*Pennsylvania Gazette,* Dec. 15, 1737), but it is dated several years earlier than any of his other pieces on philosophical subjects, and appears to be rather a compilation from various authors than an original composition. It is not without interest, however, as presenting a curious account of earthquakes, and of the theories respecting their causes.—Sparks.

[1]This paper appears to contain the first suggestion, in any public form, for an American Philosophical Society.

[1]This was in reply to an ingenious suggestion which partially anticipated the more modern systems of stereotyping. The author of it, Mr. Colden, was born in Scotland on the 17th of February, 1688, was educated at the University of Edinburgh, came to Philadelphia in 1708, where he practised medicine until 1715, then travelled in Europe, returned in 1718, and settled in New York. He died at his country home on Long Island on the 27th of September, 1776, in the eighty-ninth year of his age. Soon after taking up his residence in New York he abandoned his profession and entered public life, maintaining, however, meanwhile, an extensive correspondence, especially with the eminent men of science both at home and abroad. He held the offices of surveyor-general of the province, master in chancery, member of the council, and lieutenant-governor, which latter dignity he filled for some fifteen years. He wrote several treatises on medical, mathematical, and philosophical subjects, and a history of the *Five Indian Nations,* which is still read.

In his letter he solicits a correspondence with Franklin. In his reply Franklin promises to consider his proposal for a new method of printing, very particularly and attentively, and in a post or two to “send some observations on every article,” but no such observations have been found, nor is it likely that any were written.—Editor.

[1]Benjamin Mecom, a nephew of Dr. Franklin, whom he seems to have taken particularly under his charge.

[1]For an exposition of Franklin’s motives in writing this pamphlet, see *supra,* Vol. I., p. 237.

[1]Body or matter of any sort is said to be *specifically* heavier or lighter than other matter when it has more or less substance or weight in the same dimensions.

[1]As the writer is neither physician nor philosopher, the reader may expect he should justify these opinions by the authority of some that are so. M. Clare, F.R.S., in his treatise of *The Motion of Fluids,* says (p. 246, &c.): “And here it may be remarked, that it is more prejudicial to health to sit near a window or door, in a room where there are many candles and a fire, than in a room without; for the consumption of air thereby occasioned, will always be very considerable, and this must necessarily be replaced by cold air from without. Down the chimney can enter none, the stream of warm air always arising therein absolutely forbids it; the supply must therefore come in wherever other openings shall be found. If these happen to be small, *let those who sit near them beware;* the smaller the floodgate, the smarter will be the stream. Was a man, even in a sweat, to leap into a cold bath, or jump from his warm bed, in the intensest cold, even in a frost, provided he do not continue over-long therein, and be in health when he does this, we see by experience that he gets no harm. If he sits a little while against a window, into which a successive current of cold air comes, his pores are closed, and he gets a fever. In the first case, the shock the body endures is general, uniform, and therefore less fierce; in the other, a single part, a neck, or ear perchance, is attacked, and that with the greater violence probably, as it is done by a successive stream of cold air. And the cannon of a battery, pointed against a single part of a bastion, will easier make a breach than were they directed to play singly upon the whole face, and will admit the enemy much sooner into the town.”

That warm rooms, and keeping the body warm in winter, are means of preventing such diseases, take the opinion of that learned Italian physician, Antonino Parcio, in the preface to his tract, *De Militis Sanitate Tuendâ,* where, speaking of a particular wet and cold winter, remarkable at Venice for its sickliness, he says: “Popularis autem pleuritis, quæ Venetiis sæviit mensibus *Dec., Jan., Feb.,* ex cœli aërisque inclementiâ facta est, quod non habeant hypocausta [*stove-rooms*], et quod non soliciti sunt Itali omnes de auribus, temporibus, collo, totoque corpore defendendis ab injuriis aëris; et tegmina domorum Veneti disponant parum inclinata, ut nives diutius permaneant super tegmina. E contra, Germani, qui experiuntur cœli inclementiam, perdidicere sese defendere ab aeris injuriâ. Tecta construunt multum inclinata, ut decidant nives. Germani abundant lignis, domusque *hypocaustis;* foris autem incedunt pannis, pellibus, gossipio, bene mehercule loricati atque muniti. In Bavariâ interrogabam (curiositate motus videndi Germaniam) quot nam elapsis mensibus pleuritide vel peripneumoniâ fuissent absumti; dicebant vix unus aut alter illis temporibus pleuritide fuit correptus.”

The great Dr. Boerhaave, whose authority alone might be sufficient in his *Aphorisms,* mentions, as one antecedent cause of pleurisies, “a cold air, driven violently through some narrow passage upon the body, overheated by labor or fire.”

The eastern physicians agree with the Europeans in this point; witness the Chinese treatise, *Tschang Seng*—that is, *The Art of procuring Health and long Life,* as translated in Père Du Halde’s account of China, which has this passage: “As, of all the passions which ruffle us, anger doth the most mischief, so of all the malignant affections of the air, a wind that comes through any narrow passage, which is cold and piercing, is most dangerous; and, coming upon us unawares, insinuates itself into the body, often causing grievous diseases. It should therefore be avoided, according to the advice of the ancient proverb, as carefully as the point of an arrow.” These mischiefs are avoided by the use of the new-invented fire-places, as will be shown hereafter.

[1]The shutter is slid up and down in this manner, only in those fire-places which are so made, as that the distance between the top of the arched opening and the bottom plate is the same as the distance between it and the top plate. Where the arch is higher, as it is in the draft annexed (which is agreeable to the last improvements), the shutter is set by and applied occasionally; because if it were made deep enough to close the whole opening when slid down, it would hide part of it when up.

[1]My Lord Molesworth, in his account of Denmark, says: “That few or none of the people there are troubled, with coughs, catarrhs, consumptions, or such like diseases of the lungs, so that in the midst of winter in the churches, which are very much frequented, there is no noise to interrupt the attention due to the

preacher. I am persuaded," says he, "their *warm stoves* contribute to their freedom from these kinds of maladies."

[1]People who have used these fire-places differ much in their accounts of the wood saved by them. Some say five sixths, others three fourths, and others much less. This is owing to the great difference there was in their former fires, some (according to the different circumstances of their rooms and chimneys) having been used to make very large, others middling, and others, of a more sparing temper, very small ones, while in these fire-places (their size and draft being nearly the same) the consumption is more equal. I suppose, taking a number of families together, that two thirds or half the wood at least is saved. My common room, I know, is made twice as warm as it used to be, with a quarter of the wood I formerly consumed there.

[1]Mr. Boyle, in his experiments and observations upon cold, *Shaw's Abridgment,* vol. i., p. 684, says: "It is remarkable that while the cold has strange and tragical effects at Moscow and elsewhere, the Russians and Livonians should be exempt from them, who accustom themselves to pass immediately from a great degree of heat to as great a one of cold without receiving any visible prejudice thereby. I remember being told by a person of unquestionable credit that it was a common practice among them to go from a hot stove into cold water; the same was also affirmed to me by another who resided at Moscow. This tradition is likewise abundantly confirmed by Olearius. 'It is a surprising thing,' says he, 'to see how far the Russians can endure heat; and how, when it makes them ready to faint, they can go out of their stoves stark naked, both men and women, and throw themselves into cold water, and even in winter wallow in the snow.' "

[1]See page 94, where the trap-door is described, that ought to be in this closing.

[1]When this pamphlet was first printed, a copy of it was sent by Mr. Cadwallader Colden to the celebrated Gronovius, with a letter from which the following is an extract:

"I send with this a curious and new invention for warming a room with a small fire, and more effectually than can be done by a large fire, in the common method, and is free of the inconveniences which attend the Dutch and German stoves, because by this contrivance there is a continual supply of fresh warm air. It may be particularly useful to you and Dr. Linnæus, by preserving your health while it keeps you warm at your studies. It is the invention of Mr. Benjamin Franklin, of Philadelphia, the printer of it, a very ingenious man."

To this passage, Gronovius replied as follows, in a letter dated at Leyden, July 9, 1745:

"I am very much obliged to you for Mr. Franklin's book, which I don't doubt the next letter shall bring to you translated into Dutch."—Sparks.

[1]The American Philosophical Society, as afterwards instituted, was formed out of two societies, of which this was one. The other was the Society for Promoting and Propagating Useful Knowledge. The two societies were incorporated into one, called the American Philosophical Society, in December, 1768, and in January, 1769, Franklin was elected the first president, although he was at that time in England.

[1]It does not appear that this scheme was ever carried into execution.

[2]Dr. John Mitchell was a learned physician and botanist, and Fellow of the Royal Society. He was a native of England, but came over and established himself in Virginia. Dr. Miller says that "he wrote ably on the yellow fever, as it appeared in Virginia in 1742; and that his instructive manuscripts on this subject fell into the hands of Dr. Franklin, by whom they were communicated to Dr. Rush."—Miller's *Retrospect,* vol. i., p. 318.

[1]The father of Dr. Samuel Bard, of whom an interesting memoir has been published by Professor McVickar.

[1]A printer in New York.

[1]The expedition against Cape Breton proved successful, by the surrender of Louisburg, on the 17th of June. The news arrived in Boston on the 3d of July.

[1]Two of the more elaborate of Franklin's jokes in the *Pennsylvania Gazette* says Mr. Parton in his charming biography of Franklin, have escaped the vigilance of editors hitherto. The speech of Polly Baker is one of these; which is not only humorous, but well rebukes the cruel immorality which sent a poor miserable drab to the whipping-post, and invited her seducer to dinner. This speech was a current joke in the colonial press for thirty years, and continued to be occasionally reprinted after the Revolution. It was inserted in the *Gazette,* Franklin tells us, to amuse the town at a time when there was little news stirring.

[1]The first edition of this pamphlet seems to be out of print. The second, at the close of which first appeared the foregoing translation, was printed in 1747. The publication was provoked by the defenceless condition of the colony at that time, exposed as it was to Spain on the south and to France on the west, with both of which nations Great Britain was then at war; to say nothing of the Indians, who, like the poor, they had always with them. The efforts to induce the Quaker Assembly of Pennsylvania to pass a militia law, and make other provisions for the security of the province, having proved abortive, Franklin proposed to try what might be done by voluntary subscription of the people. "To promote this," he says in his *Autobiography,* "I first wrote and published a pamphlet entitled *Plain Truth.*" Its success was extraordinary (see *Autobiography,* vol. i., p. 213). An answer to it, entitled *Necessary Truth,* and enforcing the Quaker doctrine of non-resistance, was published in 1748. It came too late to impair, if it ever could have impaired, the impression left upon the colony by *Plain Truth.*

Substituting the words "United States" for "Pennsylvania," this pamphlet is as timely to-day [1886] as when it was written. Though we are at peace with all nations, we have many times as many lives, and many times as much property exposed, while our defences are relatively inferior to those which Franklin denounced nearly a century and a half ago as inexcusably deficient.

[1]The Praying Indians.

[1]By accounts, the ragged crew of the Spanish privateer that plundered Mr. Liston's and another plantation, a little below Newcastle, was composed of such as these. The *honor* and *humanity* of their officers may be judged of by the treatment they gave poor Captain Brown, whom they took with Martin's ship in returning from their cruise. Because he bravely defended himself and vessel longer than they expected, for which every generous enemy would have esteemed him, did they, after he had struck and submitted, barbarously *stab* and *murder* him, though on his knees, begging quarter!

[1]When God determined to punish his chosen people, the inhabitants of Jerusalem, who, though breakers of his other laws, were scrupulous observers of that one, which required keeping holy the Sabbath-day, he suffered even the strict observation of that command to be their ruin, for Pompey, observing that they then obstinately refused to fight, made a general assault on that day, took the town, and butchered them with as little mercy as he found resistance.—Josephus.

[2]Conjuravere cives nobilissimi patriam incendere, gallorum gentem, infestissimam nomini Romano, ad bellum arcessunt.—Cato, in *Sallust.*

[1]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.—F.

[2]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.—F.

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

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

[2]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.—F.

[1]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 a negative state. Then when his hand or face is touched, an equal quantity is restored to him from the person touching.—F.

[1]Our tubes are made here of green glass, twenty-seven or thirty inches long, as big as can be grasped.—F.

[1]This simple, easily-made machine was a contrivance of Mr. Syng’s.—F.

[2]The Reverend Jared Eliot was a graduate of Yale College, and for many years was settled as a clergyman at Killingworth in Connecticut. He had a taste for philosophical studies, and published essays on agriculture, some of which passed through several editions.

[1]See this opinion rectified in § 16 and 17, p. 242. The fire in the bottle was found by subsequent experiments not to be contained in the non-electric, but *in the glass.* 1748.

[2]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.

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

[2]Other circumstances being equal.

[1]See note, on p. 197 , relating to *top* and *bottom.*

[1]See note, on p. 197 , relating to *top* and *bottom.*

[1]That is, from the *inside* to the *outside.*

[2]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.

[1]See this tract, *supra.*

[1]James Logan, descended from an ancient family of Restalrig in Scotland, was born at Lurgan, in Ireland, 1674. His father was a man of great learning, and educated for the Scottish church; but, having been converted to the principles of the Quakers, he was, at the time of his son's birth, a teacher in a public school in that Society. At an early age James Logan became imbued with a love of letters and science. Before he was thirteen years old, he had made uncommon proficiency in the Latin, Greek, and Hebrew languages. He soon afterwards acquired a taste for the mathematics, in which he became profoundly skilled, and which science seems to have been his favorite study through life. For a few years he had charge of a large Grammar School at Bristol, in England; but he afterwards engaged in commerce. Becoming acquainted with William Penn, he was induced by him to give up his plans of life, and accompany him as secretary on his second visit to Pennsylvania, in 1699.

Having acquired the entire confidence of the Proprietor, he was left by him in charge of his private estate, and in the important offices of Provincial Secretary, Commissioner of Property, and Receiver-

General. In the course of his life he filled the places of Recorder of the City of Philadelphia, Presiding Judge of Common Pleas, Chief Justice of the Province, and President of the Council, in which last office he governed the Province for two years, from 1736 to 1738. He also had the entire management of the intercourse with the Indians. When William Penn left the Province, in 1701, he presented Mr. Logan to the assembled Chiefs as his representative; and this choice of an agent was justified by his conduct. During the whole of his public life the affectionate intercourse commenced by William Penn, and the confidential reliance inspired by his justice and benevolence, were preserved by James Logan. It is perhaps worthy of being mentioned that the celebrated Mingo Chief, whose eloquent speech is contained in Mr. Jefferson's *Notes on Virginia,* was named Logan by his father Shickellemy, as a mark of respect and gratitude for the friend and protector of himself and his race.

A history of James Logan's public life would be that of Pennsylvania during the first forty years of the last century. Venerating William Penn, with whose noble and generous nature he was well acquainted, he stood up at all times in his defence against the encroachments of the Assembly; and if he forfeited his popularity, and endured calumny and persecution, he preserved his fidelity, the confidence of his employers, and the respect of all good men. Weary of the burden of public office he retired in 1738 from all his salaried employments, remaining only a short time longer a member of the Provincial Council. At his estate, called Stenton, near Germantown, he passed in retirement the remainder of his days devoted to agriculture and his favorite studies. A large collection of mathematical papers in manuscript, exhibiting extensive and varied researches in that science, are marked on the envelope, *Horæ ante Nonam,* and are doubtless the results of his morning recreations before office hours. His correspondence with the literary men of America and Europe, from the year 1713, proves that there was scarcely a department of learning in which he was not interested. History, archæology, criticism, theology, ethics, natural philosophy, anatomy, and law, are treated of. Sometimes Hebrew or Arabic characters and algebraic formulas roughen the pages of his letter books. Sometimes his letters convey a lively Greek ode to a learned friend, and often they are written in the Latin language. Among his correspondents in this country were Cadwallader Colden, Governor Burnet, and Colonel Hunter, the accomplished friend of Swift; and in Europe, Collinson, Fothergill, Mead, Sir Hans Sloane, Flamsteed, Jones the mathematician, father of the celebrated Sir William Jones, Fabricius, Gronovius, and Linnæus; the last of whom gave the name of Logan to a Class in botany.

Of his printed writings perhaps the best known is his translation of

Cicero's *Cato Major, or a Discourse on Old Age,* with explanatory notes, which was printed by Franklin in 1744, and several times reprinted in England. He also wrote *Experimenta et Meletemata de Plantarum Generatione,* printed at Leyden in 1739, and afterwards translated by Dr. Fothergill and printed in London; *Demonstrationes de Radiorum in Superficies sphericas ab Axe incidentium a primario Foco Aberrationibus,* printed at Leyden, 1741; *Epistola ad Virum ClarissimumJoannem Albertum Fabricium,* printed at Amsterdam, 1740; *A Translation of Cato's Distichs into English Verse,* printed at Philadelphia. He furnished contributions to the Philosophical Transactions, and wrote other pieces on various subjects in Latin and English, some of which were published. He also left some curious papers in manuscript, particularly part of an ethical treatise, entitled *The Duties of Man, as they may be deduced from Nature.* This was prepared with great care. Parts of it were sent to his friends in England and received their high commendation; but it seems never to have been completed. Also fragments of a *Dissertation on the Writings of Moses; A Defence of Aristotle and the Ancient Philosophers;* Essays on Languages and on the Antiquities of the British Isles; a Translation of Maurocordatus περὶ καθηκόντων, and of Philo Judæus' *Allegory of the Essæans.*

His acquaintance with Franklin began at an early date, and he had the highest opinion of him from the first, as an industrious, useful, and ingenious man; giving him every encouragement as a printer, and much assistance in his scientific pursuits and public enterprises. In the military defence of the city he was prominently active, notwithstanding his connection with the Friends' Meeting. Indeed he at all times vindicated the principle of self-defence, as not only consistent with the Christian doctrines, but absolutely essential to the existence of society. In every other respect, though neither austere nor bigoted, he was a strict Friend. His virtues, his benevolence, his public integrity and services, his intimate connection with William Penn, and the honor which his talents and learning conferred on the Society of Friends, perhaps saved him from the censure which a less eminent man might have incurred.

In addition to his services as a public man, and his high reputation among his contemporaries, the valuable library left by him to the City of Philadelphia should preserve his name in grateful and honorable remembrance. . . .

James Logan died on the 31st of October, 1751, aged seventy-seven years, and was buried in the Friends' graveyard at the corner of Arch Street and Fourth Street in Philadelphia.—J. Francis Fisher.

This letter to Logan is in reply to one received from him, dated Dec.

3d, in which he had said:

"Our friends spared no pains to get and accumulate estates, and are yet against defending them, though these very estates are in a great measure the sole cause of their being invaded, as I showed to our Yearly Meeting, last September was six years, in a paper thou then printed. But I request to be informed, as soon as thou hast any leisure, what measures are proposed to furnish small arms, powder, and ball to those in the country; and particularly what measures are taken to defend our river, especially at the Red Bank, on the Jersey side, and on our own, where there ought not to be less than 40 guns, from six- to twelve-pounders. What gunners are to be depended on?

The project of a lottery to clear £3,000 is excellent, and I hope it will be speedily filled, nor shall I be wanting. But thou wilt answer all these questions and much more, if thou wilt visit me here, as on First day to dine with me, and thou wilt exceedingly oblige thy very loving friend."—Editor.

[1]Castle William in Boston Harbor.

[2]Thomas Hopkinson was born in London, in April, 1709, had been a student at Oxford, came to America while young, married and settled in Philadelphia, where he died in 1751. He was an intimate friend of Franklin, and associated with him in his electrical and philosophical experiments. Mr. Hopkinson was chosen the first president of the American Philosophical Society, instituted in the year 1744, and also took an active part in founding the City Library and the College of Philadelphia. He left several children, among whom was Francis Hopkinson, one of the signers of the Declaration of Independence, well known as a writer, and for his valuable public services during and after the revolution.—Editor.

[1]It was a book by Andrew Baxter, entitled *An Inquiry into the Nature of the Human Soul, wherein its Immateriality is evinced,* &c. One of the chief objects of this book was to prove, that a resistance to any change is essential to matter, consequently inconsistent with *active* powers in it; and that, if matter wants active powers, an *immaterial being* is necessary for all those effects, &c., ascribed to its own natural powers. After stating the several proofs, questioned by Dr. Franklin, of a *Vis inertiæ,* or *force of inertness,* in matter, the author adds. "If the immateriality of the soul, the existence of God, and the necessity of a most particular, incessant providence in the world, are demonstrable from such plain and easy *principles,* the atheist has a desperate cause in hand." (See the third edition, pp. 1-8.) In fact, Mr. Baxter's doctrine seems to establish, rather than disprove, an activity in matter, and

consequently to defeat his own conclusion, were not that conclusion to be found from other premises *Primâ facie,* it seems better for Mr. Baxter's system to suppose matter *incapable* of *force* or effort, even in the case, as he calls it, of resisting change, which case appears to me no other than the simple one of matter *not* altering its state *without* a cause, and a cause exactly proportioned to the effect.—B. V.

[1]Dr. Franklin's reasoning seems only to prove that where bodies of different masses have equal force, they "measure *equal* space in equal times." For, allowing that 2*a* moves one hundred yards in a minute (because it moves two separate fifty yards in that time), yet surely that space is not the *same* with that of the one hundred yards moved by 1*a,* in the same time, though it may be equal to it; for the body 2*a* (that is, *a* and *a*), in the first case, describes a broad double space; and the body 1*a,* in the second case, describes a long and single space. There is a farther consideration which may show the difference of celerity and force. For when Dr. Franklin says, in his second paragraph, "there is no mass of matter, how great soever, but may be moved, *with any velocity,* by any continued force, how small soever," I ask whether the *moving body* must not have its force rather in the shape of much celerity than of much matter for this purpose; since without much celerity it would not move fast enough to *apply* its force to give the required velocity, even though its quantity of matter, and consequently of force, were infinite. "Equal celerity, therefore, in moving bodies is their measuring equal space, *along a continued line,* in equal time." Equal space measured along a number of *smaller parallel lines,* suits cases of *equal motion* indeed, but, according to this corrected definition, not of *equal celerity.*—B. V.

[1]Philadelphia Market, near which Dr. Franklin lived.

[1]The title of this treatise, as originally printed, was as follows: *Explication of the first Causes of Action in Matter; and of the Cause of Gravitation. London, 1746.* A second edition enlarged was published five years afterwards with a different title, namely: *The Principles of Action in Matter, the Gravitation of Bodies and the Motion of the Planets explained from those Principles. By Cadwallader Colden, Esquire. London. Printed for Dodsley, 1751.* Appended is a chapter entitled: "An Introduction to the Doctrine of Fluxions, or the Arithmetic of Infinities; in order to assist the Imagination in forming Conceptions of the Principles on which that Doctrine is founded."—Ed.

[1]This piece I have found in Franklin's handwriting among the papers of Cadwallader Colden. Its date is uncertain, but it was probably written before the year 1750.—Sparks.

[1]Mr. Colden’s *History of the Five Indian Nations,* which was published in London, and copies of which were sent over to be sold in Philadelphia.

[1]David Hall, a Scotchman by birth, and a friend of Mr. Strahan, who had worked in the same office with Franklin as a journeyman printer in London. His partnership with Franklin continued eighteen years, during which time he had the principal charge of the business. He conducted the *Pennsylvania Gazette,* and was likewise a bookseller and stationer. He died on the 17th of December, 1772, at the age of fifty-eight years. See Thomas’s *History of Printing,* vol. ii, p. 54.

[2]In his *Autobiography* Franklin says: “I proposed a Lottery to defray the expense of building a battery below the town, and furnishing it with cannon. It filled expeditiously, and the battery was soon erected.” “Mr. Logan put into my hands sixty pounds, to be laid out in lottery tickets for the battery, with directions to apply what prizes might be drawn wholly to that service.” The following memoranda, found in Franklin’s handwriting, show his manner of proceeding on this occasion:

“Proposed, That the Managers of the Lottery be applied to, to appoint suitable persons to go down the river to the Capes, and there consult with the persons in authority, and concert with them the modes of conveying intelligence to Philadelphia, whether by express or otherwise, when any enemies appear of such force as to make an alarm necessary, or even such as may endanger our trade; who may likewise, in returning, land at such places as they judge suitable to give signals from, and endeavour to agree with the neighbouring inhabitants to keep watch and give the signals that may be agreed on, and engage to furnish them with guns, tar-barrels, or whatever else may be necessary for that purpose.

That, for the more certain alarming the country on any occasion, as soon as the commander-in-chief at Philadelphia is well-informed of the approach, on our coasts, of any considerable force of the enemy, letters and orders may be despatched by expresses to the colonels of some or all of the regiments, as the occasion may require, who may immediately communicate the same to the other officers of the regiments, and they to the men of the respective companies, who are immediately to meet at their usual place of rendezvous, and from thence march to such place as the colonel shall appoint for assembling his regiment; and when all the companies are assembled, the regiment to march to such place as the commander-in-chief shall have directed.

That, in case of any attempt on the inhabitants of the frontiers by small parties, as the Indian custom is, the superior officers of the regiment, being well-informed of the facts, may despatch away on horseback suitable bodies of active men, well acquainted with the woods, to such places or passes among the mountains, or near the conflux of rivers, by which it is probable the enemy must endeavour to make their retreat, and there to take post and lie in wait till their return, keeping proper scouts or sentinels at a distance of the body to give notice of their approach; by which means they may be cut off, and the prisoners they take may be recovered; a few instances of which would probably much intimidate those cowardly people, and make them afraid of attempting to attack us hereafter. And that such places may be known to more people, it might be proper for the officers beforehand to make a few journeys to them, guided by Indian traders or hunters, accompanied by such of their men as would be suitable to act on occasion and are disposed that way, observing and pointing out all the proper places for ambushes, &c. The expense of which journeys might be defrayed by the managers of the lottery.

That, if there be certain accounts of any large body of the enemy marching towards any part of the frontiers, the colonels of the nearest frontier regiments may despatch expresses to the commander-in-chief at Philadelphia, with the vouchers of the intelligence, from whom orders may issue to raise such force as may be necessary to march to the assistance of such threatened frontier.

That the people on the frontiers be advised to pitch on some suitable places at proper distances, and there enclose pieces of ground with palisades or stockades, so as to make them defensible against Indians, whereto, on occasion, their wives, children, and ancient persons may retire in time of danger. In parts where there may not be had sufficient voluntary labor to erect such defences, and the neighbours, being poor, cannot bear the expense, some assistance might be obtained from the lottery managers, if another lottery should go on.

That those managers be applied to, to offer rewards by public declaration to such as should be maimed in action, and pensions to poor widows, whose husbands should happen to fall in defence of their country.

That a number of spades, pickaxes, shovels, &c., be provided for the city regiment, to be used by the negroes and others as pioneers for casting up sudden intrenchments on occasion."—Editor.

[1]This was Peter Kalm, the Swedish traveller and naturalist, who spent some time in America, and afterwards published an account of his travels.

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

[1]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.—F.

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

[2]Contrived by Mr. Kinnersley.—F.

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

[1]This was afterwards done with success by Mr. Kinnersley.—F.

[1]Probably the ground is never so dry.—F.

[1]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.—F.

[1]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.—F.

[2]As the possibility of this experiment has not been easily conceived, I shall here describe it. Two iron rods, about three feet long, were planted just within the margin of the river, on the opposite sides. A thick piece of wire, with a small round knob at its end, was fixed on the top of one of the rods, bending downwards, so as to deliver commodiously the spark upon the surface of the spirit. A small wire fastened by one end to the handle of the spoon, containing the spirit, was carried across the river and supported in the air by the rope commonly used to hold by in drawing the ferry-

boats over. The other end of this wire was tied round the coating of the bottle; which being charged, the spark was delivered from the hook to the top of the rod standing in the water on that side. At the same instant the rod on the other side delivered a spark into the spoon and fired the spirit, the electric fire returning to the coating of the bottle, through the handle of the spoon and the supported wire connected with them.

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

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

[1]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.—F.

[1]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.—F.

[1]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.—F.

[1]Franklin's wife was a Miss Read.

[1]His son, William, had been an officer in the Pennsylvania forces raised for an expedition against Canada, in the year 1746.

[1]In a letter from James Logan to Mr. Collinson, dated February 14, 1750, he says: "Our Benjamin Franklin is certainly an extraordinary man, one of a singular good judgment, but of equal modesty. He is clerk of our Assembly, and there, for want of other employment, while he sat idle, he took it into his head to think of

magical squares, in which he outdid Frenicle himself, who published above eighty pages in folio on that subject alone."

[1]In the plate they are distinguished by dashed or dotted lines, as different as the engraver could well make them.—F.

[1]Professor Bache, of the University of Pennsylvania, has shown that the eclipse of the moon here alluded to happened in the evening of the 21st of October, 1743; as may be seen in his tract entitled. "An Attempt to Fix the Date of Observation of Dr. Franklin, in Relation to the Northeast Storms of the Atlantic Coast of the United States," published in the *Journal of the Franklin Institute,* in the year 1833. It appears that Dr. Franklin was the first discoverer of the above facts respecting northeast storms.—Sparks.

[1]A Swedish botanist, sent by the Swedish government, at the suggestion of Linnæus, to make a botanical tour of North America. He arrived in 1748 and returned in 1751, having travelled and collected specimens in New York, Pennsylvania, and Canada. He published an account of his travels in Swedish in 1753-1761 in three vols. It was translated into English, Dutch, and German.—Editor.

[2]Lewis Evans, author of *Geographical, Historical, Political, Philosophical, and Mechanical Essays,* of some other tracts, and of a map of the Middle Colonies.

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

[1]See the ingenious essays on Electricity, in the *Transactions,* by Mr. Ellicot.—F.

[1]See *Supra,* p. 182.

[1]See the first sixteen sections of the former paper, No. LXI.

[1]See § 10 of paper No. LXI.

[1]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.—F.

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

[1]See paper No. LXI., § 15.

[1]Dr. Samuel Johnson was the first president of King's (now Columbia) College, New York. This letter appears to have been written at the time of the first establishment of the College of Philadelphia, the presidency of which institution had been offered to him, but was declined.

[1]Mr. Bowdoin was at this time twenty-three years old. He became distinguished afterwards as a philosopher and statesman, being one of the principal founders and the first president of the American Academy of Arts and Sciences. He took an active and prominent part in the events of the American Revolution, and was subsequently governor of Massachusetts.—Sparks.

[1]A copy of this letter was found among Governor Bowdoin's papers, without the name of the person to whom it was addressed.—Sparks.

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

[1]The experiment here mentioned was thus made. An empty phial was stopped with a cork. Through the cork passed a thick wire, as usual in the Leyden experiment, which wire almost reached the bottom. Through another part of the cork passed one leg of a small glass siphon; the other leg on the outside came down almost to the bottom of the phial. This phial was held a short time in the hand, which, warming and of course rarefying the air within, drove a small part of it out through the siphon. Then a little red ink in a tea-spoon was applied to the opening of the outer leg of the siphon; so that as the air within cooled, a little of the ink might rise in that leg. When the air within the bottle came to be of the same temperature of that without, the drop of red ink would rest in a certain part of the leg. But the warmth of a finger applied to the phial would cause that drop to descend, as the least outward coolness applied would make it ascend. When it had found its situation, and was at rest, the wire was electrified by a communication from the prime conductor. This was supposed to give an electric atmosphere to the wire within the bottle, which might likewise rarefy the included air, and of course depress the drop of ink in the siphon. But no such effect followed.—F.

[1]The prospect of a rupture between the English and French governments in 1750-51 were so threatening that the friendship of the Indian tribes became a matter of supreme importance, and how

to secure it occupied the attention of leading men throughout the colonies. In the appendix to the second edition of a pamphlet entitled *The Importance of Gaining and Preserving the Friendship of the Indians to British Interests Considered,* London, 1782, is a letter which bears so many distinctive traces of Franklin's authorship that it has seemed to merit a place in this collection.

The editor is happy to acknowledge his obligations to Professor Edward Eggleston for calling his attention to this letter, which that gentleman found in the Harvard College Library. "I think," says Professor Eggleston, in a note to the editor, "the pamphlet is anonymous, but I have a minute that the author is Archibald Kennedy. The first edition, N. Y., 1751, and the letter I believe to be Franklin's was dated at Philadelphia and addressed to the printer of the first edition.—Parker."

[1]Nor will tables which are accurately calculated at one period, necessarily continue to be correct in the same country at another period. The chances of life have been ascertained to be greater in Europe during the last half century than they were formerly.—W. Phillips.

[1]It is a curious fact that to this tract the world is largely, if not entirely, indebted for a book which, in its day, produced a remarkable sensation, and the theories of which are still occasionally debated. Malthus' *Essay on Population* would probably never have been written but for the support of his theory which he was able to extract from the 22d clause of this paper. In that clause Franklin, with his habitual caution, referring to the number of "English souls" then in North America, says: "This million doubling, suppose but once in twenty-five years, will in another century be more than the people of England." Malthus accepts this rather hypothetical statement as evidence of a demonstrated fact, and proceeds to build upon it his chimerical theory that the population of the earth increases in a geometrical ratio, while the means for its subsistence increases only in an arithmetical ratio William Godwin wrote a reply to Malthus entitled *An Enquiry concerning the Power of Increase in the Numbers of Mankind, being an Answer to Mr. Malthus' Essay on that Subject,* which was published in 1820. He did not see any way of demolishing Malthus but by first trying to demolish the statement of Franklin. "Dr. Franklin," he says, "is in this case particularly the object of our attention, because he was the first man who started the idea of the people of America being multiplied by procreation so as to double every twenty-five years. Dr. Franklin, born in Boston, was eminently an American patriot; and the paper from which these extracts are taken, was expressly written to exalt the importance and glory of his country." Mr. Godwin, who is open to the suspicion of having

taken his knowledge of Franklin's paper at second-hand, and to have never read more of it than was quoted by Malthus, stumbles into a curious blunder as to its date. He says (p. 119) "it was written in 1731 when the author was twenty-five years of age," meaning evidently to imply thereby that it was the work of an immature political economist. The fact was that Franklin's paper was written in 1751, when he was forty-five years of age. Franklin understood what he was writing about much better than Godwin, and time and science have fully justified all the statements which Godwin contested.

[1]The explanation here referred to will be found in the following paragraph of a letter written to Franklin by Bowdoin on 21 Dec., 1751. Franklin had in September of the same year given Mr. Kinnersley a letter of introduction to Bowdoin, to pave the way for a course of lectures in Boston on electricity, which Mr. Kinnersley had prepared and delivered in Philadelphia:

"The electrical fire passing through the air has the same crooked direction as lightning. This appearance I endeavour to account for thus. Air is an electric *per se;* therefore there must be a mutual repulsion between air and the electrical fire. A column or cylinder of air having the diameter of its base equal to the diameter of the electrical spark, intervenes between that part of the body which the spark is drawn from and that of the body it aims at. The spark acts upon this column, and is acted upon by it more strongly than any other neighbouring portion of air. The column being thus acted upon, becomes more dense, and, being more dense, repels the spark more strongly; its repellency being in proportion to its density. Having acquired by being condensed a degree of repellency greater than its natural, it turns the spark out of its straight course, the neighbouring air, which must be less dense, and therefore has a smaller degree of repellency, giving it a more ready passage. The spark having taken a new direction must now act on, or most strongly repel, the column of air which lies in that direction, and consequently must condense that column in the same manner as the former, when the spark must again change its course, which course will be repeatedly changed, till the spark reaches the body that attracted it."—Ed.

[1]The Rev. Ebenezer Kinnersley was a professor in the College of Philadelphia.—Editor.

[2]The experiments here referred to were described in the following letter from Mr. Kinnersley to Dr. Franklin:

[Boston] 3 February, 1752.

Sir:—

I have the following experiments to communicate. I held in one hand a wire, which was fastened at the other end to the handle of a pump, in order to try whether the stroke from the prime conductor, through my arms, would be any greater than when conveyed only to the surface of the earth, but could discover no difference.

I placed the needle of a compass on the point of a long pin, and, holding it in the atmosphere of the prime conductor, at the distance of about three inches, found it to whirl round like the flyers of a jack, with great rapidity.

I suspended with silk a cork ball, about the bigness of a pea and presented to it rubbed amber, sealing-wax, and sulphur, by each of which it was strongly repelled; then I tried rubbed glass and China, and found that each of these would attract it, until it became electrified again, and then it would be repelled as at first; and while thus repelled by the rubbed glass or China, either of the others when rubbed would attract it. Then I electrified the ball with the wire of a charged phial, and presented to it rubbed glass (the stopper of a decanter) and a China tea-cup, by which it was as strongly repelled as by the wire but when I presented either of the other rubbed electrics, it would be strongly attracted, and when I electrified it by either of these, till it became repelled, it would be attracted by the wire of the phial, but be repelled by its coating.

These experiments surprised me very much, and have induced me to infer the following paradoxes.

1. If a glass globe be placed at one end of a prime conductor, and a sulphur one at the other end, both being equally in good order, and in equal motion, not a spark of fire can be obtained from the conductor; but one globe will draw out as fast as the other gives in.

2. If a phial be suspended on the conductor, with a chain from its coating to the table, and only one of the globes be made use of at a time, twenty turns of the wheel, for instance, will charge it, after which, so many turns of the other wheel will discharge it, and as many more will charge it again.

3. The globes being both in motion, each having a separate conductor, with a phial suspended on one of them, and the chain of it fastened to the other, the phial will become charged; one globe charging positively, the other negatively.

4. The phial being thus charged, hang it in like manner on the other conductor, set both wheels a going again, and the same number of turns that charged it before will now discharge it, and the same number repeated will charge it again.

5. When each globe communicates with the same prime conductor, having a chain hanging from it to the table, one of them, when in motion (but which I cannot say), will draw fire up through the cushion, and discharge it through the chain; the other will draw it up through the chain, and discharge it through the cushion.

[1]The discoveries of the late ingenious Mr. Symmer, on the positive and negative electricity produced by the mutual friction of white and black silk, etc., afford hints for farther improvements to be made with this view.—F.

[1]Dr. Perkins, of Boston, had asked Franklin for the number that had died of inoculation in Philadelphia, at the instance of Dr. Douglass, who designed to write something on the small-pox.

[1]See this paper *Supra,* p. 338.

[1]This is the only evidence in our literature, so far as I know, that any of this sect, for whose principles Fenelon suffered and Molinos died, ever found a refuge in the United States.—Ed.

[1]The bookseller in London, who first published Franklin's papers on electricity.

[1]The paper alluded to, of which fifty copies were struck off for distribution, was entitled, *Letters relating to a Transit of Mercury over the Sun, which is to happen May 6, 1753.*

[1]As early as 1743, Franklin had endeavored to procure the establishment of an Academy in Philadelphia. His efforts were not successful till 1749, when, chiefly through his instrumentality, the Academy was instituted and went into operation. Franklin was chosen the first president of the Board of Trustees. From this institution arose, first the College of Philadelphia, and afterwards the present University of Pennsylvania. The Reverend William Smith was appointed Provost of the Academy in 1754, and he filled that office, at the head of the Academy and College successively, for the period of thirty-seven years, till the University was founded in 1791. A full account of these institutions, in their various stages, may be seen in Wood's *History of the University of Pennsylvania,* contained in the third volume of the *Memoirs of the Historical Society of Pennsylvania.*

[2]A General Idea of the College of Mirania.—Stuber.

[1]The Rev. Francis Alison, afterwards Vice-Provost of the College in Philadelphia.—Stuber.

[2]Theophilus Grew, afterwards Professor of Mathematics in the College.—Stuber.

[3]Those assistants were at that time Charles Thomson, afterwards Secretary of Congress, Paul Jackson, and Jacob Duché.—Stuber.

[1]The name given to the principal or head of the ideal college, the system of education in which has 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.—Stuber.

[1]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.—Stuber.

[1]This letter was first printed in the *Gentleman's Magazine* for January, 1834, as contained in the Diary of Mr. Thomas Green. The person who communicated it to the *Magazine* says the original manuscript, from which he transcribed the letter, ends thus abruptly, and that the remainder could not be recovered. He conjectures that the words of Milton, alluded to by the writer are the following:

> "Yet sometimes nations will decline so low
> From virtue, which is reason, that no wrong
> But justice, and some fatal curse annex'd,
> Deprives them of their outward liberty,
> Their inward lust.'
> *Paradise Lost,* xii., 97.

[1]Mr. Bowdoin replied as follows, in a letter dated at Boston, November 12th:—"Our Indians formerly (as yours now) made great complaints of the abuses they suffered from private traders, which induced the government to erect truckhouses for them; where they have since been supplied with the goods they wanted in a much better manner both in regard of the quality and price of them, and with more certainty than the private traders could. The government used to put an advance on the goods supplied, but now they let the Indians have them in the small quantities they want at the same rate they are purchased here in the wholesale way, and allow them for their peltry what it sells for here; and, notwithstanding, they are frequently complaining about the prices of the exchanged commodities, and say that the French supply them at a cheaper rate, and allow them more for their skins than we do; but some

allowance is to be made for this account of theirs.

“The best method we can go into, is to supply them with what they want at the cheapest rate possible, which will not only undermine the French trade with them, but in proportion thereto bring them into our interest and friendship against the French; for trade and commerce between nation and nation, especially when carried on to mutual advantage, have a natural tendency to beget and confirm a mutual and lasting friendship. Another good effect of this method is, that it prevents the Indians from being concerned with private traders; for not being able to supply them at so low a rate as the government, the Indians will not trade with them, and it is therefore a more effectual bar against private trade than all the laws that can be invented.

Our truckhouses are built in form of a square, each side one hundred and fifty feet or more, at each corner a flanker, in which is a couple of cannon; three sides of the square are built upon to accommodate the garrison and for storehouses, the whole being surrounded with palisades.”

[1]This treaty, or rather conference, was held at Carlisle, in Pennsylvania, with deputies from several tribes of western Indians. See Sparks’s *Life of Washington,* 2d edition, p. 25.

[2]To this inquiry Mr. Colden replied, November 19th:—“We have at present no law in this province for restraining the trade to Canada, except that by which a duty is laid on Indian goods sold out of the city of Albany and applied for support of the garrison at Oswego. It is certain that a very considerable trade is carried on between Albany and Canada by means of the Caghnawaga or French Indians, all of them deserters from the Five Nations. When I was last at Albany, there were at least two hundred of them, stout young fellows, at one time in the town. The Indians have passports from the governor of Canada, and I therefore conclude that this trade is thought beneficial to the French interest, and it may be a great inducement to our Indians to desert, by the benefit they receive from it; for none are allowed to be the carriers between Albany and Canada but French Indians.”

[1]President of Yale College.

[1]See a paper on this subject, by the late ingenious Mr. Hadley, in the *Philosophical Transactions,* wherein this hypothesis for explaining the trade-winds first appeared.—F.

[1]In Pennsylvania.