that the cloth may not be injured but that the sticks may weigh less and cut through the air with less resistance than if left with perfectly flat surfaces. This applies particularly to the struts, cleats, etc. When completed the kite should weigh about 16 ounces.

Finally, the kite can be made much more rigid by fitting it with a set of string or wire ties. These may be placed outside the cloth and should connect all the corners of the interior frame work.

To fly the kite.—Unless the wind is very strong the safest way to start the kite in flight is to run out 150 feet or so of twine while the kite is held by an assistant. When all is ready the assistant may toss the kite upward a little in the direction in which it is to go. It will take care of itself afterwards. It is important the kite be cast off directly in line with the wind, otherwise it may seem to dart badly. The object of this method is to get the kite quickly above the irregular and greatly disturbed air currents near the ground, and give the kite more room to dart about with less danger of striking anything until it gets into steady currents. When fairly up these kites may sweep a little from one side to the other, but if they ever dart or turn over, there is something radically wrong, probably due to an uneven distribution of the cloth surface, or some permanent distortion of the frame work. Sometimes the weight of the wood varies and one side is heavier than the other. This should be corrected by weighting the light side with a small strip of sheet lead, or otherwise.

If the wind is very light a finer twine may be used in flying, and it may be necessary to run a little with a long string out, in order to get the kite into upper and more rapidly moving currents.

When the wind is very strong drop the ball of twine on the ground so that the cord can pay out rapidly and let the kite go up directly and quickly from the hand.

Tandem kites.—Several kites can be sent up on the same line. When an additional kite is to be sent up it must be first carried out, say 100 feet attached to a separate line of this length, the end being tied to a loop formed in the main line. When all is ready the kite is tossed up as already described.

Fine wire is the only suitable material to be used for flying kites at the very greatest elevations. Steel piano-forte wire capable of sustaining over 200 pounds will weigh about half as much as hemp twine of the same strength. A still more important advantage, however, is the fineness of the wire, the diameter of which will be about one-fifth that of twine. The wind presses against the coarse twine with a seriously detrimental force, whereas the fine wire cuts through with but little resistance. The wire employed by the Weather Bureau is just about the thickness of an ordinary pin.

In Franklin's famous kite experiments, in which he drew lightning from the clouds, the wetted string became the conductor of the electricity, and, in recent experiments a fine copper wire was used with the kite string, the former conducting the current and the latter flying the kite. When wire alone is used the electrification is considerable at all times, and with two or three thousand feet of wire out, sparks an inch or more long may be drawn from the wire.

When recording meteorological instruments are sent up they are attached to the wire below the kites.

The proportions of the kite may be varied considerably without impairing its flying qualities, and the size can be changed to any extent.

FLUCTUATIONS OF THE WATER LEVEL IN THE GREAT LAKES.

By Ossian Guthrie, C. E., Chicago, Ill. (dated Feb. 14, 1896).

The unprecedented and long continued low stage of water in the lakes has been the occasion of much discussion, and to those interested, but unfamiliar with their irregular source of supply, has been the cause of much alarm; and added to this natural cause the proposition of Chicago to divert 600,000 cubic feet of water per minute through her drainage channel, now nearly completed, has greatly increased the popular anxiety.

I shall endeavor to show that neither the present low stage of water nor the proposition to divert 600,000 cubic feet of water per minute through the Chicago drainage canal need cause any serious alarm, but on the contrary, I shall encourage the hope that ultimately there will result a greatly improved condition of the lakes for navigation.

The same varieties of trees now growing in the Lake Region were growing soon after the close of the Glacial epoch; hence we conclude that no climatic change has taken place during the past several thousand years. If this conclusion is well founded, the rainfall will continue, and as the lakes are supplied entirely by the precipitation that falls upon the area of their basins, their levels will be maintained as heretofore. If the rainfall is heavy or light the stage of water in the lakes will be correspondingly high or low, as has invariably been the case heretofore, although as a rule the effect of increased or diminished precipitation has been seen the following year, but not always so. The year 1876 was one of heavy rainfall and of high stage of water. In the latter part of the year Lake Michigan reached 2.56 feet above datum. The maximum effect of a heavy snowfall after January 1, followed by early and heavy rainfall, would undoubtedly be seen the same year, while the same amount of precipitation in reversed order would not be seen until the following year.

The Chicago drainage channel diverting 600,000 cubic feet of water per minute [for a whole year] would reduce the level of Lakes Michigan and Huron a fraction less than 3 inches in a year, but the peculiar annual rise and fall of the lakes would reduce this effect by a large percentage, especially during the season of navigation. On an average these lakes are 14½ inches lower at the end of winter than in July. Now suppose the drainage channel had drawn their level 3 inches last year, the flood of next spring would flow directly into this void and restore the levels of last year instead of being wasted in an excessive spring outflow over Niagara Falls, and we would begin on the second year's drawing substantially where we began the first. But notwithstanding these arguments the public has become greatly excited, and the subject has been discussed as it never would have been under ordinary conditions, and consequently the fluctuations of the lakes, their source of supply, and their past and future history, are now better understood than ever before. We find upon investigation that a dam at the outlet of Lake Superior 5 inches high would hold back a supply for the Chicago drainage channel for a year, and that dams or controlling works can be constructed at the outlets of lakes Superior, Huron and Erie, which would not only maintain a nearly uniform stage of water throughout the season of navigation, but also nearly tide us over a short series of dry years with water which now goes to waste. As an illustration, the water power of the Merrimac River would be of little value without her artificial storage basins for flood water. This idea is by no means new, but public attention has been focused upon a prodigal waste of such magnitude that it has become a matter of national concern. Let me give you a few figures: The total basin area of the lakes contains about 230,000 square miles. In round numbers an acre is 209 feet square. There are 640 acres in a square mile, and upon each acre from 20,000 to 25,000 barrels of water annually fall.

The belief is quite common that the lakes rise and fall through a uniform series of seven years. This belief is absolutely without foundation. The fluctuntions are as irregular as the precipitation that falls upon their basins, and is their only source of supply.

In 1887 I had occasion to make a table showing the average precipitation upon the basins of Superior, Huron, and Michigan, for a period of about twenty years. This average I found to be 35.65 inches, and the average stage of Lake Michigan during the same period, 1.65 above datum. For the purposes of this article I have done the same thing for a series of eight years, 1888 to 1895, both included. The precipitation during this period averaged 30.44 inches. Lake Michigan fell from +2.64 feet in 1886, the end of a long wet period, to +1.96 in 1887, and to +1.30 in 1888, and finally to —0.5 foot in 1895. Further illustrations upon this point will be found in the following table, which shows the average level of the lake at Chicago for each year. The levels are referred to the adopted datum plane or low water of February and March, 1847.

Chicago datum was established in February or March, 1847, by Edward B. Talcott, chief engineer of the Illinois and Michigan Canal, and Alfred Guthrie (my father), designer and chief engineer of the Canal Pumping Works, which were to supply the summit level (30 miles) with water from the Chicago River (Lake Michigan). It was necessary to place the foundation of these works at a certain point below extreme low water. The unparalleled low stage then prevailing seemed to justify its adoption, and since then it has been the standard.

Many people, especially sailors, believe that the Great Lakes have subterranean sources of supply. This, it seems to me, is disproved by the fact that the lakes are lowest in winter and highest in summer, and always begin to rise as soon as the ice and snow melt in the spring.

Year.	Height.	Remarks.	Year.	Height.	Remarks.
1859	2.98		1879	1.06	Fall in 3 years, 1.50 feet.
1864	1.57	Fall in 5 years, 1.41 feet.	1880	1.26	Lakes continuously high
1865	1.30		1883	2.10	1880-1886, inclusive. Rainfall
1866	1.07	Fall in 7 years, 1.91 feet.	1886	2.64	46 inches in 1886.
1867	1.49		1889	0.77	Fall in 3 years, 1.87 feet.
1868	1.01	Fall in 9 years, 1.97 feet.	1890	0.63	
1869	1.13		1891	0.06	
1870	2.09	Rise in 2 years, 1.08 feet.	1892	—0.17	Fall in 6 years, 2.47 feet.
1872	0.81	Fall in 2 years, 1.28 feet.	1895	—0.50	
1876	2.56				

NOTES BY THE EDITOR.

THE CHEMICAL STORM GLASS.

In response to a request from one of our esteemed observers, the Editor would say that the "chemical storm glass," sometimes called "Fitzroy's weather glass," ought not to be considered as in any way a substitute for the mercurial or the aneroid barometer. Meteorologists cannot encourage the application of the word barometer to any instrument except such as measure the pressure or the changes in pressure of the atmosphere. If a hygrometer or a thermometer indicates the approach of a storm, that is no good reason for calling it a barometer.

As a general rule, in our country the temperature rises before a storm and falls afterwards, so also the wind changes, the clouds change, and the humidity rises. If, as an additional help in observing and predicting storms, the observer wishes to know something about the pressure of the air, he must get the genuine barometer and not the chemical storm glass. The substances in these storm glasses are made according to various recipes, some of which are the secrets of the makers (usually camphor and sal ammoniac dissolved in alcohol and water), but in all cases, so far as the Editor knows, the tubes are hermetically sealed and the changes that are apparent in the solution within them are due to the temperature of the solution and to the rate at which this temperature has been changing for a few hours before the observation. There may be cases in which the action of the daylight is appreciable. If any observer has recorded carefully the behavior of his chemical storm glass during a month or year, we shall be glad to have him investigate wherein its indications are better than those of his thermometer.

EVAPORATION.

The quantities of water added to the atmosphere daily by evaporation from the oceans and the continents constitute a fundamental consideration in meteorology; the quantities evaporated from cultivated fields, forests, and other forms of vegetation are equally important in agriculture, but as yet we have confessedly attained to only a very imperfect knowledge of this subject. Meteorologists have generally observed the amount evaporated from a small surface of water exposed either in the open air and sunshine, or else within such a shelter as is used for the open air thermometer; lately a disc of moist paper has been substituted for the surface of water, as in the Piche evaporometer. Agriculturists, on the other hand, have made use of the lysimeter, which consists of a deep metallic box buried in the earth and having its open upper side flush with the surface of the ground. This box is filled with soil in which plants may or may not be growing, according to the object of the investigator. Record is kept of the amount of water or rain that is added to the lysimeter box from day to day, and also of the amount of water that drains from the bottom of the box. The difference between the two is adopted as the natural evaporation from the soil. The soil in the box may be kept very wet, to imitate a morass, or very dry to imitate a desert; the fineness of the soil may vary from coarse gravel to the finest silt.

If we desire the actual amount evaporated into the atmosphere we must do more than record the results of the above forms of apparatus. The evaporating surface of water in the shaded thermometer shelter will indeed give up its moisture in proportion to the temperature of the water and to the velocity and dryness of the wind at its surface, but these three important factors have values so different out of doors from those within the shelter that such records can, at the best, only give us a crude idea of the actual evaporation from surfaces in the open air. A great evaporation within the shelter, caused by a strong, hot dry wind, may be accompanied by but little evaporation from the surrounding country if the latter be a desert of rock and gravel.

On the other hand, by means of the lysimeter, one may indeed determine directly the evaporation from soil of any character exposed to the natural outdoor conditions, but there then remains the difficult task of determining how much soil of each respective kind really occurs in the surrounding territory. In order, therefore, to determine the actual evaporation from land surfaces one must observe a large number of lysimeters and make an extensive minute survey of the country. The calculations incident to this latter method are very laborious.

The ordinary psychrometric observations give the dew-point or quantity of moisture in a small unit volume of air at any moment. If in the course of the day this quantity increases we are not thereby warranted in concluding that the increase is due to a local evaporation, it may have been brought from a distance by the wind, or it may even have