of the climatic features of British Columbia, may be found in an appendix written by me for the Canadian Pacific Railway Report of 1880, p. 107.

The mean temperature of Tongass at the southern extremity of Alaska, from two years' observations, is stated as 46°·5.

Observations have been maintained at Sitka with little interruption for a period of forty-five years. The latitude of this place is 57° 3', or about one degree north of Glasgow. The mean temperatures are as follows:—spring 41°·2, summer 54°·6, autumn 44°·9, winter 32°·5, and for the year 43°·3.

According to the *Pacific Pilot* above quoted, that portion of the Kuro-siwo, having a temperature of 55° F. or more, approaches the coast in the vicinity of Vancouver Island. Temperatures not much lower than this however prevail much further north. The average temperature of the surface of the sea during the summer months in the vicinity of the Queen Charlotte Islands as determined by me in 1878 ("Report of Progress, Geological Survey of Canada, 1878-79") is 53°·8. Observations by the U.S. Coast Survey in 1867, in the latter part of July and early in August between Victoria and Sitka, gave a mean surface-temperature of 52°·1.

GEORGE M. DAWSON

Geological Survey of Canada, February 1

"The New Cure for Smoke"

IT was not my intention to trouble you further on this subject at present, but as Dr. Siemens has been good enough to notice the result of my trials with the coke-gas grate, and has asked a question with reference to the grate used by me, it is due to that gentleman that I should at once explain that the grate in which the trials were made is of modern construction and permanently fitted with side-cheeks and back of fire-clay lumps, and that when in use with the coke and gas the back was fitted with a copper plate, and in all other respects the grate was arranged in the manner described and illustrated in NATURE, vol. xxiii. p. 26.

J. A. C. HAY

On the Space Protected by Lightning-Conductors

THE very interesting article by Mr. W. H. Preece on the "Space Protected by a Lightning-Conductor" (*Phil. Mag.* 5th series, vol. x. p. 427 *et seq.*, December, 1880) revives this important practical question. The old rule, first enunciated by M. Charles, which makes the radius of the protected circular area around the base of the rod equal to twice its vertical height, has never been satisfactorily verified either on theoretical or experimental grounds. This rule was adopted in the Report of the Commission of the French Academy of Sciences drawn up by M. Gay-Lussac in 1823 (*Ann. de Chim. et de Phys.* 2nd series, t. 26, p. 258), and also in two other reports drawn up by M. Pouillet, one in 1854 (*Comptes rendus*, t. 39, p. 1142), and the other in 1867 (*Comptes rendus*, t. 64, p. 102). But still more recently the Committee appointed by the Préfet de la Seine to superintend the construction of lightning-conductors in the City of Paris, in their Report in February, 1876, *reduced* the radius of the protected area to 1·45 times the height of the rod. I am ignorant on what grounds the Commission adopted this precise number.

In this state of the problem Mr. Preece's paper was both apposite and welcome. The rule which he deduces certainly has the merit of *definiteness*; but it seems to me that it fails to be *practically satisfactory*. For it is very evident that his investigation is exclusively applicable to "*Blunt-Conductors*," since the "*Power of Points*" is entirely left out of consideration. His deductions might apply to the *blunt*-conductors which crowned the Royal Palace of George III., but are scarcely applicable to the *pointed* rods now employed! His investigation assumes that the *distance* of the earth-connected objects from the electrified cloud is the *only element* which determines the *direction* of the discharge. It seems to me that the well-established "power of points" to discharge, or rather to *neutralise* the electricity of charged conductors, is an essential element in the problem of the protected space.

It is a well-known fact that when an electrified cloud approaches a *pointed* lightning-conductor which is in good conducting connection with the earth, the sharp point becomes charged by induction with opposite electricity of *high tension* long before the distance between them approximates that required for a *disruptive* discharge; so that electricity of the opposite kind from that of the cloud *escapes* from the point in the form of a *connective discharge* or electrical *glow*, and *neutralises* that of the cloud, and thus silently *disarming* it, *averts* the disruptive stroke of lightning. This *neutralisation*, due to the power of points, constituting the *preventive action* of lightning-conductors, is justly regarded as the *most important* function of such rods; although, under certain extraordinary circumstances, they may be forced to carry disruptive discharges. Under any circumstances, however, it is obvious that *pointed* conductors must *enlarge* the protected area as compared with *blunt* conductors.

It is very difficult, if not impossible, to estimate in a precise manner how this *power of points* would *modify* and *distort* the *equipotential surfaces* in the intervening electric field. The problem is evidently one of great complexity. The following circumstances must obviously influence, to a greater or less extent, the *magnitude* and *direction* of the resultant electromotive force, which determines the path of discharge, *convective* or *disruptive*, viz.: (1) *Distance* of thunder-cloud from the point of the conductor; (2) variable *dielectric properties* of the intervening air; (3) *size* of the cloud; (4) the variable *tension* of its electric charge, especially under the neutralising action of the pointed rod; and (5) the *velocity* with which the thunder-cloud approaches the point of the conductor. The *last* consideration is very important, and at the same time most difficult to formulate; for the *convective neutralisation* is a *gradual* process requiring *time*. It is evident that a heavily-charged thunder-cloud *rapidly* driven towards the point of the conductor might give rise to a *disruptive* spark, while, if *slowly* approaching the same, it would have been *silently neutralised*, and the stroke averted. In fact the strength and direction of the resultant force is influenced by so many variable conditions that it would tax the resources of a powerful calculus to indicate a formula which would satisfy, even approximately, the demands of practice in the construction of lightning-conductors.

Nevertheless, it is quite certain that Mr. Preece's rule, which makes the radius of the protected circular area equal to the *height* of the rod for *blunt* conductors, is perfectly *safe* for *pointed* rods; for there can be no question as to the fact that the "power of points" *enlarges* the protected area.

The late Prof. Henry frequently witnessed the efficacy of convective discharges from the point of the lightning conductor attached to the high tower of the Smithsonian Institution. During violent thunder-storms at night, at every flash of lightning he observed that "a jet of light, at least five or six feet in length, issued from the point of the rod with a hissing noise."

It is proper to add that while the circumstances influencing *disruptive* discharges of electricity have been experimentally investigated by a number of physicists, the laws of *convective* discharges from points do not seem to have received attention from any experimenter. Thus I have not been able to find a satisfactory answer to the following elementary inquiry, viz.—Under given conditions, at what *distance* will a pointed conductor connected with the earth *begin* to neutralise the electricity of an insulated conductor by the convective discharge of the opposite kind of electricity from the point?

In short, the whole subject of the "power of points," although one of the best-established and most conspicuous phenomena in electricity, is sadly in need of experimental investigation. This class of electrical phenomena is pretty much in the same condition in which Franklin left it more than a century ago.

Berkeley, California, January 1 JOHN LE CONTE

[Mr. Preece has shown by considering the area between the conductor and the charged cloud as an electric field mapped out in equipotential surfaces and lines of force, that "a lightning-rod protects a conic space whose height is the length of the rod, whose base is a circle having its radius equal to the height of the rod, and whose side is the quadrant of a circle whose radius is equal to the height of the rod."—*Phil. Mag.*, December, 1880.—ED.]

Localisation of Sound

MY friend the Rev. H. J. Marston, Second Master of the School for Blind Sons of Gentlemen at Worcester, has communicated to me some very singular instances of the power of localising sound possessed by blind boys.

One of the games in which his pupils most delight is that of *bowls*. A bell is rung over the nine-pins just as the player is ready to throw the bowl, when, totally blind as he is, he delivers it with considerable accuracy of aim. Mr. Marston vouches for the fact that it is no uncommon feat for a boy to strike down a single pin at a distance of forty feet three times in succession.