

and the exposed mouths of the tubes, allows one to catch the influence of any gust and read the pressure at leisure.

The theoretical problem of the precise mechanical action of these tubes, especially that which Hagemann calls a Magius tube, *i.e.* one across which the wind blows at right angles, will, I hope, prove attractive to the mathematical physicists of England. Some interesting experimental work by Robinson will be found in *Van Nostrand's Magazine*, vol. xviii., 1878, p. 255, and xxxv., 1886, p. 89. A small closed room with only a chimney flue opened, such as usually obtains at the mountain stations of meteorologists, is virtually a Magius tube, and the barometer within must, under favourable conditions, show a depression depending on the so-called suction or draft up chimney. The direction of the wind combines with the structure of the building and the aspect of the various doors and windows to modify the influence of the force of the wind; the sluggishness due to the close cisterns, and the pumping due to the inertia of the liquid of ordinary mercurial barometers, further complicate the phenomena of suction during gusty winds, so that a simple general rule for correcting the observed barometric readings becomes impracticable, but the use of aneroids within closed Pitot or other tubes, with air-tight stop-cocks as above, simplifies the wind's action, and allows of its measurement at definite moments.

The distribution of pressure over the face of a large building fronting the wind, and in some part of which is the window of the room containing the barometer, is approximately known from Curtis's and Burton's measurements for a thin flat plate.

The location of each station with respect to mountains or other orographic features has also an influence on the pressure, which will still remain to be investigated; thus, on the leeward side there is a diminution, and on the windward side an increase of pressure, but this may be generally inappreciable.

It may also be mentioned in this connection that in delicate barometric measurements, such as those made by the International Bureau of Weights and Measures, it is important to prevent even the slightest currents from blowing across the open end of the siphon tube.

The suction effect of wind blowing over chimneys surmounted by cowls of different shapes was under investigation from 1878 to 1881 by a special committee of the Sanitary Institute, but, so far as I can learn, their experiments were never completed. Lord Rayleigh also read a short paper on the same subject at the meeting of the British Association in 1882, but as I do not know of its publication, I take this opportunity to express the hope that he will give meteorologists both a theoretical and experimental exposition of the action of the Pitot, the Magius, and the reversed Pitot tubes, and a suggestion as to the best method of determining, by means of stationary apparatus, the static pressure within a mass of moving air.

CLEVELAND ABBE

Washington, October 23

M. PASTEUR'S TREATMENT OF RABIES

AT the meeting of the Paris Academy of Sciences on November 2, M. Pasteur submitted a further communication on the results hitherto obtained from his method of treating hydrophobia by inoculation, which has now been in operation for a twelvemonth. The paper is divided into three parts, the first giving the statistical details brought down to the present date, the second describing certain modifications in his method as originally applied, the third giving the results of fresh experiments on animals. Up to October 31 as many as 2496 persons were inoculated at his Paris establishment, and at first the treatment was uniform for all alike, whatever their age, sex, or other varying conditions. Of the total number 1726 were from France and Algeria, 191

from Russia, 165 from Italy, 107 from Spain, 80 from England, 57 from Belgium, 52 from Austria, 22 from Roumania, 18 from the United States, 14 from Holland, the rest from various other parts of Europe, besides 3 from Brazil and 2 from British India. Of 1700 French patients, apart from 2 who arrived too late, 10 only succumbed, whereas of the small minority not treated at the laboratory as many as 17 died in the same period in the rest of France, while for the last five years the average yearly mortality from hydrophobia was 11 in the Paris hospitals alone. Last year it rose to 21, but since November 1885, when the new system was introduced, 2 only died, and these had not been inoculated, besides a third who had been imperfectly treated. Most of those who perished were children bitten in the face and subjected to the simple treatment, which experience now shows to be insufficient in such cases.

A first lesson on the necessity of stronger doses was taught by the 19 Russians bitten by a mad wolf, one of whom died while under treatment, and two others shortly after. In consequence of these deaths the 16 survivors were subjected to a second and third treatment with the strongest and freshest virus from the spine of the rabbit of 4, 3, and 2 days' standing, whereas, for the milder treatment, virus from 14 to 5 days' old had alone been used. To these repeated treatments should most probably be attributed the recovery of these Russians, who are reported to be all still in excellent health.

Encouraged by these results and by the fresh experiments described further on, M. Pasteur modified his treatment, making it at once more rapid and more active for all cases, and even still more energetic for bites on the face, or for deep and numerous lacerations of exposed parts of the body. In such cases the inoculations are now hastened, in order to arrive more promptly at the freshest virus. Thus, on the first day, virus of 12, 10, and 8 days will be used at 11, 4, and 9 o'clock; on the second day that of 6, 4, and 2 days, at the same hours; on the third, virus 1 day old. Then the treatment is repeated: the fourth day with virus 8, 6, and 4 days old; the fifth with that of 3 and 2 days; the sixth with that of 1 day; the seventh with virus of 4 days; the eighth with that of 3; the ninth that of 2; the tenth with that of 1 day.

If the bites are not healed, or the patients arrive somewhat late, the same treatment may be renewed at intervals of two or a few days for four or five weeks, which are the critical periods for children bitten in the face. This system of vaccination has been in operation for the last two months, hitherto with excellent results, as shown by comparing the case of the six children who perished under the mild treatment, with that of ten others also seriously bitten last August, and subjected to the more energetic treatment, and all of whom were doing well on the first of this month. This new system requiring an increase of the staff, M. Pasteur and his assistant, Dr. Grancher, have been aided for some time past by Dr. Terrillon, Dr. Roux, Dr. Chantemesse, and Dr. Charrin.

With regard to the fresh experiments on dogs, an objection to the inoculation of human beings after being bitten might be raised on the ground that the immunity of animals treated before being bitten had not been sufficiently demonstrated after their undoubted infection by the virus. In reply to this objection M. Pasteur points to the immunity of dogs after trepanning and intra-cranial inoculation with the virus of ordinary street rabies. Trepanning is the surest method of infection, and its effects are constant. The first experiments on this point, dating from August 1885, had but partial success. They were resumed during the last few months, with certain modifications which produced the best results. The vaccination is begun the day after inoculation, and proceeded with rapidly, the series of prophylactic virus being all administered within twenty-four hours and even in a shorter period, and then repeated

once or twice at intervals of two hours. The failure of Dr. Frisch, of Vienna, in experiments of this kind is due to the slow process of vaccination adopted by him. Success can be secured only by the rapid method here described. The immunity conferred under such conditions is the best proof of the excellence of this method.

REPORT ON THE CHARLESTON EARTHQUAKE¹

THE earthquake of August 31, which, from the locality in which its greatest power was displayed, will generally be known as the "Charleston Earthquake," was, perhaps, the most notable disturbance occurring within the limits of the United States of which we have any knowledge. It is entitled to this rank both on account of the wide area over which it was distinctly felt, and of the magnitude of the disaster which it caused in the immediate vicinity of the point of maximum intensity.

The earthquake consisted of a series of seismic disturbances which began in slight but distinctly noticeable tremors occurring on August 27 and 28, at the town of Summerville, about twenty-five miles north-west of Charleston, South Carolina.

The shock of greatest violence occurred a little before ten o'clock on the night of Tuesday, August 31. It was followed by several of lesser magnitude on that night, and during the succeeding three or four weeks. The great shock began in the city of Charleston within a few seconds of 9.51 p.m., 75th meridian time. The duration of the vibratory motion of the earth at that point was probably about forty seconds; the motion at first being moderate, but increasing with great rapidity during the last ten or fifteen seconds.

All of the loss of life and property during the whole series of disturbances is to be attributed to this first shock. Five minutes later another occurred, and ten minutes later still another; the latter being of considerable violence, but neither alone would have done any damage. The same may be affirmed of the succeeding series of disturbances, which, with greatly diminished intensity and at increasing intervals of time, continued to maintain the conditions of alarm and terror into which the people of the afflicted locality were naturally thrown by the first disturbance. Although some injury to buildings resulted from these after shocks, it is tolerably certain that in all such cases displacement and fracture had taken place in the great shock; the lesser disturbances simply finishing what had then been nearly completed.

The origin of the disturbances, appears to have been somewhere below a point fifteen or twenty miles north-west of Charleston; that is, in the neighbourhood of the town of Summerville. A chart of provisional co-seismal lines drawn by Mr. Hayden of the Geological Survey, and published in *Science* for September 10, seems to locate this centre somewhat further north than the point indicated above. At the time of its construction, however, information from many points was lacking, and that which was at hand was admittedly doubtful in some degree.

Reference is made later to the iso-seismal chart which accompanies this Report, and which indicates that the origin was near the point referred to above. Strong proof of this is also furnished in the intensity and character of the disturbance as shown by the effects which were still visible when an examination was made a few days after the principal shock. The appearance of the brick piers upon which many houses in Summerville rest was such as to justify the conclusion that the principal component of the motion at that point was vertical, and it was evident that the destruction of buildings was much less than would have resulted from a horizontal movement equal to that

which had taken place in Charleston and elsewhere in the neighbourhood.

Another fact of importance is that in the vicinity of Summerville the disturbances preceding that of August 31 took place, and here they have been most numerous and most persistent. Indeed, at the present writing, nearly a month after the first perceptible shock, they still occur at irregular intervals varying from a few hours to a few days. Only the most violent of these have been felt as far as Charleston.

Nearly all the movements in Summerville and vicinity have been accompanied by, and, indeed, generally preceded by, a low rumbling sound, lasting one or two seconds, and not infrequently this sound, always unmistakable in its character, was neither accompanied nor followed by a perceptible movement. This was a common occurrence at Summerville and in the immediate vicinity, and it was found that among several observers there would be no agreement upon the direction from which the sound appeared to come.

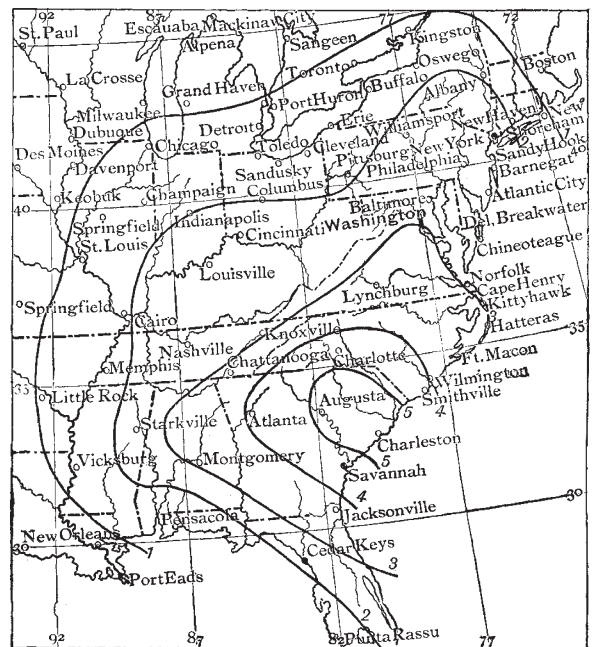


Chart of iso-seismal lines.

At a distance from ten to fifteen miles from Charleston in the direction of Summerville some of the most curious and interesting effects of the disturbance were to be seen. These were the "sand craters" and crevices, out of which extensive eruptions of sand and water had taken place on the night of August 31. The craters thus formed varied in size from an irregular oval, twenty-five feet long by fifteen feet wide, to shallow cones not over an inch in diameter and beautifully symmetrical in form. The area surrounding these openings was generally flooded with sand, often acres in extent, to a depth varying from a fraction of an inch to fifteen and eighteen inches. About the larger cavities the average depth was probably not less than six inches, and the area covered often an acre or more. The flow of sand was unquestionably only an incident to the outflowing of vast quantities of water, the greater part of which disappeared within a few hours after its appearance. The few crevices or "cracks" in the earth which were found were in character and origin similar to the "craters," being long and narrow openings, through which water with sand had been ejected.

It was difficult, in fact quite impossible, to obtain reli-

¹ By Prof. T. C. Mendenhall, Assistant. From the *Monthly Weather Review*, U. S. Signal Serv. ce, August 1886.