Progressive Lightning.

DR. N. ERNEST DORSEY (*Jour. Franklin Inst.*, 201, pp. 485-496, April 1926) in America, and Dr. G. C. Simpson (*Proc. Roy. Soc.*, A, vol. 111, No. 757, May 1926) in England, have recently published papers in which they have discussed from theoretical considerations the start and progress of a lightning flash, and in a recent number of NATURE (August 7, p. 190) these two authors discuss the question again, and even if they do not arrive at opposite conclusions they, nevertheless, are not by any means in accord.

So long ago as 1900 I made some apparatus with a view to obtain by experimental means, if possible, some evidence as to the progressive character of the lightning flash; but before dealing with this I think it well to refer the two authors to a paper by Dr. H. H. Hoffert (*Proc. Phys. Soc.*, 10, 1890, pp. 176-179) which appears to me to bear on the subject, and which I think they have overlooked. Dr. Hoffert desired to test an assertion which I had made in a discussion on a paper by Mr. Whipple (NATURE, May 16, p. 71, 1889), to the effect that very often the lightning flash was multiple; two, three, or many more succeeding one another very rapidly along exactly the same path, which I thought was obvious to every one, but the truth of which, nevertheless, was not readily accepted. He therefore exposed a camera during a very heavy thunderstorm in the direction in which the frequent flashes were seen, and kept it waggling rapidly to and fro. So far as he knew, he exposed the plate to a single flash only. In the first place he obtained a triple photograph of the flash he had seen, the three images being widely separated. They are all identical in form, bearing out fully what I had said, but the photograph showed much more than this, and it is these other points that bear, so I think, on the later theoretical discussion. I have three prints which Dr. Hoffert gave me at the time, which are entirely untouched.

The print accompanying the paper is exceedingly faithful and true for the purpose of illustration, and there is a skeleton diagram with reference to which Dr. Hoffert gave a very full discussion of all that is shown. The point of greatest interest in connexion with the controversy above mentioned is the almost certain conclusion that a flash within the cloud and terminating (or starting ? C.V.B.) at a point from which the main flash started preceded this by a very evident interval. The other point of interest is that this region remained luminous all that time and until the third main flash had occurred; also that the more marked angles in the main flash, which may have been foreshortened portions directed towards the camera, also remained luminous in the intervals between the three main flashes. These were more in the upper part of the flash from which branches directed towards the ground emanated, and the branches were far more conspicuous in the first of the three main flashes. The lower part was devoid of branches and of continuous luminosity. Reproduced herewith is one of Dr. Hoffert's prints (Fig. 1), but I doubt if the more delicate features can be reproduced. It would be better added to Dr. Simpson's collection if it interests him.

Before describing my apparatus of 1890 I should like to refer to an observation which I made about the year 1876, as in a life's observation of lightning the phenomenon then accompanying every flash is one which I have seen on no other occasion. It may have some bearing on the conclusions of the two authors. A storm one evening in the autumn had passed directly over the village of Wing in Rutland and moved away to the north, leaving a clear starlit sky above the thundercloud, with the stars of the Great Bear in their lowest position far above. When the storm was distant about ten miles and more, for every flash seen in the rain cloud and below, and simultaneous with it, there were one or more very slender flashes of typical lightning form from the cloud upwards and many times as long as the usual kind of lightning below. According to my recollection, these reached one-third or perhaps half-way towards the stars of the Great Bear, and in one instance there were seven of these flashes going simultaneously into the clear sky.

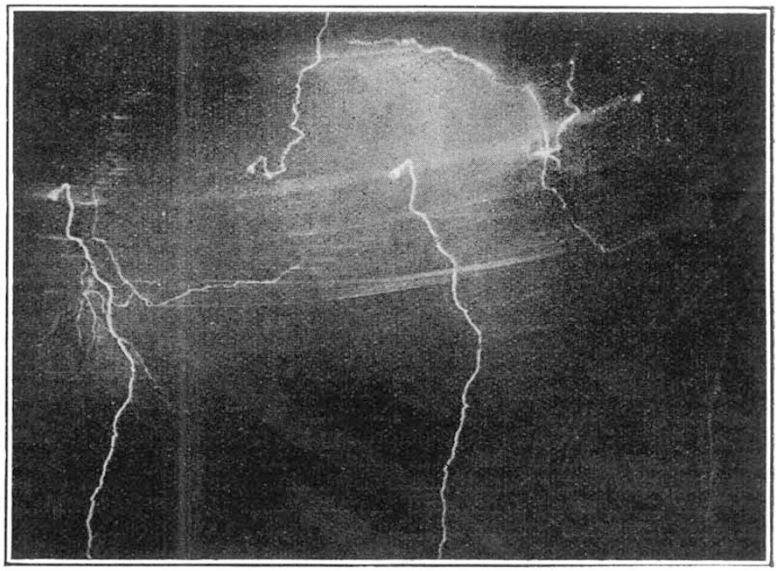

FIG. 1.

Coming now to the year 1900, I wished to obtain some experimental evidence, if possible, of the progress of the lightning flash. The impression that there is a downward direction in a flash is very common, and occasionally observers believe one has an upward direction. Without paying too much attention to impressions of this kind, and yet not ignoring them altogether, I desired to make a conclusive test, and to get any information possible as to the beginning or to the progressive character of the flash. The scheme was to use a pair of identical camera lenses (specially selected for stereoscopic photography) and to mount these on a disc which could be rotated by hand through gearing at any desired speed. In the apparatus I then made I could drive them at any speed up to about forty turns a second. The lenses were four inches apart, centre to centre; the two images of a lightning flash would then be carried in opposite directions at any speed up to about forty feet per second, and if the flash in each part of its length should be 'instantaneous' a difference in time between the two ends of the flash of about $\frac{1}{4000}$ second would be observable. If, for example,

the flash were a vertical line and the lenses at the moment were one above the other, one image would be tilted in one direction while the other would be tilted in the other direction, and the more so the greater the duration. If the lightning were not at any part 'instantaneous,' by which I mean if it lasted long enough for its image to be broadened —that is, $\frac{1}{4000}$ second or more—the two images would fade away, but on opposite sides, and the sharp side would still be available for comparison. If the lenses should happen to be on the same level, then one image would be lengthened and the other shortened, and measurements between well-defined kinks would show this. Similarly for other positions of the lenses there should be both tilting in opposite directions and change of length. If the duration of the illumination at each point in the flash should be sufficiently short the stereoscopic method of observation seemed to promise to be most convenient. For this purpose it would be necessary to cut a print, taken from the 10 × 8 backed plate used to receive the images, into two parts, and to slide the two parts so as to bring the two images to stereoscopic distance, and so that the motion due to the lenses was parallel to the line joining the eyes. If then they were maintained strictly parallel to their former positions, the effect of the movement due to the lenses, if apparent, would be to make the stereoscopic image appear to leave the plane of the paper; and owing to the extreme delicacy of the stereoscopic sense, this might be as valuable a test as a micrometric one and much more convenient.

I made this apparatus in 1900, and carried it about with me, for example, to the British Association meeting at Glasgow the following year, and only once obtained a moderately good view of a few flashes, but the developed plates showed nothing at all! Though I have had this now for twenty-six years, I still have not succeeded in obtaining any photograph. It had been my intention to go on until I did get a result before describing the method, but as I now have no window in London with a good sky view, and in my present house at St. Marybourne in Hampshire, while I have all the sky there is, I have no 'compact' storms such as we so often have in London. For twelve years I have not seen a storm in which the lightning is fairly frequent and in one direction, which is what I mean by 'compact,' and therefore if any results of interest are ever to be obtained in this way they must be by some one else. If Dr. Simpson thinks the method worth following, the apparatus with the 10 × 8 double back, which it is made to take, is freely at his disposal.

In the case of a multiple flash on the same track the different pairs of images would be at altogether different azimuths, and the wheel of lenses might well have made more than one turn between each. They would therefore in no way clash when examined. There might, however, be a marked difference between the first and succeeding flashes if the first showed any sign of progressive character due to the operations discussed by Drs. Dorsey and Simpson. The first flash has certainly left the whole track conducting, and succeeding flashes therefore might well fail to show any such progression.

There is one more experiment which I have wished to make with this apparatus. This is to fire a rocket towards or into a thundercloud when it is getting ripe for another flash. The ordinary display rocket would do perhaps, especially if its head were removed and its stick lightened. I should, however, prefer to make suitable rockets on purpose with perhaps an extra calibre of composition over the spindle and no head. Such a rocket would go at an immense speed to twice the usual height if undisturbed by lightning on the way, leaving a conducting trail of potash smoke and ions of every kind. A six-oz. rocket ($\frac{7}{8}$ inch) or a half-pound (1 inch) would be the most convenient to use. The pound rocket ($1\frac{1}{4}$ inch) is more difficult to make, but it would be very persuasive, while a 3 lb. rocket ($1\frac{3}{4}$ inch), the largest within my experience, is too much of an undertaking and too dangerous in its descent to be lightly selected.

If a photograph were obtained with the revolving lenses of a flash striking a rocket a good way up, the rocket itself might be expected to be the place of origin of the flash, and this position would be obvious on the plate, as below this the lightning would no doubt follow the rocket trail.

Rocket-directed lightning also would be good for spectrum examination, as a prismatic camera could be employed with certainty as to time and direction. There might be some indication of potassium in the spectrum below the rocket, and a great splash of potassium at that place if the lightning got inside and fired the remaining charge all at once.

To fire such a rocket, the only safe plan would be to pull a string lying on the ground and leading to a striker at the rocket. No slow match would work at the desired instant, and electric communication by wire would be too dangerous. I am unable to make the rocket experiment as I am in a village of thatched houses.

C. V. BOYS.

The Detection of Icebergs.

THOUGH navigation in iceberg-infested waters has been recognised from early times to be fraught with special dangers, it is only comparatively recently that attempts have been made to apply scientific methods to the detection of these floating dangers to navigation. Early whalers and explorers in Arctic and Antarctic waters met and surmounted these dangers without such assistance, but the present circumstances of sea travel in waters occasionally subject to invasion by icebergs are so different as to render special precautions necessary. Some of these circumstances are the increasing size and speed of passenger vessels, the replacement of wooden hulls by steel, and the need, in the face of competition from rival steamship companies, to complete the voyages within scheduled times. The small ice 'growler,' floating almost submerged, is not only the most difficult to detect, but is also almost as dangerous an obstruction to modern steel ships as the iceberg of large dimensions, which is likely to be more readily perceived even in a fog.

The apprehension of the need for early warning of the approach of the ice has been especially lively since the *Titanic* disaster in 1912. This disaster led directly to the formation of the International Ice Patrol, which now maintains a continuous patrol during the ice season in the dangerous area of the North Atlantic. This organisation is maintained by the United States, the countries chiefly concerned contributing to the cost in proportion to their shipping tonnage. At present the chief duties of the Ice Patrol are: The continuous location of ice endangering the shipping lanes, and dissemination of relevant information to vessels approaching the danger area; oceanographical