to obey the voice of its master, is pleased to be caressed, and cleanly in its habits. Hearne states that he has kept various individuals about his house, during his residence at Hudson's bay, and remarks, "they made not the least dirt, though they were kept in my own sitting room, where they were the constant companions of the Indian women and children, being so fond of their company that when the Indians were absent for any considerable time, the beaver discovered great signs of uneasiness, and on their return showed equal marks of pleasure by fondling on them, crawling into their laps, laying themselves on their backs, sitting erect like a squirrel, and behaving to them like children that see their parents but seldom." In general during the winter they lived upon the same food as the women did, and were remarkably fond of rice and plum-pudding. They would eat fresh venison and partridges very freely, but I never tried them with fish, though I have heard they will at times prey on them.*

[TO BE CONTINUED.]

FOR THE FRANKLIN JOURNAL.

On the causes of the inadequate protection afforded by Lightning Rods, in some cases, and the means of insuring their perfect competency: also, a refutation of the prevalent idea, that Metals are peculiarly attractive of Electricity. By R. HARE, M. D., Professor of Chemistry in the University of Pennsylvania.

In some of our American newspapers, a letter has been republished from the London Times, calculated, as I conceive, most perniciously to lessen the confidence of the public in metallic conductors, as a mean of protection against lightning. In common with many other persons, the author of the letter appears to suppose, that metals are peculiarly attractive of electricity; and infers that, when a metallic rod is attached to a house, or ship, a discharge of electric fluid may be induced from a cloud, which, otherwise, would not have been sufficiently near to endanger the premises. Nothing in my opinion can be more erroneous than this notion. The truth is, that the earth, and the thunder clouds being in opposite electrical states, the electric fluid tends to pass from one to the other, in order to restore

* "It is well known that our domestic poultry will eat animal food; thousands of geese that come to London market are fattened on tallow craps, and our horses in Hudson's Bay would not only eat all kinds of animal food, but also drink freely of the wash or pot-liquor intended for the hogs. We are assured by the best authorities, that in Iceland not only black cattle, but also the sheep, are almost entirely fed on fish and fish-bones during the winter season. Even in the isles of Orkney, and that in the summer, the sheep attend the ebbing of the tide as regularly as the Esquimaux curlew, and go down to the shore, which the tide has left, to feed on the sea-weed. This, however, is through necessity, for even the famous island of Pomona will not afford them an existence above high water mark." *Hearne*, 8vo. p. 245. It must always be borne in mind that observations made on the diet of captive animals will not at all apply to them when they are free to follow the dictates of nature. It is, however, highly interesting, to know how far they can accommodate themselves to necessity.

the equilibrium. The atmosphere being a non-conductor, through which a discharge cannot be accomplished without a forcible displacement of air, any solid body rising above the earth's surface, which may be more capable than the air, of transmitting electricity, is made the medium of communication. Metals being pre-eminently capable of acting as conductors, the transmission of electricity is made through them, with proportionably greater facility. Yet they do not attract it more than other substances, similarly electrified. A glass, or wooden ball, is as readily attracted, by the excited conductor of an electrical machine, as a ball of metal; and as much more, than a metallic point, as the superficies of the ball, may be greater, than that of the point.

Nothing, to me, appears more unfounded than an idea, lately suggested, that the attraction between a ship, and a thunder cloud, can be increased, by the presence of a pointed metallic rod, surmounting the main-mast.

If houses, or vessels, have been struck with lightning, while provided with conductors, it is, in my opinion, owing to the conductors being improperly constructed; or having no adequate connexion with the earth. The power of any body to receive an electric discharge, is dependent on the conducting power of the medium in which it terminates, no less than upon its own. A metallic rod, held by a glass handle, or entering a mass of pounded glass, or dry sand, would not be more efficacious, as a conductor, than a glass rod similarly situated. If terminated by an imperfect conductor, as for instance by earth, or water, its power is reduced in proportion to the imperfection of the medium thus bounding it. This influence of the media, in which conductors terminate, has not been sufficiently insisted upon, in treatises on electricity. I should not consider a metallic rod, terminating, without any enlargement of surface, in the water, or the earth, as an adequate protection against lightning; but were such conductors to terminate in metallic sheets, buried in the earth, or immersed in the sea, or, *by a connexion duly made with the iron pipes, with which our city is watered, or the copper with which ships are generally sheathed*, I should have the most perfect confidence in their competency.

It is not only important that the points of contact, between the metallic mass, employed to afford lightning an adequate passage, and the earth, or water, in which it terminates, should be so multiplied as to compensate for the inferior conducting power of the earth, or water; but it is also necessary that the conducting rod be as continuous as possible. When conductors are to be stationary, as when applied to buildings, they should consist of pieces screwed together, or, preferably, joined by solder, as well as by screwing. Where flexibility is requisite, the joints should be neatly made, like those of the irons in fall top carriages; and should be rivetted so as to ensure a close contact at the junctures.

In all cases, the ordinary, but important, precaution of having the rod to terminate above, in a fine clean point, should be attended to. Where platina tips cannot be had, multiplying the points by split

zing the rod into a ramification of pointed wires, may compensate for the diminution of conducting power, arising from rust.

The efficacy of the point, or points, is, however, dependent on the continuity of the conductor of which I have already spoken: since it is well known, that, if a pointed rod be cut into parts, so as to produce intervals, bounded by blunt terminations, its efficacy will not be much greater than if it had no point; because the fluid will, in that case, pass in sparks, instead of being transmitted in a current. It is on this account that I object to chains, or rods joined by loops, or hooks and eyes. The error of supposing that a metallic rod, must be more capable of attracting electricity injuriously, because of its known wonderful power in transmitting it, will be evident, when it is understood that the only difference between metals and other bodies, arises from the superior power of transmission. Hence, when by a defective communication with the earth or sea, the efficacy of the metal, as a conductor, is diminished, or destroyed, its influence over a charged cloud is proportionably lessened. It follows, therefore, that so far as it acts, its action must be beneficial, unless its lower termination should, by an inconceivable degree of ignorance or inattention, be so situated, as to render it more easy for the electrical fluid to leave the rod, and pass through a portion of the house or vessel, than to proceed, by means of the rod, into the earth or sea.

Thus Richman was killed by a conductor which he employed to receive electricity from the clouds, and to convey it to an electrometer, necessarily insulated: under these circumstances, the head of the professor being about a foot from the conductor, he became a part of the channel of communication with the earth. Had the apparatus been surrounded by a cage of wire, and this duly connected with a metallic rod soldered to a sheet of metal buried in the earth, Richman might have made his observations with perfect security. That with due precaution, experiments, analogous to his, are not productive of injury to the operator, is rendered evident by the subjoined quotation from Singer's *Electricity*.

I must premise, that the apparatus, by means of which the phenomena alluded to were produced, consisted of a wire a mile long, supported and insulated, upon very high poles, and terminating in the house of the electrician, Andrew Crosse, Esq.

"The approach of a charged cloud, produces sometimes positive, and at others negative signs, at first: but, whatever be the original character, the effect gradually increases to a certain extent, then decreases, and disappears, and is followed by the appearance of the opposite signs, which gradually extend beyond the former maximum, then decrease, terminate, and are again followed by the original electricity. These alternations are sometimes numerous, and are more or less rapid on different occasions; they usually increase in intensity at each repetition, and at last a full dense stream of sparks, issues from the atmospherical conductor to the receiving ball,* stop-

* That is, a ball communicating with the earth, by an adequate metallic conductor.

ping at intervals, but returning with redoubled force. In this state a strong current of air proceeds from the wire and its connected apparatus; and none but a spectator can conceive the awful, though sublime, effect, of such phenomena. At every flash of lightning, an explosive stream, accompanied by a peculiar noise, passes between the balls of the apparatus, and enlightens, most brilliantly, every surrounding object, whilst these effects are heightened by the successive peals of thunder, and by the consciousness of so near an approach to its cause."

"During the display of electric power, so awful to an ordinary observer, the electrician sits quietly in front of the apparatus, conducts the lightning in any required direction, and employs it to fuse wires, decompose fluids, or fire inflammable substances; and when the effects are too powerful, to attend to such experiments securely, he connects the insulated wire with the ground, and transmits the accumulated electricity with silence, and with safety."

FOR THE FRANKLIN JOURNAL.

Remarks upon Water Wheels, and upon some prevailing errors respecting the Application of water as a Motive Power.

I suppose that, at the present day, no man who professes to be capable of directing the construction of a water wheel, or of estimating the amount of a water power, is ignorant of the fact, that water falls through a distance of about sixteen feet in the first second. But I suspect that many who assume the above qualifications, do not know the ratio of increase, either of the distance, or the velocity. I have drawn this conclusion, not only from conversations with several practical engineers, but also from essays published in our scientific journals. As an instance of the latter, I will select, for its convenience of reference, an article on water wheels published in this Journal (Vol. I. p. 103.) which being the production of a practical engineer, and having passed the inspection of a scientific committee, may be considered as corroborating my commencing observations. In the third paragraph of that article, is the following sentence: "As a falling body, water descends at the *speed* of nearly 16 feet in the first second, and it will appear evident, that if a water wheel is required to be so driven, that the water with which it is loaded has to descend 10, 11, or 12 feet per second, at which rates wheels are generally constructed to work, that a *very large proportion* of the power is lost."

Here, in the first place, we find *speed*, or *velocity*, confounded with the *distance* fallen in the first second; whereas, the latter is 16 feet, and the former is accelerated, from nothing, at the commencement, to 32 feet per second, at the end of the first second; so that this part of the sentence conveys, strictly, no intelligible meaning; it is, nevertheless, made a standard, by a comparison between which, and any