mal; the highest was 104°, at Covington on the 7th and 8th, and the lowest, 49°, at St. Joseph, on the 28th. The average precipitation was 1.75, or nearly 2.00 below normal; the greatest monthly amount, 7.63, occurred at Bristol, and the least, 0.07, at Fairmont.

Texas.—The mean temperature was 2.5° above the normal; there was a general excess except over the extreme western portion of the State, where it ranged from about normal to 0.8° below in the vicinity of El Paso. The excess in temperature ranged from 0.5° to 2.6° over the southwestern and the coast districts; from 2.9° to 3.4° over the central and eastern portions, and from 1.9° to 4.9° over the northern and Panhandle portions, with the greatest in the vicinity of Paris. Maximum temperature, 113°, observed at Panter, on the 2d, and 109° from self-recording thermometers, at Sulphur Springs on the 3d and 8th; minimum, 50°, at Dean on the 22d and 23d. The average precipitation for the State was 2.01 below the normal. There was a general deficiency throughout the State, ranging from 0.71 to 2.05 over the north, central, west, and southwest portions; from 1.49 to 2.34 over the Panhandle and eastern portions, and from 2.56 to 5.19 over the coast district, with the greatest in the vicinity of Galveston. The rainfall was generally light and not well distributed, there being very little during the first and second decades. The greatest monthly amount, 4.78, occurred at Fort Worth, while none fell at Point Isabel and Round Rock.

Utah.—The mean temperature was 69.7°, or about 5.0° below normal; the highest was 107°, at St. George on the 13th and 14th, and the lowest, 33°, at Soldier Summit on the 20th. The average precipitation was 1.04, or slightly above normal; the greatest monthly amount, 3.00, occurred at Parowan, and the least, 0.05, at Park City.

Virginia.—The mean temperature was 75.7°, or 0.7° above normal; the highest was 105°, at Nottoway Courthouse, and the lowest, 32°, at Guinea on the 20th. The average precipitation was 2.78, or about 0.80 below normal; the greatest monthly amount, 7.63, occurred at Bristol, and the least, 0.10, at Birdsnest. The thermal conditions for the month of August were noteworthy. Opening with means about normal, the temperature rose steadily, holding from 2° to 10° above the average and yielding maximums each day ranging between 90° and 105° from the 3d to the 16th. This phenomenal heat was accentuated by a most oppressive and debilitating sultriness, general absence of cloudiness and rainfall, and burning southerly winds. As a result, sunstrokes and heat prostrations were numerous and crops of all kinds suffered severely, cotton, peanuts, tobacco, late corn, and pastures, especially.

Washington.—The mean temperature was 65.3°, or 0.3° above normal; the highest was 104°, at Fort Simcoe on the 13th, and the lowest, 20°, at Cascade Tunnel on the 19th and 20th. The average precipitation was 0.85, or 0.24 above normal; the greatest monthly amount, 2.48, occurred at Tatoosh Island, and the least, 0.09, at Cascade Tunnel.

West Virginia.—The mean temperature was 72.4°, or slightly above normal; the highest was 97°, at Parkersburg on the 10th, and the lowest, 40°, at White Sulphur Springs on the 20th and Bloomery on the 29th. The average precipitation was 2.82, or 1.25 below normal; the greatest monthly amount, 5.69, occurred at Bluefield, and the least, 0.88, at Harpers Ferry.

Wisconsin.—The mean temperature was 69.0°, or 0.6° above normal; the highest was 102°, at Osceola Mills on the 4th, and the lowest, 31°, at Florence on the 19th and at Keopenick on the 24th. The average precipitation was 2.50, or 0.22 above normal; the greatest monthly amount, 6.32, occurred at Antigo, and the least, 0.75, at Gratiot.

Wyoming.—The mean temperature was 65.8°; the highest was 101°, at Fort Laramie on the 3d and Wheatland on the 14th, and the lowest, 25°, at Wheatland on the 26th. The average precipitation was 0.90; the greatest monthly amount, 2.52, occurred at Cheyenne, and the least, "trace," at Sheridan.

SPECIAL CONTRIBUTIONS.

EXPERIMENTS WITH KITES AT SAN FRANCISCO, CAL.

By W. H. HAMMON, Forecast Official (dated Sept. 19, 1896).

As early as February, 1896, Mr. Alexander McAdie began experiments at this station in flying kites for scientific purposes. With the aid of the San Francisco Examiner a team of over forty kites of the Eddy pattern were constructed. With the exception of two, of 9 feet beam, they were all of uniform size—68 by 60 inches. On February 19, 1896, the kites were taken to the summit of Mount Tamalpais, a small peak of 2,600 feet elevation, about 13 miles from the city, but the wind was too light to float the kites.

On February 22 the attempt was made to fly them from Sutro Heights, a bluff on the San Francisco side of the Golden Gate. Eighteen kites were let out in tandem, when the cord broke and the kites were lost. A dense fog afterward obscured the sky and prevented further experiments. However, it is believed that this is the largest team of kites ever flown in tandem. Early in March the writer, after having read vague descriptions of cellular kites, attempted to produce one. Having no knowledge of the methods of construction, one was made of somewhat elliptical or lune-shaped cells. The upper and lower surfaces of the cells were supported by light bamboo bows of about 90° arc, placed in the edges of the cells. Four of these bows attached at equal distances to the longitudinal ribs of the kite formed the frame for each surface. The kite was very efficient and light. One, 48 inches long and with 40-inch bows, containing nearly 18 square feet of area, weighed but 14 ounces when covered with No. 16 Irish hand linen paper. It could be flown to angles of from 45° to 70°, and remained very steady with winds from 7 to 22 miles per hour. With higher velocities the pressure of the wind upon the bows convex to the wind would distort the kite and cause it to dive. To prevent this, the bows of the lower side were extended beyond the ends of those forming the frame of the upper side of the cell. These ends were covered as well as the cell, thus forming wings to the kite.[1] The pressure of the wind against the kite caused the wings to bend backward; at the same time the two sides of the cells were spread farther apart. Thus the area of the kite normal to the wind was greatly reduced in winds of high velocity. This action tended to equalize the strain upon the string. The effective area of the kite would diminish about 40 per cent with an increase of wind velocity from 12 to 30 miles per hour. This effect was still further increased and the stability of the kite improved by the method adopted for attaching the string. Instead of using the usual bridle or bellyband, a stick was attached to the rear of the upper surface of the front cell and passed diagonally through the cell and allowed to extend from 16 to 18 inches below the lower surface. A flexible tube attached to the lower cell encased the stick, and to this tube the flying string of the kite was attached. As the upper and lower surfaces of the kite spread farther apart in high winds, the stick was withdrawn from the tube, thus shortening the bowsprit, which allowed the surfaces of the kite to become more nearly parallel to the wind. The bowsprit formed a rigid point of attachment for the string several inches in front of the surface of the kite, and also tended to increase its steadiness.

This kite has many advantages, but the continuous bending of the bows tends to loosen the joints which must be fastened by strings or wire, and the kite soon becomes less efficient. At the same time it is somewhat difficult to construct.

After reading the article by Prof. C. F. Marvin in the MONTHLY WEATHER REVIEW for November, 1895, experiments were made with the Hargrave and Potter designs of kites. It was found that with equal care in construction, kites of large size proved the more efficient. A slight inaccuracy in a long stick has less proportional effect than in a shorter one.

By the aid of an appropriation from the Weather Bureau, supplemented by a donation from the San Francisco Call, an attempt was made to fly a team of eight large cellular kites of three different patterns on July 4, 1896. Twenty-six pounds of piano wire was obtained (about 3½ miles in length). It was of sizes varying from .015 inch to .028 inch in diameter. It was made of pieces of from one-quarter to one pound each, joined together. The joints were made by sawing a deep

[1] See page 164 and Fig. 49, MONTHLY WEATHER REVIEW, for May, 1896.

groove in a piece of brass wire one-eighth of an inch in diameter and one inch long. The ends of the pieces to be spliced were twisted about one another, and were then laid in the groove and soldered. The joints were all tested to strains of from 50 to 150 pounds, the strain being proportioned to the probable pull of the kites. The size of the wire used was made commensurate to the strain that it was expected to stand, the larger wire being reserved for the lower end of the line which would be compelled to bear the combined pull of all the kites.

The kites were taken to Twin Peaks a hill 1,000 feet high west of the city. One of the kites was broken in transporting them. Several attempts were made to hoist them before noon, but while a wind of from 15 to 30 miles an hour prevailed near the surface, the kites would only rise 200 or 300 feet above the hill, when they would float away and downward, apparently upon the top of the current. During this time only very light winds prevailed over the comparative level surface of the city. It would seem that the draught of air from the west was concentrated over the top of the range of hills, of which Twin Peaks form a part, thus causing the wind to be high near their summits, but lighter at a small distance above; the hills evidently served the purpose of a dam in the current of air. By one o'clock the wind was blowing a gale of not less than 45 miles an hour near the surface, which wrecked every kite exposed to it. At the office in the city the maximum velocity measured was 28 miles. After breaking several kites in attempting to hoist them the remainder were loaded on the dray and brought back to the city, but all but one were broken either on the hill or while returning.

The experience of this trip convinced the writer that some more portable kite was essential. With this end in view, he has designed a kite of the Potter form in which the frame folds, making the sticks parallel and in contact. A kite of this character, 82 inches long, 62 inches wide, and 32 inches thick and of more than 40 square feet in area has been made. It can be spread in five minutes and folded in an equal time, its gross weight is 3 pounds 4 ounces. It has been flown six or eight times during the past two months, and in winds of from 10 to 25 miles per hour; while somewhat less rigid than the common frame, it has proved equally durable and efficient.

During the past two months we have flown kites on eight or ten occasions. Nearly every afternoon, in the summer time, a west wind of about 30 miles per hour prevails in San Francisco. In every instance the kites rose rapidly through this current, which seems to reach its maximum force (as evidenced by its pull on the wire) within 500 feet of the surface. At an elevation of from 800 to 2,500 feet the kites reach a stratum in which they refuse to rise. On July 29 three kites were let out in tandem, and all three floated off one behind the other at an elevation of about 2,000 feet. I think that a strong proof that this surface current has a depth of only 800 to 2,500 feet.

However, on August 28, with only moderate west winds (about 14 miles per hour) two kites were hoisted. After an elevation of about 1,000 feet was reached the kites began to drift more and more to the northward, the pilot kite being 10° to 12° north of the lower, this resulted in greatly increasing the angle made by the kites, which rose higher and higher. The winds were light, as shown by the strain on the string, but elevations of from 50° to 58° were made with from 3,800 to 4,600 feet of wire. Unfortunately there were but two serviceable kites at the station, which were unable to lift more than 6,656 feet of wire. The angle to the upper kite was then 33°, indicating an elevation of 3,650 feet above the roof of the office building from which the kites were flown, or 3,850 feet above the bay over which the kites were suspended. This is the greatest height we have attained.[1]

On the next day another hoist was made and the same south current was met at an elevation of 1,200 feet but it was lighter than on the day before. Only at times was it strong enough to lift the kites. The sky was pretty cloudy on both these days and on the earlier date the kites were frequently above the clouds which had an elevation of about 2,000 feet.

On the second day there was a very marked electrification of the air. Sparks one-third of an inch long could be taken from the wire without the use of a condenser and the escaping discharge would make an audible whistling noise when the connecting wire was 1½ inches from the ground connection. It is well to observe that on the following night (Saturday) and Sunday general rain fell throughout northern California, the heaviest August rain in many places of which we have a record.

In conclusion we would summarize the work performed at this station as follows:

First. A flight of eighteen kites in tandem by Mr. McAdie on February 22.

Second. Construction of a cellular kite which so adjusts itself as to render more nearly constant the lifting power of the kite and strain on the string in winds of varying velocity.

Third. Measurement of the altitude of the summer winds on many occasions.

Fourth. Construction of an efficient folding cellular kite of the Potter kind.

Fifth. We have certainly flown kites higher above the surface than has been accomplished by any other person west of the Mississippi River, and probably higher than the greatest ever attained by balloon or kite in this region.

Sixth. Discovered the existence of an unusual south wind above the surface current from the west on two days before the heaviest August rain in northern California, and an unusual electrification of the atmosphere on the day preceding the storm.

In all this work Mr. McAdie has rendered valuable assistance. The initial experiments were performed by him and, in all, he has given his hearty cooperation.

THE HEATED TERM FROM JULY 28 TO AUGUST 17, 1896.

By Prof. H. A. HAZEN.

During these three weeks the temperature remained abnormally high from the middle and lower Mississippi valley to the Atlantic Coast. In Missouri the temperature on each of these days was 7° to 8° above the normal and in the Middle Atlantic States it was 5° to 6° above. This term covered a larger region and gave abnormal heat on a larger number of consecutive days than ever before recorded. It can not be said that there were specially abnormal conditions in the atmosphere so far as shown by the high and low areas of pressure. During most of the period the air pressure remained high in the Gulf States and was accompanied by light variable winds and an almost stagnant air which was probably heated to great heights. The storms went far to the north and had little or no influence in modifying the conditions. The ground became very hot and there was less radiation to cool it during the period. It is also probable that the atmosphere was favorable to intense surface insolation because of some condition not well understood.

[1] On September 19, 1896, an elevation of 4,150 feet above roof and 4,350 feet above the bay was reached. The upper kite was for a large portion of the time lost in the clouds, which had an elevation of about 4,000 feet.