Lightning-Discharge.

ON Feb. 24, 1890, at 8.45 P.M., there was a case of lightning-discharge here which is perhaps worthy of notice. The building struck was Newcomb Hall, the property of Washington and Lee University. It is a three-story brick building covered with tin, having seven downfalls not connected with the earth, and having no lightning-rods. On top of the building, for lighting and ventilating purposes, is a square cupola. This has wooden corner-posts six or eight inches square; its walls are almost entirely glass; its roof is tin. The distance between the tin on the roof of the cupola and the nearest tin in connection with that on the roof of the building is about four feet. The lightning struck the roof of the cupola, passed down one of the corner-posts to the roof of the main building, and then down five of the seven downfalls to the ground. The roof of the cupola is "hipped;" and just under each of the four eaves, in a horizontal position, are two planks, each about ten inches wide. The four planks adjacent to the post struck were thrown entirely off. The tin on the roof just above the post was thrown back, uncovering about a square yard of the roof. The post itself was torn to splinters at the top. All but five panes of glass, out of a total of about fifty in the walls of the cupola, were shattered. Nearly all of the glass fell outside, and the tin all over the roof of the cupola showed signs of having been pushed upwards. When the discharge left the post, it divided, part of it going to the tin on the lower part of the post and thence to the roof, and part of it to a strip of tin on the window-sill. This strip of tin was composed of five or six pieces tacked together, not soldered. Nearly all of these joints were separated, about two inches of the tin being bent over in the direction in which the discharge travelled, from above down. This part of the discharge reached the tin on an adjacent post of the cupola, and thence passed down to the roof. One sharp corner of tin was burnt off, leaving a burnt curved edge about an inch in length. The two posts and the tin on them were blackened at the point where the discharge reached the tin. There was no further trace of the discharge until it reached the ground. As already stated, it passed down five of the downfalls, but apparently much the largest part passed down one. At this point, for a distance of ten or twelve feet, the ground was as much turned up as it would have been by a large plough. Some of the earth was thrown to a distance of twenty or thirty yards. The clerk of the faculty has his office in a corner room on the ground floor next to this downfall. He found the steel pens in a box on his desk so strongly magnetized that one pen could support four or five others. The pens in the penholders were also magnetized. Two panes of glass were broken in this room. Fifteen or twenty feet from this corner of the building is a water-pipe, wrought iron, one inch in diameter. This pipe at a short distance connects with a cast-iron pipe whose internal diameter is two inches; this, in turn, connects with the system of pipes supplying the town of Lexington with water. The two-inch cast-iron pipe was found the next day to be leaking badly in seven places within a few hundred yards of Newcomb Hall. There seems to be no reason to doubt that the discharge in some way burst the pipe. The leak nearest the building was over fifty yards away. There were no indications of melting. One hole in the pipe was an inch wide and about three inches long, a piece of that size apparently having been knocked out. The pipe is very old and rotten, being almost as soft as graphite. The water in the pipe is under a pressure of about a hundred feet of water. The only other case with which I am acquainted, where water-pipes were damaged by lightning, is that given by Secchi in the *Telegraphic Journal and Electrical Review* (London, 1872, translated from *Les Mondes*). In that case the pipe was broken, and some lead melted, at the point where the discharge first reached the pipe.

The report at the time of the discharge may be described as terrific; it was the more so, because it was the very first indication of any thing like a thunder-storm. There was no lightning before this discharge, and not much after it.

Besides the facts given above, there were some other reports concerning the discharge which may be of interest. Having heard that some persons saw what seemed to be a ball of lightning, I made as careful inquiry as I could concerning it, with the following result:—

1. A student was sitting before an unshaded window, from the roof of which Newcomb Hall is visible, and less than two hundred yards from it. Attracted by a bright flash, he looked up, and reports that he saw a ball of fire, in size and appearance about like a Roman candle, slowly descending on the building. It disappeared about the time it reached the roof, when the explosion was heard. He at once reported what he saw to his uncle, the president of the university, saying he thought the building was struck. They then looked out for signs of fire, but saw nothing.

2. In another direction, and at a greater distance, is a house from which Newcomb Hall is plainly visible from top to bottom. A lady in this house, sitting before a window, had her attention attracted by a flash, looked up, and saw a shower of fire-balls falling on Newcomb Hall. On careful inquiry, I learned that she did not see these balls above the top of the building: they seemed to be very nearly or quite on it when she saw them. She possibly saw what was concealed by the building from the student. This lady told me that some young ladies in another room in her house saw what she herself saw: I did not talk with them about it.

3. About a quarter of a mile from Newcomb Hall, on Main Street, stands the Court-House, a short distance back from the street. Mr. B. was standing in the door of the Court-House, looking out on Main Street in the direction of Newcomb Hall. He first heard a sharp, quick noise like that produced by slapping the hands together, which seemed to come from his telephone. He then saw across the street from him, at a height of about fifteen feet from the ground, a ball about the size of a large orange just luminous enough to be plainly visible, followed by a brighter trail ten feet long. This ball moved horizontally and slowly up the street about twenty yards, and then burst with the brightest flash Mr. B. ever saw, and a terrible noise. This noise was immediately followed by another of like character in the direction of the university buildings. Mr. B., I should state, is a man of the very highest character, and his word would be taken without question by all who know him. He is calm and unimaginative. I omitted to mention that his face felt as if it had been hit with sand, and that there was an unpleasant sensation for some hours afterwards. It was rainy, and Mr. B. saw no one on the street; but I learned that three negroes were standing on the sidewalk nearly under the point where Mr. B. saw the globe burst. As they were not moving, Mr. B. might easily miss seeing them. I questioned two of these negroes. They were standing facing each other, one looking up the street, and the other down. Each of them thought he saw a ball of fire fall in the street in the direction in which he was looking, and at a distance of from fifty to one hundred yards away. Neither of them knew any thing of the explosion reported by Mr. B., although it was almost immediately over their heads, and only twenty or thirty feet away. Newcomb Hall could not be seen by either Mr. B. or the negroes.

I give the facts as I gathered them, without comment. There is no reason to think that any of the persons questioned failed to give a substantially correct report of the impressions made on their senses.

S. T. MORELAND.

Washington and Lee University, Lexington, Va., April 26.

Sunspots and Tornadoes.

THE following figures show a slight parallel between the frequency of tornadoes in the United States for the last twelve years, and the sunspot curve of the eleven-year cycle. The solar data employed have been obtained from Professor Rudolph Wolf (Zurich), the well-known sunspot specialist. The tornado numbers are supplied by Lieut. John P. Finley of the United States Signal Service, but should be regarded as only approximate, and subject to more or less change, for these reasons: (1) better facilities now exist for obtaining news of tornadoes than existed fifteen or twenty years ago, owing to the special activity of the United States service, the organization of State weather bureaus, and the co-operation of the press; and (2) west of the Mississippi the coun-

try is more densely settled than it was one or two decades ago, and many local storms would now be observed where they could not have been seen and reported some years ago. Thus, the average number of tornadoes reported annually for the last ten years is 159, while for the previous ten years it was only 45. For this reason, it would not be safe to compare the spots with any former cycle. In order to make the figures for 1878–89 fairly comparable, those for the first three or four years may be raised slightly, perhaps; and those for the last two may be increased 2 or 3 per cent by belated returns. The annual average, then, would be more than 160 (say 170), with minima at the ends of the series, and a maximum near the centre:—

Year.	Spots.	Tornadoes.	Year.	Spots.	Tornadoes.
1878	3.4	77	1884	63.3	216
1879	6.0	88	1885	50.3	139
1880	31.6	141	1886	25.7	290
1881	54.1	113	1887	13.1	178
1882	59.3	90	1888	6.7	122
1883	62.8	167	1889	6.1	129

Another curious fact is that the greatest number of tornadoes reported upon one day, according to Finley, was 60, on Feb. 19, 1884. Wolf's relative number for January, 1884 (92.1), is the largest for any month during this whole cycle, except April, 1882 (97.0); but the average for the six or seven months beginning with October, 1883, is much greater than for any similar period in 1882. Tacchini (says *Nature*, July 1, 1886, p. 194) fixes the height of solar excitement in February, 1884; but Professor P. M. Garibaldi of Genoa quotes Tacchini as placing the maximum in May, 1884. The maximum of protuberances found by Tacchini (*Nature*) was in March, 1884, though Garibaldi says June–August, 1884. At the Royal Observatory, Greenwich, the rotation-period (27 days) containing the largest daily average spottedness in twelve years, began July 4, 1883, when it was 2,037 millionths of the sun's visible hemisphere; but the best two-period exhibit was from Dec. 14, 1883, to Feb. 7, 1884, when the daily mean was 1,817 millionths. The greatest facular displays recorded in the Greenwich "Results" were in the rotation-periods beginning Dec. 14, 1883 (3,151 millionths) and Feb. 7, 1884 (3,467 millionths). Garibaldi, at the Royal University, Genoa, recorded the greatest magnetic variation (in the needle's daily swing) in April–July, 1884, and from August, 1885, to April, 1886. At Toronto, the biggest magnetic storms of the maximum stage of this last sunspot cycle occurred in November, 1882, September, October, November, 1884, and March, 1886. During the first seven months of 1884, at Toronto, the magnetic perturbations were few and slight.

The general yearly parallel between spots and tornadoes is far from proving any relation between the phenomena; and the correspondence between the maxima of spots, protuberances, magnetic variations, magnetic storms, and tornadoes is not very close. Yet the comparison here made is not without interest.

JAMES P. HALL.

Brooklyn, N.Y., May 1.

BOOK-REVIEWS.

Graphics, or the Art of Calculation by Drawing Lines. By ROBERT H. SMITH. Part I. London and New York, Longmans, Greene, & Co. 8°.

THIS work treats of graphics as applied especially to mechanical engineering. The volume before us is but the first part of the complete treatise, and deals mainly with the analysis of stresses in engineering structures. It is accompanied by an atlas containing twenty-nine plates and ninety-five diagrams, the text and the diagrams being each essential to the better interpretation and ready comprehension of the other. The second part of the work, which it is hoped will soon be published, will deal mainly with synthetic problems, aiming more at the design than the analysis of structures and machines.

The department or branch of descriptive geometry dealt with in this work, the "art of calculation by drawing lines," has assumed considerable importance, so that Professor Smith's scientific treatise on the subject is as timely as it is practical and comprehensive. The graphic method of computation, of course, has limitations in many directions, being less useful in simple cases than arithmetical and algebraic methods; but the method once thoroughly mastered, and its scope and limitations clearly understood, it will enable those who have a knowledge of elementary mechanics to utilize that knowledge to better advantage and with a greater degree of thoroughness, and to apply it to many of the every-day problems of engineering science without the aid of the more complicated portions of algebraic and trigonometrical mathematics or of the differential and integral calculus. Wherever the method is applicable, its use will result in a saving of mental fatigue, as it possesses great simplicity in many of its applications, leaves but little opportunity for the accumulation of gross errors, and is in itself a test of its own accuracy.

The work opens with a glossary of special terms and symbols, some of which are new and possessed of advantages in the matter of conciseness and precision. The introductory chapter presents clearly and with evident impartiality the advantages as well as the disadvantages of the method, and gives a brief sketch of the theoretical development of the subject. This is followed by a chapter on the instruments needed in the accurate working-out of the method; after which follow in order chapters on graph-arithmetic, graph-algebra, graph-trigonometry and mensuration, combined multiplication and summation, moments of parallel vectors, vector and rotor addition, locor addition and moments of locors and of rotors, the kinematics of mechanisms, flat static structures without beam links, flat static structures containing beam links, and solid static structures. The diagrams in the accompanying atlas are neatly engraved, and clearly printed on heavy plate paper.

AMONG THE PUBLISHERS.

THE issue of *Harper's Weekly* for April 26 devotes considerable space to the Stanley-Emin relief expedition. The article, which is copiously illustrated, gives the whole history of the expedition.

— A cheap edition, limited to a hundred thousand copies, of "Tom Brown's School-Days," is announced by Macmillan & Co., uniform in style with their paper-covered editions of Charles Kingsley's novels, of which something over a million copies have been sold in the past six months.

— One of the literary sensations of the winter in Paris was Camille Flammarion's astronomical romance, "Uranie," of which the Cassell Publishing Company are the American publishers. Up to the present time, M. Flammarion has been known as an astronomer, but now he has become a popular romancer. Mrs. Mary J. Serrano, translator of "Marie Bashkirtseff: The Journal of a Young Artist," has put M. Flammarion's French into English.

— In *Garden and Forest* for last week, Mr. H. H. Hunnewell, whose gardens at Wellesley, Mass., have been famous for a generation throughout the country, writes of rhododendrons and their culture; Professor Greene continues his notes on the shrubs of California; and the concluding portion of the review of Dr. Mayr's great work on the forests of North America is given. "The Woods in Spring," "Wild Plants under Cultivation," and "Hardy Plants for Cut Flowers," are titles of other articles. A road in Sherwood Forest is the subject of one illustration, and there is also a picture of a giant *Cattleya*.

—Messrs. Ginn & Co. announce as in press "Political Science and Comparative Constitutional Law" (two volumes), by J. W. Burgess, professor of constitutional and international law and history in Columbia College. In these two volumes Professor Burgess sets forth the general principles of modern political science and constitutional law. The State, as sovereign organization of the Nation, is sharply distinguished from the government. Government, to the author, is but one of the means through which the State attains its ends. The other means is liberty. The first volume treats of the Nation and the State as concepts of