tions meteorologists can do nothing better than to secure for the whole earth the longest and most homogeneous series of observations possible.—*C. A.*

A POSSIBLE CASE OF BALL LIGHTNING.

By WILLIAM H. ALEXANDER, Local Forecaster. Dated Burlington, Vt., August 13, 1907.

During the month of July, 1907, the weather in the Champlain Valley, if not in the entire State of Vermont, was characterized by several interesting (not to say abnormal) features. Perhaps the most prominent feature was the large number of violent, and in many cases destructive, thunderstorms that occurred. A considerable number of lives was lost and much valuable property destroyed by lightning. Without doubt one of the most singular, certainly one of the most unusual, electrical phenomena known to the writer occurred at Burlington on the 2d, incident to the passage of a barometric depression from the Lake region to the lower St. Lawrence Valley during the last days of June and the first days of July. The distinctive feature of this storm was the single peal of thunder or explosion attended by what is believed to have been a case of "ball" or "globe" lightning. The "explosion" was so sudden, so unexpected, and so terrific that it startled practically the entire city, and there was a general, spontaneous rush to the window or street to see what had happened.

Effort has been made to obtain from eyewitnesses all observed details of importance relative to the phenomenon, but it appears that altho all heard the sound only a few actually saw anything. Fortunately, however, there were competent and reliable witnesses whose statements are given below in their own words.

Bishop John S. Michaud says:

I was standing on the corner of Church and College streets just in front of the Howard Bank and facing east, engaged in conversation with Ex-Governor Woodbury and Mr. A. A. Buell, when, without the slightest indication or warning, we were startled by what sounded like a most unusual and terrific explosion, evidently very near by. Raising my eyes and looking eastward along College street, I observed a torpedo-shaped body some 300 feet away, stationary in appearance and suspended in the air about 50 feet above the tops of the buildings. In size, it was about 6 feet long by 8 inches in diameter, the shell or cover having a dark appearance, with here and there tongues of fire issuing from spots on the surface resembling red-hot unburnished copper. Altho stationary when first noticed this object soon began to move, rather slowly, and disappeared over Dolan Brothers' store, southward. As it moved, the covering seemed rupturing in places and thru these the intensely red flames issued. My first impression was that it was some explosive shot from the upper portion of the Hall furniture store. When first seen it was surrounded by a halo of dim light, some 20 feet in diameter. There was no odor that I am aware of perceptible after the disappearance of the phenomenon, nor was there any damage done so far as known to me. Altho the sky was entirely clear overhead, there was an angry-looking cumulo-nimbus cloud approaching from the northwest; otherwise there was absolutely nothing to lead us to expect anything so remarkable. And, strange to say, altho the downpour of rain following this phenomenon, perhaps twenty minutes later, lasted at least half an hour, there was no indication of any other flash of lightning or sound of thunder.

Four weeks have past since the occurrence of this event, but the picture of that scene and the terrific concussion caused by it are vividly before me, while the crashing sound still rings in my ears. I hope I may never hear or see a similar phenomenon, at least at such close range.

Mr. Alvaro Adsit says:

I was standing in my store door facing the north; my attention was attracted by this "ball of fire" apparently descending toward a point on the opposite side of the street in front of the Hall furniture store; when within 18 or 20 feet of the ground the ball exploded with a deafening sound; the ball, before the explosion, was apparently 8 or 10 inches in diameter; the halo of light resulting from the explosion was 8 or 10 feet in diameter; the light had a yellowish tinge, somewhat like a candle light; no noise or sound was heard before or after the explosion; no damage was done so far as known to me.

Mr. W. P. Dodds (who was on the south side of the street, in the office of the Equitable Life Insurance Co.) says:

I saw the "ball" just before the explosion; it was moving apparently from the northwest (over the Howard Bank Building) and gradually descending; did not see it at the moment of the explosion, or afterward; no damage resulted so far as known to me.

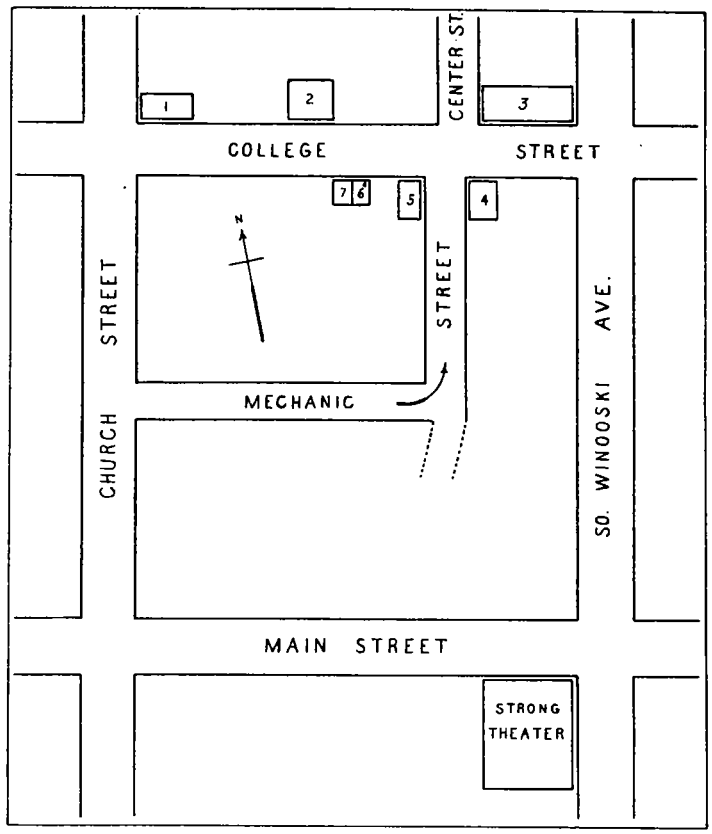

FIG. 1.—Plan of small section of Burlington, Vt., drawn (not to exact scale) to show roughly the several places mentioned in connection with the electric phenomenon of July 2, 1907. 1. Howard National Bank. 2. National Biscuit Company. 3. Hall's Furniture Company. 4. Ferguson & Adsit's store. 5. Dolan Brothers. 6. Equitable Life Insurance Company. 7. Standard Coal and Ice Company.

The following account is taken from the Burlington Daily Free Press of July 3, 1907:

A forerunner to one of the series of heavy and frequent thunderstorms that have characterized the early summer in this vicinity startled Burlingtonians yesterday just before noon. Without any preliminary disturbance of the atmosphere, there was a sharp report, the like of which is seldom heard. It was much louder in the business section of the city than elsewhere, and particularly in the vicinity of Church and College streets. People rushed to the street or to windows to learn what had happened, and when a horse was seen flat in the street in front of the Standard Coal and Ice Company's office it was the general impression that the animal had been struck by lightning and killed. This theory was not long entertained, as the horse was soon struggling to regain his feet. * * *

Ex-Governor Woodbury and Bishop Michaud were standing on the corner of Church and College streets in conversation when the report startled them. In talking with a Free Press man later in the day Governor Woodbury said his first thought was that an explosion had occurred somewhere in the immediate vicinity, and he turned, expecting to see bricks flying thru the air. Bishop Michaud was facing the east and saw a ball of fire rushing thru the air, apparently just east of the National Biscuit Company's building. Alvaro Adsit also saw the ball of fire, as did a young man who was looking out of a window in the Strong Theater Building. Another man with a vivid imagination declared that the ball struck the center of College street near the Standard Coal and Ice Company's office, knocked the horse down by the jar and then bounded up again to some undefined point in the sky. * * * The unusual disturbance was followed in a few minutes by a downpour of rain, which continued, with brief interruption, for nearly two hours.

Another described the sound as "like the tearing of new cambric". All agree that it was the most startling phenomenon of the kind ever experienced, because so unexpected.[1] The "explosion" was followed in a few minutes by a heavy

[1] This "ball of fire" may have been a distant meteor, and it will be worth while to seek for observations by distant observers about noon, Tuesday, July 2, 1907.—EDITOR.

downpour of rain, 1 inch falling in 35 minutes between 12:10 p. m. and 12:45 p. m.

Fig. 1 is a rough plan of a small section of the city of Burlington, and shows the streets, buildings, and stores mentioned by the eyewitnesses; this section is nearly a mile west-northwest of the local office of the Weather Bureau.

STUDIES ON THE PHENOMENA OF THE EVAPORATION OF WATER OVER LAKES AND RESERVOIRS.

By PROF. FRANK H. BIGELOW. Dated June 20, 1907.

I—THE PROPOSED STUDY ON THE PROBLEMS OF EVAPORATION AT THE SALTON SEA, SOUTHERN CALIFORNIA.

The Salton Sea in May, 1907, consisted of a sheet of fresh water, 45 miles long and about 10 or 15 miles wide, containing 440 square miles of surface area, 205 feet below the mean tide level of the Pacific Ocean. This body of water has recently been formed by overflow from the Colorado River and has been protected from further inflow; it will probably dry out in ten or twelve years, so that an unusually fine example of evaporation on a large scale in that arid climate is offered for study. Mr. G. K. Gilbert, of the U. S. Geological Survey, proposed that a preliminary examination be made of the shores of the lake, to see whether the surface inflow and underground seepage can be measured. Subsequently, after several conferences between the representatives of the U. S. Geological Survey, the U. S. Reclamation Service, and the U. S. Weather Bureau, a Board of Conference was sent to the Salton Basin in May, to examine in detail the feasibility of undertaking a campaign on evaporation. A few extracts from reports are here given in order to show that suitable action has been taken to inaugurate such a study of the problems of evaporation on the large scale presented by the drying out of the Salton Sea.

Mr. M. O. Leighton, Chief Hydrographer of the U. S. Geological Survey writes as follows:

(A) NOTES ON THE PRACTICAL VALUE OF INVESTIGATIONS OF EVAPORATION.

Great water supplies in the arid regions must in nearly all cases be the result of conservation of flood waters. This makes it necessary that these waters be stored for long periods in reservoirs with an enormous surface exposure. Such conditions are ideal, especially in hot countries, for maximum loss by evaporation. Loss of water in the arid regions is always a serious factor. It may mean a loss of productivity over large areas of country. It, therefore, becomes a practical question, the importance of which can hardly be overestimated.

In planning reservoirs for the conservation of water, the capacity of the reservoir controls its usefulness; that is, a reservoir of a certain capacity will supply water sufficient to irrigate a certain acreage, to provide municipal supply to a certain population, or to guarantee a certain minimum amount of power. In determining these duties it is obviously necessary to take into account the losses arising during storage. Therefore, in designing a water supply system of whatever kind, it is necessary to deduct from the amount of water available for storage a certain percentage resulting from loss by evaporation. This would be simple if there were at hand any reliable method for computing such losses. Attempts have been made, but it is apparent that the factors secured are erroneous. Therefore it is of the utmost importance to all water supply installation to have the rate of evaporation under fixt and variable conditions determined. A few practical illustrations: It has been estimated that the evaporation in southern Arizona is equivalent to about 6 feet per year. Whether or not this is true we do not know. Assuming, however, that the figure is a fair approximation, the amount of water lost from the Roosevelt Reservoir, surface extent, 16,320 acres, will be 97,920 acre-feet, sufficient to irrigate 48,960 acres, assuming a duty of water equivalent to 24 inches per annum. The same computations may be made with respect to all the great reservoirs in the arid West. It will, therefore, be seen that in computing the area to be reclaimed under the Roosevelt Reservoir it was necessary to deduct nearly 50,000 acres from that which might have been reclaimed had it not been for evaporation. The Sweetwater and Otay reservoirs in the San Diego region in southern California have never performed the duty that was expected of them. Indeed, during the greater part of the time since they were constructed they have been empty or only partially filled. The evaporation from these reservoirs is enormous, and it is highly probable that had there been any worthy information concerning the rate of evaporation at these points it would have been appreciated that the drainage areas would not provide for actual use an amount of water equivalent to the storage installation. In other words, the plans would have been entirely changed and a large amount of money would have been saved.

The above constitute two typical instances of the practical importance of determining all the factors connected with evaporation. If the facts were known, the engineering profession would probably change its ideas with reference to economic depth of water stored, and shallow areas within reservoirs at which it is assumed that evaporation may be greatest would be avoided. If the effects of winds were known, ideas with reference to the proper location of reservoirs would probably be changed, and there would be some useful study and experimentation with reference to the effect of windbreaks, etc. In fact, we can only generalize about the matter, even as it is necessary to generalize with reference to the methods of evaporation study. Each reservoir in the west is subject to great loss. We do not know how much, but it is apparent that did we know subsequent work of this character would be more intelligently carried on.

Appendix B of the report of the Conference Board is given in full as follows (see Chart IX):

(B) MEMORANDUM ON THE IMPORTANCE OF THE PROPOSED INVESTIGATION OF EVAPORATION IN THE SALTON BASIN.

Past and future history of the Salton Sea.

Salton Basin, in the extreme southeastern part of California, is a depression below the level of the sea, its lowest point being 287 feet below mean tide. The basin is separated from the Gulf of California by the delta of the Colorado River. In past time the river has flowed alternately to the gulf and to the basin. Four years ago all the water of the river flowed to the Gulf of California, and the basin was dry. A canal made for irrigation purposes, leading water from the river toward the Salton Basin, became enlarged in time of flood and past beyond control, so that after a few months the entire river discharged to the basin. For more than a year it flowed in that direction, and it was finally brought under control only after strenuous effort. The river has now been returned to its former channel and discharges to the Gulf of California, excepting a small portion employed for irrigation in the Imperial Valley—"Imperial Valley" being the name given to that part of the river delta which slopes toward the Salton Basin.

While the river flowed into the Salton Basin it gradually flooded the lower part of the basin so that now there is a lake or sea about 80 feet deep with a surface area of 440 square miles. As important interests are involved, it may be assumed that the river will be restrained from again invading the basin and that the lake which now exists will gradually dry away, its dissipation requiring between ten and fifteen years.

Need for investigation of evaporation.

In the construction of reservoirs, for whatever purpose, it is necessary to make allowance for evaporation in order to determine in advance what will be the available supply of water. In the work of the Reclamation Service the allowance for evaporation is often very large and affects the plans and estimates of cost in important ways. It is always a factor to be considered in estimating the available supply obtainable from a reservoir of known capacity, and is likewise a factor used in determining the height of a dam of greatest storage efficiency. The exposure of an unnecessarily large area behind a dam of too great height may result in excessive wastage of the supply. Moreover, an inadequate allowance for loss by evaporation from the reservoir surface leads to erroneous assumptions concerning the water which can be made available for useful purposes.

Unfortunately the rates of evaporation for different climates are not well known, so that at present it is impossible to make estimates with desirable precision. It is known that the rate of evaporation in any locality depends on certain factors, namely, the temperature of the air and water, the dryness of the air, and the velocity of the wind; but the nature of the law or formula connecting the evaporation with these factors is not known. Various attempts have been made to determine it, but the results are so discordant that little confidence is felt in any of them. It is known also that a formula for evaporation derived from experiments with a small water surface—such as that afforded by a tank, for example—can not be applied directly to the computation of the evaporation from a reservoir or lake, because the larger bodies are differently affected by the wind. As the air moves across a reservoir and gradually becomes charged with moisture its rate of absorption diminishes, and the average rate of evaporation from a broad surface is therefore less than from a small surface. For this reason the formula for evaporation can not be put on a sound basis without taking account of large water surfaces as well as small. Attempts to measure evaporation from lakes and reservoirs have heretofore been hampered by the difficulty of accurately measuring inflow and outflow so as to discriminate the various factors determining changes in the level of the water surface.

Availability of the Salton Sea.

The conditions afforded by the Salton Sea are peculiarly suitable for the investigation of the laws of evaporation. The amount of water flowing into it is small and can readily be measured. The rainfall is nominal in amount. No water flows out of it. The climate is so dry that the total evaporation in a year will probably amount to 6 or 8 feet. It is therefore possible to determine by gaging the actual rate of evaporation, and to make this determination with high precision. By making the gaging continuous, and by making simultaneous observations of the temperature, atmospheric humidity, wind, etc., the relations of evapo-