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°.

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,

mean temperatures are as follows :—spring 41 $^{\circ}$ 2, summer 54 $^{\circ}$ 0, autumn 44 $^{\circ}$ 9, winter 32 $^{\circ}$ 5, and for the year 43 $^{\circ}$ 3. According to the *Pacific Pilot* above quoted, that portion of the Kuro-suwo, having a temperature of 55 $^{\circ}$ 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 surface of the 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°'I.

GEORGE M. DAWSON Geological Survey of Canada, February I

"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.

J. A. C. HAY p. 26.

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 This rule was adopted in the Report of experimental grounds. the Commission of the French Academy of Sciences drawn up by M. Gay-Lussac in 1823 (Ann. de Chim. et de Phys. 2nd by M. Gay-Lussac in 1023 (Ann. ac Cram. et al Trys. 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 145 times the height of the red. I am 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 investi-gation 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 kiud 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 disrupive, 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 (c) the *rule rule rule* with which the thunder cloud approaches 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 lightningconductors

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 lightningrod 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 com-municated 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.