EXPERIMENTS WITH KITES.

INCLUDING AN ACCOUNT OF THE WRITER'S ASCENT FROM GOVERNOR'S ISLAND, NEW YORK HARBOR.

DRAWN BY G. WRIGHT.

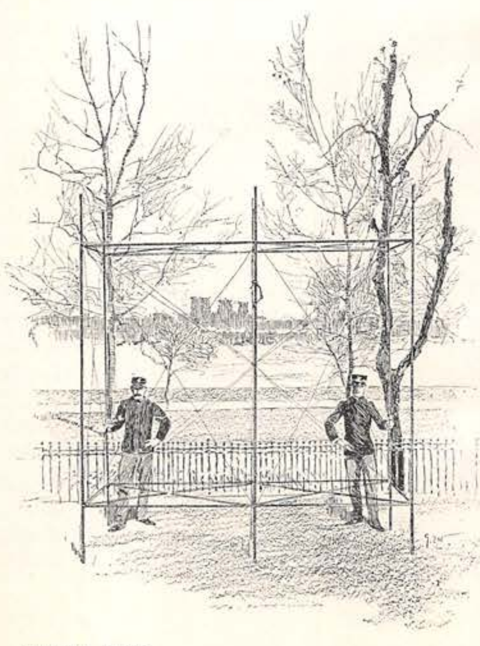
A 12-FOOT EDDY KITE (MODIFIED MALAY).

IT is not my intention to discuss the mathematical principles of the kite, or to enter into an investigation of the forces acting upon it; for, however interesting it might be to the student of the subject, it would be decidedly uninteresting to the average reader. My object is simply a description of a few of the many experiments that I have undertaken in the neighborhood of New York.

The invention of the kite is usually attributed to the Chinese. The first man on actual record as having used the kite is Archytas (about 400 B. C.). For what purpose he employed it I have been unable to ascertain, but it is not probable that he accomplished anything of scientific importance; and it was not until 1749, when Dr. Alexander Wilson and Mr. Thomas Melville, in Scotland, used it for taking the temperature of the upper air, that the kite showed possibilities of becoming a useful and scientific apparatus. Franklin's well-known experiment of obtaining atmospheric electricity by means of a kite again drew attention to it. It is, however, within the last decade that the kite has gained nearly all of its importance; and this is due to its development by men who have studied it, and the forces acting upon it, in a scientific way. Among others may be named Marvin, Langley, Hargrave, and Eddy; by their labors a hitherto useless toy has become an important scientific apparatus.

The limits of this article forbid even a hasty reference to the experiments conducted under the direction of these men, or to the wonderful results accomplished in aërial photography by Eddy, and in meteorological observations by the Weather Bureau. My own experiments began in September, 1896, when, having become interested in the subject, I took it up principally for the amusement that it afforded, without feeling at all sure that it was of any value, and without knowing that it was then receiving much attention. Since then I have devoted much study and labor to kites, and have experimented with them with a view to determining their value for various purposes, two of which are the subject of this article.

The first kite that I built was a five-foot kite of the Hargrave cellular type modified by Lieutenant J. K. Cree, Fifth United States Artillery. This kite, which was built exceedingly light and was covered with Manila wrapping-paper, was excellent in light breezes; but one day, in a moderate wind, it suddenly collapsed. In the meantime I had read all the kite literature that I could find, and had obtained descriptions of the Hargrave kite and the Eddy Malay kite, one of each of which I built; and though I have since experimented with a number of other forms, I have found none equal to these.

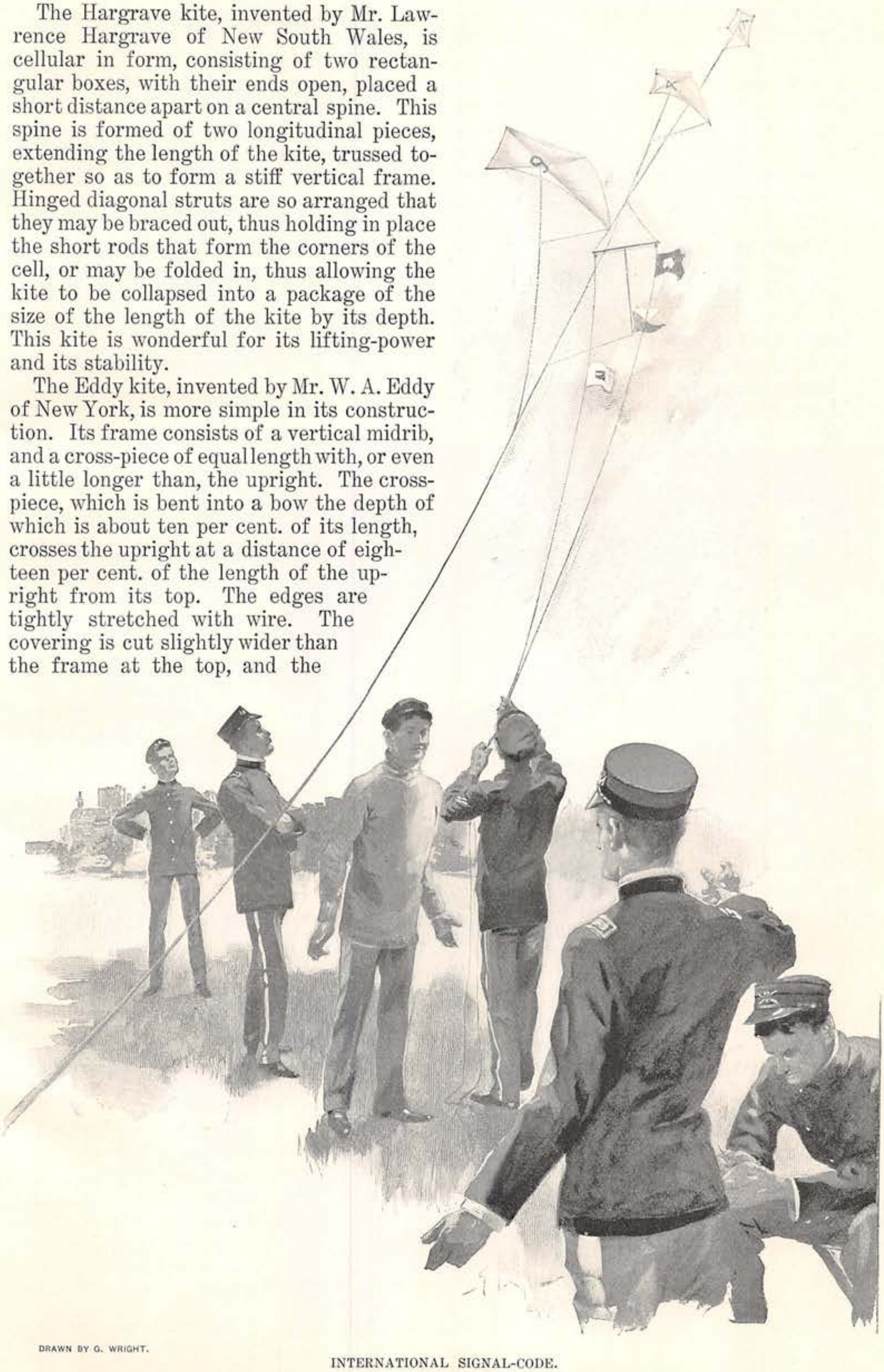


DRAWN BY G. WRIGHT.

FRAMEWORK OF THE LARGEST CELLULAR KITE (LIEUTENANT WISE'S MODIFIED HARGRAVE KITE).

The Hargrave kite, invented by Mr. Lawrence Hargrave of New South Wales, is cellular in form, consisting of two rectangular boxes, with their ends open, placed a short distance apart on a central spine. This spine is formed of two longitudinal pieces, extending the length of the kite, trussed together so as to form a stiff vertical frame. Hinged diagonal struts are so arranged that they may be braced out, thus holding in place the short rods that form the corners of the cell, or may be folded in, thus allowing the kite to be collapsed into a package of the size of the length of the kite by its depth. This kite is wonderful for its lifting-power and its stability.

The Eddy kite, invented by Mr. W. A. Eddy of New York, is more simple in its construction. Its frame consists of a vertical midrib, and a cross-piece of equal length with, or even a little longer than, the upright. The cross-piece, which is bent into a bow the depth of which is about ten per cent. of its length, crosses the upright at a distance of eighteen per cent. of the length of the upright from its top. The edges are tightly stretched with wire. The covering is cut slightly wider than the frame at the top, and the



DRAWN BY G. WRIGHT.

INTERNATIONAL SIGNAL-CODE.

fullness is gathered in a box-plait in the middle. Mr. Eddy has had for his object the development of a kite that would fly at a high angle, and that would require only a low wind-velocity to raise it, and for these purposes the Eddy kite is unexcelled. It lacks the lifting-power of the cellular kite, and I have therefore used it principally when the wind was not strong enough to sustain the cellular kite, but when by a tandem of large Eddy kites I could obtain sufficient lifting-power.

For a while my Hargrave kite flew well, but one day, in a high wind, it suffered the fate of my first kite. I was too well pleased with this form to abandon it, so I decided to build one that would not collapse. Retaining the Hargrave proportions, which, after experiments with others, proved to be the best, I modified simply the structure. It will be remembered that in the Hargrave kite the corners of the cells were short rods. The result was that, even when the fore and aft cells were connected by wires, there was always some independent movement of the cells—a twisting of the central truss—which greatly impaired the strength and efficiency of the kite. Again, there being no connection between the ends of the struts, a sudden strain was liable to break them.[1] To overcome these weaknesses, portability had to be sacrificed to some extent. The trusses were made complete by ties, the corner pieces were extended the entire length of the kite, and the whole structure was strongly braced with wire. To prevent fluttering of the sails, leeches were formed by sewing in their edges a strong cord boiled in paraffin. This construction slightly increased the weight of the kite, but not enough to offset the advantages of increased strength and rigidity. In smaller kites the struts were replaced by diagonal ties of wire. The first kite built of this form was 5 feet 7 inches high, covered with cambric, and had a lifting-surface of 34.8 square feet.

At 9 P. M. on the day that it was completed it was sent aloft in a twenty-mile breeze, bearing a two-pound stable-lantern, the weight of which had apparently no effect upon the action of the kite. It was evident that if lanterns of different colors were sent up, so arranged that their relative positions could be changed, the army signal-code could be used. Accordingly a very simple apparatus was devised. A bamboo rod five feet long was hung in a horizontal position below the kite. From the middle of this rod, and about ten feet below it, was suspended a white railroad-lantern.

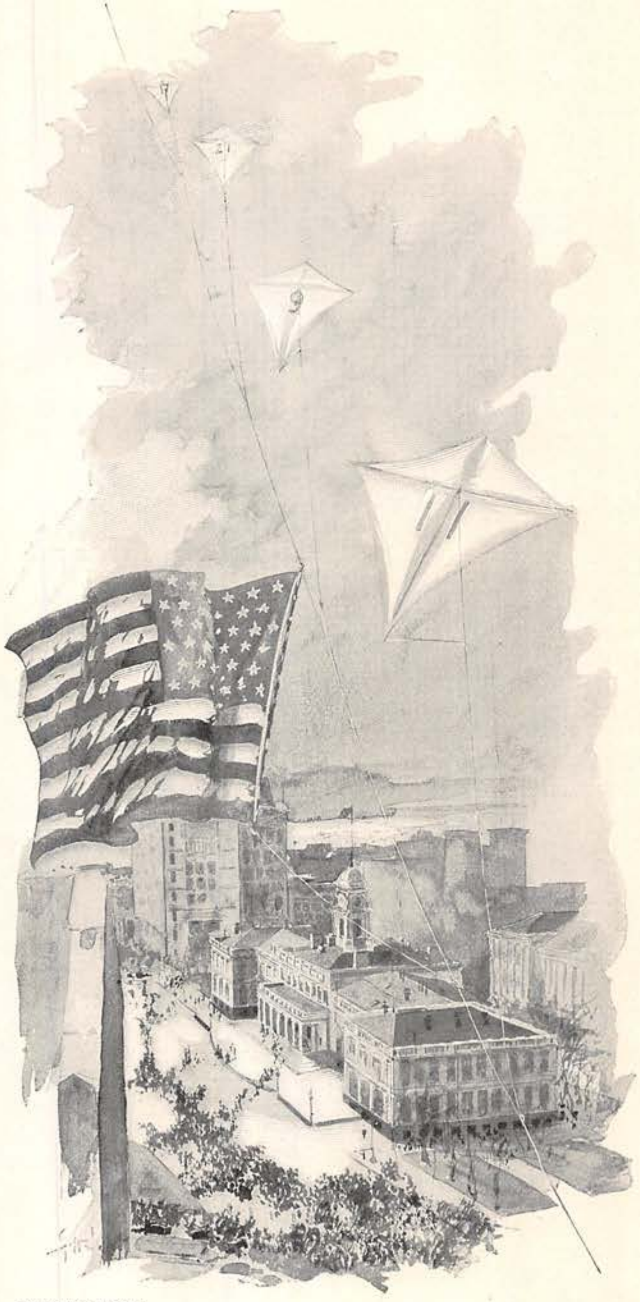
DRAWN BY G. WRIGHT.

A CHEMICAL-LIGHT SIGNAL.

[1] In Mr. Hargrave's more recent construction this fault has been overcome.

At each end of the rod was a pulley, and over these passed an endless cord which hung to the ground. To each side of this cord, twenty feet below the rod, was attached a lantern, one red, the other green. This apparatus was then sent aloft in a twelve-mile breeze by a tandem of two cellular kites. When it had reached an altitude of about five hundred feet, a man on the ground beneath the kites, grasping the halyard, could make the following combinations, reading from top to bottom: (1) white, red, green; (2) red, white, green; (3) white, green, red; (4) green, white, red. These were sufficient to enable us to use the regular signal-code, and a message was sent and read. On the following day the same experiment was repeated, using signal-flags instead of lanterns.

It was, of course, a simple matter to use a code of set signals, such as the international code; for in that case the only apparatus necessary was a pulley, over which passed a halyard. The flags, being tied to the halyard in their proper order, were quickly run up to the pulley; and while they were aloft the next set was tied to the other side of the halyard, and rose as the first set was lowered. This method made it possible to use powerful chemical lights instead of lanterns. A long bamboo rod with holes in it being lashed to the halyard, sticks of combustible substances that burned with great brilliancy and gave different-colored lights were stuck in the holes in the proper order. The fuses being lighted, the rod was run up to the pulley, where the lights burned for five minutes with sufficient brilliancy to be seen at a distance of about fifteen miles.



DRAWN BY G. WRIGHT.

DISPLAYING THE AMERICAN FLAG.

While these devices for night signaling were successfully operated, yet there are certain objections to them. A better device by far would be a powerful incandescent electric light of about fifty-candle power. Such a light could be seen for about twelve miles. The current could be sent over the small wire cable with which the kite is flown, the core and surface of which should be separated by insulation, the current going up the inside of the cable and down the outside. A key similar to the telegraph-key would enable the operator to flash his messages as with a heliograph, and all heavy apparatus and cumbersome trailing

DRAWN BY G. WRIGHT.

LAUNCHING A LARGE KITE.

lines would be avoided. A sample which I have of such a cable fulfils all the requirements of strength and lightness, and I hope some day in the near future to operate successfully an electric light on a kite.

One of the most powerful tandems of Eddy kites that I have ever flown was composed of eleven kites varying in size from $5\frac{1}{2}$ feet to 12 feet high, and aggregating 329 square feet of surface. On this tandem a United States flag measuring 20 feet by 36 feet was raised. The top of the staff was tied to the main cord below the sixth kite, and a back guy to the foot of the staff held it in a vertical position. The flag was brailed to the staff by a cord, the end of which was retained as the flag rose. When at an altitude of five hundred feet a quick pull withdrew the cord from the flag, the cord fell to the ground, and the stars and stripes burst forth and stood spread in the breeze as though alone in the sky.

Having been successful in sending aloft such considerable weights, I determined to try to raise even greater ones, and, if possible, to lift a man by kites. Before this was done it was necessary to determine what was the best form of tandem and to what point the weight could be most advantageously attached. The wonderful lifting-power of the cellular kites made it evident that they should be used, and the rectangular cell was unquestionably the best form. Accordingly, four small kites of this form were carefully built for the experiments. I now had a most valuable assistant in Corporal Lewis, and after a number of experiments we decided that a tandem of cellular kites, each tied to the back of the one below it and rather close together, gave the best results; for though a single kite of the same area of lifting-surface apparently had a slightly greater lifting-power, yet the tandem gave greater stability. To determine the proper position for the

Kite.	Total length.	Total width.	Length of cell.	Breadth of cell.	Distance between cells.	Distance from front edge to flying-knot.	Size of Spines.	Size of Corner-pieces.	Size of Struts.	Weight.	Lifting-surface.	Covering.
	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	inches.	inches.	inches.	lbs. oz.	sq. ft.	
A	5 7	4 10	4 10	1 10	1 11	1 6	$\frac{5}{8} \times \frac{5}{8}$	$\frac{3}{8} \times \frac{3}{8}$	$\frac{3}{8} \times \frac{3}{8}$	4	34.8	Cambric.
B	9	9	9	2 6	4	2 10	1×1	$\frac{3}{4} \times \frac{3}{4}$	$\frac{1}{2} \times \frac{1}{2}$	16 8	90	Muslin.
C	4 6	4 6	4 6	1 3	2	1 5	$\frac{5}{8} \times \frac{5}{8}$	$\frac{1}{2} \times \frac{1}{2}$	$\frac{3}{8} \times \frac{3}{8}$	4 8	22.6	Cambric.
D	9	9	9	2 6	4	2 10	1×1	$\frac{3}{4} \times \frac{3}{4}$	$\frac{1}{2} \times \frac{1}{2}$	17	90	Muslin.
E	12	12	12	3 6	5	3 10	$\frac{7}{8} \times \frac{7}{8}$	$1\frac{1}{8} \times 1\frac{1}{4}$	$\frac{5}{8} \times \frac{5}{8}$	30	160	Muslin.
F	6	6	6	1 9	2 6	1 11	$\frac{3}{8} \times \frac{3}{8}$	$\frac{5}{8} \times \frac{5}{8}$	$\frac{1}{4} \times \frac{1}{4}$	8	40	Cambric.
G	2	2	2	7	10	8	$\frac{1}{4} \times \frac{1}{4}$	$\frac{3}{8} \times \frac{3}{8}$	$\frac{3}{16} \times \frac{3}{16}$	8	5	Silk.
H	3 4	3 4	3 4	10	1 8	1 1	$\frac{3}{8} \times \frac{3}{8}$	$\frac{1}{4} \times \frac{1}{4}$	$\frac{3}{16} \times \frac{3}{16}$	12	10	Silk.
I	2 9	2 9	2 6	2 6	1 1	1 3	$\frac{3}{8} \times \frac{3}{8}$	$\frac{1}{4} \times \frac{1}{4}$	$\frac{3}{16} \times \frac{3}{16}$	$10\frac{1}{3}$	8.5	Silk.
J	3 7	3 7	3 7	2 9	1 11	1 2	$\frac{3}{8} \times \frac{3}{8}$	$\frac{1}{4} \times \frac{1}{4}$	$\frac{3}{16} \times \frac{3}{16}$	12	9	Silk.

attachment of the weight was by no means an easy task, for the uncertain action of the wind rendered it almost speculative. We finally concluded, however, that the best place to attach the weight was to the main line, close up against the lower kite. An excellent carpenter was put to work, and I soon had, besides twenty-two Eddy kites and a number of kites of various forms, the cellular kites, some completed and others well under way, given in the table on page 82.

When B was completed it was taken out for trial; and though it flew well, there was great difficulty in launching and landing it. This difficulty was overcome by tying to its back a smaller kite; but no windlass that I had was strong enough to withstand the pull of this powerful kite. The post quartermaster kindly lent me a massive iron derrick windlass with a diminishing gear, and with this one man could easily handle the kite.

We now began experiments for lifting a man. A dummy weighing thirty pounds was made, and being seated in a rope chair, was sent aloft beneath a tandem composed of B and C, retained by a $\frac{5}{16}$-inch Manila rope. The wind was blowing seventeen miles an hour, and the two kites, aggregating 112 square feet of lifting-surface, had little difficulty in rising with their burden. Indeed, the angle of flight was not much diminished, being nearly 40°. Had the dummy been a live man, he would surely have died of seasickness, for the loose-jointed way in which he performed as the kites first rose, at times

DRAWN BY G. WRIGHT.

«THIS EXCURSION IS POSTPONED.»

swinging entirely over the main rope, was almost appalling even to those who knew him to be simply an old uniform stuffed. This aëronaut rose to an altitude of five hundred feet, and was then wound in and landed safely. Having demonstrated that if a man was to go up on the kites, they should first be allowed to rise far enough to become steady, this martyr, like Columbus, was cast into a cellar, and has never made another voyage.

Experimenting with large kites is not without its humorous phases, and a day or two after the experiment with the dummy an incident occurred which, though ridiculous, well nigh resulted seriously. The same kites that bore the dummy aloft had been sent up about two hundred feet, when the two men who were assisting me went for another kite, leaving me alone at the windlass. Noticing that the rope was in danger of being cut by the cogs, I put on the brake, and passing around to the front, bore down on the rope, which did not appear to be under great strain. In order to readjust the rope on the drum it was necessary to relieve the tension. Near the windlass a piece of rope had been spliced to the main line as a leader for the cord of another kite. This I wrapped around my waist and tied with a bow; then, drawing my knife, I cut the main line from the windlass. I was not long in discovering my mistake, for as the rope parted the knife flew from my hand, I was jerked over on my back, and started for a sleigh-ride across the grass at a rapid pace. In my efforts to untie the bow, I pulled the wrong end and made a hard knot. Finally I managed to get to my feet; but this was little better, and in spite of my efforts I was rapidly approaching the sea-wall. Where it would all have ended I am unable to say; but I am inclined to believe that I should have needed no ferry ticket to Staten Island had not a friendly lamp-post happened to be directly in the line of travel. I approached it with outstretched arms, clasped it in a fond embrace, and there I hung until assistance arrived. With great difficulty three men led back this runaway team and harnessed it again to the windlass. Since then I have not been «so attached» to large kites.

THE FIRST KITE ASCENT.

Having successfully lifted the dummy, my next attempt was to lift a man. I had now two nine-foot kites, B and D. On an afternoon when the anemometer showed a wind-velocity of twenty-two miles an hour, B, D, and C, aggregating a lifting-surface of 202 square feet, which a hasty calculation showed to be sufficient, were taken out. The windlass having been pegged to the ground, 300 feet of $\frac{7}{16}$-inch Manila rope, capable of bearing a strain of 1250 pounds, was run out and stretched to leeward, and to it D was made fast. Sixty feet of $\frac{5}{16}$-inch rope, capable of bearing a strain of 750 pounds, was tied to the back of D and stretched in prolongation of the other rope, and to its end B was made fast. A man was stationed by each kite to hold it flat upon the ground. A pulley was lashed to the main line close up to D, and over it passed a long rope to one end of which a boatswain's chair was attached, my idea being to allow the kites to rise unhampered at first, and when they became steady to hoist myself to them, then to cleat the halyard to the chair and allow the kites to rise. C, having been launched, was tied to the back of B. Taking my seat in the chair, I gave the signal. The man at B raised its front edge, and it bounded into the air, followed by D, and the halyard spun over the pulley. Anticipating a jerk on the main line, I had stationed six men to hold it in front of the windlass in order to lessen the jar upon the kites. I had underestimated, however, the tremendous power of the tandem; for as it rose the men were dragged forward, and the rope tightened upon the windlass with a jerk that tore the whole central truss from the lower kite. The two upper kites, steadied by the weight of the helpless lower one, floated away. As they passed over the fort they were caught by some soldiers, and the tandem was saved, though the kites were broken against the neighboring walls in lowering them. So ended this experiment, and the work of weeks had been torn to pieces in a few moments.

An experiment is a failure when nothing is accomplished by it; therefore this one was not a failure, for by it were detected errors to be avoided in the future, and the damaged kites were the price paid for their detection.

For the next two months I was engaged in experiments of another kind, which are not within the limits of this article; and it was not until E, probably the largest kite of this type ever built, was completed that I again attempted an ascent. In the meantime the broken kites had been repaired, and strong ash spines had been substituted in the large kites. On January 22, at 4 P. M., the anemometer registered a wind-velocity of fifteen miles an hour, which was more than sufficient to lift a man with the kites now at my disposal. All my experiments had shown that the best tandem for lifting weight was one in which the kites were tied one to another; but as I had more power than I needed, I decided to send up two tandems, and to unite them, since this greatly facilitated their management. The windlass, wound with 500 feet of $\frac{1}{2}$-inch rope, was placed in position and lashed to a tree. C was launched and tied to the back of B, and the two kites were allowed to rise to the end of 150 feet of $\frac{5}{16}$-inch rope, which was then made fast to a tree. One hundred feet of the large rope was now run from the windlass and made fast to E, to the back of which F, having been launched, was tied. Six men took hold of the rope fifty feet from E, the man stationed by the kite raised its front edge, and it rose gracefully from the ground. The strain was given gradually to the windlass, and then the first tandem was brought up and tied to the main line. At the point of junction the same apparatus used in the last experiment was made fast, and the kites were allowed to rise until the pulley was about thirty feet from the ground, when,

DRAWN BY G. WRIGHT.

A RUNAWAY.

taking my seat in the chair, I was hoisted to the pulley. The line sagged badly, so that I was at a height of only about twenty feet. In a few minutes the breeze died out considerably, and I was lowered to the ground, where I waited for the wind to freshen.

After a short wait the wind rose to seventeen miles an hour, and when I was hoisted to the pulley there was not a great sag in the line. Grasping the halyard, I made it fast to the chair, and gave the signal to the men at the windlass. As the rope ran out the kites bore me up until I was as high as the neighboring houses, when I signaled to stop the windlass. A measurement of the trailing rope showed a height of forty-two feet from the ground to the chair. The sensation was not at all unpleasant—a gentle swaying and lifting not unlike the motion of a swing. I was tempted to go higher, for there would have been no difficulty; but I was not provided with a parachute, and I did not wish to run any unnecessary risk. After remaining aloft a short while and observing the action of the kites, I signaled to wind in, and when near the ground I was lowered by the pulley, with the satisfaction of knowing that this experiment at least had been a success, and that it was the first kite ascension in the United States.

In this ascent the lifting-area was:

	sq. ft.
C	22.6
F	40.0
B	90.0
E	160.0
Total	312.6

The weight lifted:

	lbs.
Four kites	59
Ropes	20
Chair and man	150
Total	229

The tension on the cord varied from 300 to 500 pounds. The angle from the windlass to the seat was 32°.

I am not altogether satisfied with the experiment, and I now see how many improvements may be made; but as a result of it I believe a kite can be built that will safely carry a man.

It is nonsense to suppose that the kite can ever replace the captive balloon, for in its very nature it is dependent upon the wind. On the other hand, a kite of the proper form, with a frame of steel tubes—for these offer great advantages of strength and lightness—and covered with strong cloth, can be safely used in a wind that would render an ascent by a captive balloon most hazardous, if not impossible. Such a kite can be made portable, its cost is relatively small, the expense of an ascent is nothing, and I think it highly probable that it might be a valuable accessory to the balloon service.

Again, there are instances where the balloon cannot be used on account of its size, such, for instance, as on a small war-ship. A tandem of ten folding cellular kites, each of about thirty square feet lifting-surface, could be stored in a small space, and could be sent up with a man, even in a calm, by the wind pressure due to the speed of the ship, affording the man an opportunity of observing everything within the range of a telescope.

To signaling with kites the same objection holds true—the wind is too uncertain to be relied upon. But occasions might arise when large flags or bright lights high in the air would prove valuable.

On the whole, the kite, though not a new invention, is new in its development. It has proved itself most efficient for some purposes, and doubtless the scientific study which it is now receiving will soon render this old toy an apparatus useful for many purposes of peace and of war.

Hugh D. Wise,
U. S. A.

PHOTOGRAPHING FROM KITES.

INCLUDING ACCOUNTS OF THE FIRST PHOTOGRAPHING FROM KITES AND OF THE FIRST TELEPHONING AND TELEGRAPHING THROUGH A LINE HELD BY KITES.

ON May 30, 1895, at Bayonne, New Jersey, I obtained my first photograph by means of a camera suspended from a kite-line. This was undoubtedly the first aërial kite photograph of any kind taken in the Western Hemisphere. My instantaneous camera worked too readily, however, making the first exposure too near the ground, although I sent the camera up several hundred feet, supposing the exposure had not been made. I first used a dropping lead weight with a fall of about six inches to operate the shutter, the detach-