XXI. *Proposal of a Method for securing the Cathedral of* St. Paul's *from Damage by Lightning; in consequence of a Letter from the Dean and Chapter of* St. Paul's *to* James West, *Esquire, Pr. R. S.*

March 9, 1769,

The following Letter to the President was read; videlicet,

St. Paul's, March 6, 1769.

SIR,

THE consideration of the old church of St. Paul's having twice suffered by lightning, and a solicitude to secure the present fabric from similar accidents; which, but for the interception of the storm by St. Bride's church, within these few years, might have already happened; induce us, the Dean and Chapter of this cathedral, to request the opinion of the Royal Society (so justly eminent for the abilities of its members in every branch of science), relative to the best and most effectual method of fixing electrical conductors. We shall esteem ourselves obliged to the very respectable body over which you preside,

preſide, for their ſentiments and directions on this ſubject, and are, with much regard,

SIR,

Your moſt obedient,

humble ſervants,

Thomas Briſtol, D.
Chr. Wilſon.
S. Barrington.
J. Lich. & Cov.

To James Weſt, Eſquire, Preſident of the Royal Society.

In conſequence of this application, it was deſired that John Canton, M. A. Edward Delaval, Eſquire, Benjamin Franklin, LL.D. William Watſon, M. D. and Mr. Benjamin Wilſon, be a Committee to conſider the above letter, and report their opinion thereon to the Society; and, accordingly, June 8, 1769, Dr. Watſon, at the meeting of the Society, read, in his place, a report from the Committee appointed to conſider the application from the Dean and Chapter of St. Paul's, relating to the preſervation of that elegant ſtructure from damage by lightning; for which report, thanks were ordered to the Committee, and returned to Dr. Watſon: and it was alſo ordered, that a copy of the ſaid report be tranſmitted to the Dean and Chapter of St. Paul's, ſigned by the Secretary.

Report from the Committee appointed to conſider of the propereſt means to ſecure the Cathedral of St. Paul's *from the Effects of Lightning. Addreſſed to* James Weſt, *Eſquire, Preſident of the Royal Society.*

SIR,

Read June 8, 1769. AS, in conſequence of a letter addreſſed to the Royal Society from the Dean and Chapter of St. Paul's, the Society did us the honour to appoint us a Committee to examine that magnificent ſtructure, and, as far as our experience would enable us, to prevent miſchief thereto from lightning, by a properly diſpoſed apparatus; we lay before you the following as our opinion thereupon, to be communicated, if you think proper, to the Royal Society. And here, Sir, you will permit us to take notice of, and acknowledge, the obligations we were under to Mr. Mylne, a very worthy member of this Society, who is ſurveyor of St. Paul's, and attended ſeveral meetings of the Committee. This gentleman furniſhed us with a great variety of information, in relation to the ſtructure of the ſeveral parts of this fabric, which, without his aſſiſtance, could not eaſily have been obtained.

As all metals are now known readily to conduct or tranſmit the electric fluid, or, which is the ſame thing, lightning, through them; the large quantity of lead, and ſome iron, diſpoſed in different parts of St. Paul's church, will, by having its ſeveral parts connected,

connected, where there is at preſent no ſuch connection, prevent the erecting a conſiderable part of the apparatus, which otherwiſe we ſhould judge abſolutely neceſſary.

We are of opinion that, *cæteris paribus*, all buildings upon the ſame level are liable to be injured by lightning in proportion to their height: and that the danger is increaſed by croſſes, weather-cocks, or pieces of metal, in any form, placed upon or near their tops, unleſs there is a compleat metallic communication from theſe to the bottom of the building, which metal ſhould terminate either in water, or moiſt ground.

In St. Paul's church, the objects of our more particular attention were the dome and its lanthern, and the two towers at the weſt end. The roof over the body of the church, being compleatly covered with lead, will, we conceive, prevent miſchief thereto from lightning; and the more ſo, as the lead on the roof joins to that of the ſeveral leaden ſpouts, which come down the ſides of the building, and terminate in the ground at a conſiderable depth. For our more certain information, one of theſe ſpouts was examined; and it was found to deſcend perpendicularly about three feet under the ſurface of the earth: and then, after being laid about ſeven feet in an inclined direction, it ended in a brick drain, which communicates with the ſewer. Theſe circumſtances induce us to conclude, that what has been juſt now deſcribed is a ſufficient metallic communication between the roof of the church and the ground.

No part of this whole fabric ſeems to be in ſo dangerous a ſituation of being injured by lightning, as

the ſtone lanthern placed above the dome. This danger ariſes not only from its height, but from the different pieces of metal in different parts of it, being at preſent detached and ſeparated from each other. This ſtone lanthern is ſupported by a truncated cone of brick-work, of no more than eighteen inches, or two bricks, thick. To the honour, however, of the architectural ſagacity of Sir Chriſtopher Wren, who was formerly our Preſident, this ſupport of the lanthern, which has already ſtood much above half a century, has not in the leaſt given way in any of its parts. How far it would ſuſtain the violence of a ſtroke of lightning will, it is to be hoped, never be tried: and what we have now to propoſe will, we flatter ourſelves, leſſen the probability of its being injured by it. The firſt object of our attention, therefore, was to make a compleat metallic communication between the croſs, placed over this lanthern, and the leaden covering of the great dome; as from its height, if any lightning was in its neighbourhood, it would moſt probably affect the croſs.

This croſs with the ball, both compoſed of metal, are ſupported by, and connected with, ſeven iron rods. Theſe deſcend perpendicularly through the ſmall leaden dome, which covers the lanthern, and are inſerted into and paſs through a ſtrong frame of timber, placed horizontally under that dome. The lower extremities of theſe iron rods are faſtened to the under ſurface of this timber frame with iron nuts and ſcrews.

From this timber work, ſeveral large iron bars, placed at ſome diſtance from the ends of the above-mentioned iron rods, deſcend obliquely, and are fixed in

in the ſtone-work of the lanthern. The upper ends of each of theſe oblique iron bars paſs through the frame of timber before mentioned, and are faſtened to its upper ſurface with iron nuts and ſcrews. Between theſe iron bars and the leaden covering of the great dome, there is at preſent no metallic communication. To this arrangement, therefore, is owing the danger from lightning, which the Committee apprehends that this part of the building is liable to. To obviate which, we are of opinion, that four additional iron bars, each not leſs than an inch ſquare, ſhould be ſecurely placed over the frame of timber before mentioned in ſuch a manner, that one end of each of theſe four additional iron bars may be in contact with one of the perpendicular iron rods, and the other end of each be in contact with one of the iron nuts and ſcrews, which faſten the obliquely deſcending iron bars to this frame of timber. At the bottom of theſe oblique iron bars, juſt above where they are inſerted into the ſtone-work, the Committee recommends, that a ring, made of bar iron, of about an inch ſquare, ſhould be placed ſo as to be faſtened to, and be in contact with, theſe iron bars.

From this propoſed ring to the upper part of the lead which covers the great cupola, the diſtance is about forty-eight feet. In this ſpace, we are of opinion, that four iron bars ſhould be placed, each not leſs than an inch ſquare. Theſe ſhould be fixed within the lanthern in ſuch a manner, that the upper end of each ſhould be faſtened to, and in contact with, the iron ring before mentioned, and their lower ends in contact with the lead on the upper part of the cupola; from which the metallic communication is compleat

compleat to the lower end of the pipes, that diſcharge the water from the circular part of the great cupola, upon the floor of the ſtone gallery.

From the bottoms of theſe pipes, which terminate with a ſhoe of lead within half a foot of the floor of the ſtone gallery, the metallic communication is again interrupted to the top of the leaden pipes, which convey the water from thence. Here it is propoſed, that conductors of lead, not leſs than four inches in breadth and half an inch in thickneſs, ſhould be placed ſo as to be in contact with the bottom of four of the pipes that come from above, and with the top of four of thoſe that deſcend. Lead is recommended to be employed here, as more readily adapting itſelf to the various curvatures it muſt meet with in the now propoſed arrangement.

Theſe laſt pipes, after deſcending below the colonnade, near the circular ſtair-caſes, make their appearance upon the outſide of the drum-part of the cupola; where they are bent at obtuſe angles, and diſcharge their water upon the roof of the church. From theſe angles to the roof the diſtance is about five feet. Here then is another interruption to the metallic communication. This is propoſed to be compleated by conductors of lead, ſimilar to thoſe before mentioned, which ſhould be ſo placed as to be in contact both with the bottom of the pipes and the adjoining roof.

From the roof, as has already been mentioned, the leaden pipes are continued below the ſurface of the earth, and terminate in a drain; and thus, by the method now directed, the metallic communication will be compleated from the croſs on the top of

St. Paul's church to ſome feet below the ſurface of the ground.

The Committee then turned their thoughts towards the two towers at the weſt end of the church; and here they beg leave to obſerve, that in one of theſe towers, between the pine apple and the leaden bell-ſhaped covering near it, placed at the top of each of theſe towers, there is no metallic communicatson deſerving notice, till you come to the lead on the roof of the church. This diſtance is eighty-eight feet. To this tower, therefore, it is propoſed to adapt a rod or bar of iron, not leſs than an inch and a quarter ſquare, in ſuch a manner that one end of the bar ſhould be in contact with the metal communicating with the pine apple on its top, which is of copper, and the other end with the lead on the roof of the church.

In the middle of the other tower, in which the great bell is hung, there is an iron ſtair-caſe of conſiderable height, which is placed in the middle of it, in order for the more conveniently coming at the clock-work. The top of this ſtair-caſe is at no great diſtance from the leaden covering upon the top of the tower: but from the bottom of this ſtair-caſe to the roof of the church, between which there is no metallic communication, the diſtance is conſiderable, not leſs than forty feet. The Committee recommend, therefore, that a bar of iron, of an inch and a quarter ſquare, may be placed between the pine-apple, or the lead in contact with it, and the upper part of this ſtair-caſe; and that another iron bar, ſimilar to this laſt, may be adjuſted ſo, as to paſs from the bottom of the ſtair-caſe to the lead on the roof of the church. The roof,

as

as has been already mentioned, communicates with the leaden pipes, and theſe with the ground.

Theſe towers, from their near ſituation to the cupola, which is a building ſo much higher, may poſſibly be leſs liable to miſchiefs from lightning than if they were erected at a more conſiderable diſtance. As the direction of the lightning is, however, uncertain, from a variety of cauſes, as alſo to what extent one building will protect another, the Committee are of opinion, that this apparatus to the towers will be expedient.

It is to be remarked, that wherever iron is employed as a conductor of lightning, eſpecial care muſt be taken to prevent its becoming ruſty; as, from being long expoſed to the moiſt atmoſphere, it will be corroded to a conſiderable depth: and ſo much of the iron as is corroded ceaſes to be of uſe as a conductor; the Committee therefore have, in directing the ſize of theſe iron bars, made ſome allowance for the waſte of the iron by ruſt.

The ſize, as well as number, of the iron bars recommended here by the Committee, are only to be conſidered as applicable to St. Paul's, and not as a ſtandard for any church or building of leſs dimenſions; as in theſe laſt, conductors of a ſmaller ſize, and fewer in number, may anſwer the purpoſe as ſecurely as the larger. But St. Paul's church is particularly circumſtanced: it is an edifice not only of great height, but its cupola, to ſay nothing of the lead on the body of the church, preſents a large ſurface of metal to the clouds; on which account it is very liable to receive greater quantities of the electric fluid; and, from large quantities of ſuch an elaſtic power, great

great miſchiefs may ariſe to this magnificent building, in conſequence of obſtructions the fluid may meet with in paſſing through it. For theſe reaſons we have recommended very large conductors, that it may paſs through them into the ground, as readily as it enters.

Theſe, Sir, are our ſentiments in relation to the matter, referred to us by the Royal Society, upon the requeſt of the Dean and Chapter of St. Paul's. If they ſhould be acceptable to the Society, and by their means to the Dean and Chapter; and if, by being carried into execution, they ſhould at all contribute to the preſervation of that noble fabric, it will be a great ſatisfaction to us. We are, with very great reſpect,

SIR,

Your moſt obedient,

humble ſervants,

W. Watſon.
B. Franklin.
B. Wilſon.
John Canton.
Edward Delaval.

7 June, 1769.