turbance of the potential gradient, associated with 17 storms which passed over the station, preceded the first rain (taken as indicating the arrival of the storm) by periods ranging from 3 to 109 minutes and averaging 46 minutes. In 6 cases the rate of travel of the storm was known, the average being 33 km. per hour, yielding an average distance at the time of the first disturbance of the gradient of 33 km. Of the storms which passed at a distance from the station, some were associated with rain at the station and others not. Of the former, the first disturbance of the gradient preceded the rain by intervals ranging from 0 to 42 minutes. From the forecasting point of view, however, the first disturbance of the gradient by a thunderstorm can not be distinguished from disturbances due to minor causes. The author goes on to consider the time at which the gradient has reached a certain value as a criterion of the approach of a storm and reaches the conclusion that it is within the bounds of possibility to receive a warning of half an hour to one hour by observations of the potential gradient considered in relation to its normal course. This warning will usually precede the first thunder heard. The instruments used at Leipzig are described, and the mean diurnal variation of potential gradient for each month and the seasonal variation for the period Jan., 1913, to July, 1914, are included in the paper.—*M. A. G.*

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INVESTIGATIONS ON LIGHTNING DISCHARGES AND ON THE ELECTRIC FIELD OF THUNDERSTORMS.[1]

By C. T. R. Wilson.

[Abstract of discussion at the Meteorological Office, London, by G. C. Simpson, Nov. 29, 1920; reprinted from *The Meteorological Magazine*, London, March, 1921, pp. 242-243.]

Mr. Wilson has invented very ingenious apparatus by which rapid changes in electric force near the ground are recorded, and he has obtained records which show how the electric field varies during a thunderstorm. Between two lightning flashes the change in the force is gradual, an asymptotic approach toward a limit, but when a flash occurs there is a sudden change in the field. In the flash equal positive and negative charges run together and the electric moment which is proportional to the magnitude of these charges and their distance apart can be estimated from the record. It is found that the charges are of the order of 20 coulombs. According to Mr. Wilson, the clouds may carry either negative charges above and positive below or positive above and negative below. Dr. Simpson demonstrated, however, that the new evidence was consistent with his own theory, according to which the electrification, being due to the breaking up of drops, was always negative above and positive below. He criticised with some severity an extension of Wilson's theory which purported to explain the normal fine-weather potential gradient as a by-product of thunderstorms.

In the subsequent discussion Dr. Chree explained the bearing of these researches on the growth of crops under electric stimulus. Sir Napier Shaw emphasized the desirability of obtaining simultaneous records from three or more stations during the progress of a storm.

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LIGHTNING EXPLODES TREE AND DIGS TRENCHES.

On the night of December 20th, at 7:30 p. m., a thunderstorm came up from the southwest, with occasional thunder about 7:45 p. m. A vivid flash of lightning lighted up the darkness about as much as a brilliant light in a room.

A fraction of a second after the first thunderclap an explosion took place in my telephone. The report was equal to that of firing a shotgun in the room with a charge of three drachms of powder. I immediately investigated the telephone and a strong odor as of burning powder was escaping from it. I could see no damage to the phone, but it failed to operate.

On the morning after the storm I went out to look along the telephone line. Sixty-four rods west of the house I found that a tree had been struck by lightning 100 feet north of the telephone line.

The tree was about 15 or 20 inches in diameter at the ground and about 50 feet high, as near as I could estimate its height. The entire body of the tree was riven into pieces and none of it left near the place where it had been standing. About 18 feet of the top with many branches intact lay immediately over the place where the tree stood. What remained in the ground was torn

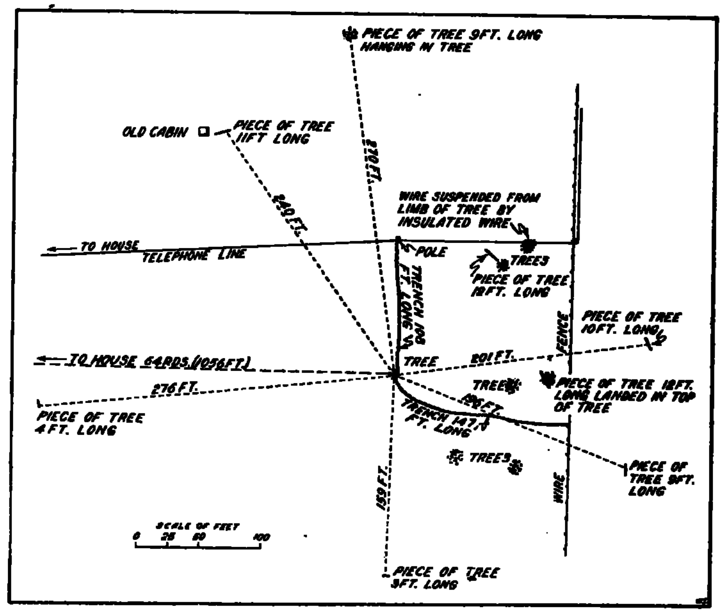

Fig. 1.—Lightning-stroke dispersion of tree-splinters and course of root trenches. (A. F. Stevens, Gravette, Ark.)

off at the surface of the ground, but was riven and shivered into slivers.

The telephone pole 100 feet south of the tree was shorn off at the top of the ground and lay some 50 feet southwest of its original position, riven into slivers.

But what surprised me most after looking over the area over which the body (of the tree) lay strewn was what I have marked "trenches" on the rude plat I am inclosing. [Fig. 1.] These start at the stump of the tree and run in directions indicated by solid lines and marked "trench." The one running south is 108 feet long, a little longer than a direct line from the stump to the telephone pole and ends abruptly at the pole with but little disturbance of the earth on the south side of the pole. What I call trench is not a clean dug trench. In places there have apparently been explosions that have thrown out much dirt; again it was heaved up like the dirt along where a mole has heaved up a runway. Some places it is widely cracked open along the middle of that portion of the earth that lies highest or is raised highest. It runs in a sinuous line as I have tried to draw it. The other trench is 147 feet long, starts out from the stump in a northerly direction, then curves to the left and takes

[1] Phil. trans. Roy. Soc. London, 1920, Ser. A, 221 : 73-115.