BULLETINS

OF THE

Aerial Experiment Association

Bulletin No. X Issued MONDAY Sept. 14, 1908

MR. McCURDY'S COPY.

BEINN BHREAGH, NEAR BADDECK, NOVA SCOTIA

Bulletins of the Aerial Experiment Association.

BULLETIN NO. X ISSUED MONDAY SEPTEMBER 14, 1908.

Beinn Bhreagh, Near Baddeck, Nova Scotia.

TABLE OF CONTENTS.

MISCELLANEOUS COMMUNICATIONS.

Illustrations.

----------oOo----------

THE COMING OF THE WINGED CYCLE. THE WINNING OF THE FIRST AMERICAN TROPHY FOR A MAN CARRYING FLYING MACHINE: by David Fairchild.

We have seen a man fly through the air like a bird. A feat that centuries have waited for has been done, and we have seen it. A mile in a minute and forty seconds, twenty feet high in the air!

Standing at sunset in the Pleasant Valley where the clover was knee high and with the last rays of the sun lighting up the forest and vine covered hills around, we waited for the breeze to die down so that Curtiss could fly.

On an old race track a hundred yards away was a big thing of yellow cloth stretched on sticks and stayed by wires. Our eyes were riveted on it and in breathless expectation we waited for it to move.

What can compare with these first beginnings of great things! The crowds who lined the Hudson when Fulton first steamed up it have scarcely crumbled to dust; those who listened in expectation for the first spoken word over miles of metal wire are not yet old; and to stand in the gathering dusk of a mountain valley in your own country and wait to see, not only a man but a man whom you have been interested in for years fly over you, is the experience of a lifetime.

Scattered over the field were the reporters of New York dailies with their cameras, the representatives of the Aero Club, the relatives of our friend, and the admiring workmen of his motor cycle factory, while seated on the hillside close by were the hundreds of towns-people who had come to see the hero of their town win the first American trophy for a

man carrying flying machine.

Mixed with the expectation was an anxiety lest something happen, lest you should be on the point of seeing a tragedy with all that your near association with the man and your admiration for him would mean.

The groups of workmen discussed the previous trials of the aeroplane and expressed their confidence that Glenn Curtiss, the boy who put in electric door-bells in the village and sold the repaired bicycles of the town in his little shop at the corner of the square, would carry off the trophy this time all right.

Suddenly the group of people about the machine scattered into the fields, Curtiss climbed into the seat in front of the yellow wings, the assistant turned over the narrow wooden propeller, there was a sharp loud whirr and a cloud of dust and smoke as the blades of the propeller churned the air 1200 times a minute.

The men holding the gigantic bird let go. It started down the track on its rubber tired wheels going faster and faster. Then, before we realized what it was doing, it glided upward into the air and bore down upon us at the rate of 30 miles an hour. Nearer and nearer it came like a gigantic ochre colored condor carrying its prey. Soon the thin, strong features of the man, his bare outstretched arms with hands on the steering wheel, his legs on the bar in front, riveted our attention. Hemmed in by bars and wires, with a forty horse-power engine exploding behind him leaving a trail of smoke and with a whirling propeller cutting the air 1200 times a minute, he

sailed with forty feet of outstretched wings twenty feet above our heads.

Thirty miles an hour in an auto seems fast going where fence posts and wayside flowers mark the speed, but in the air with nothing but the distant hills to go by the passage of this giant flying thing seemed leisurely and graceful.

What a moment for the vivid imagination. The thing is done. Man flies! All the tedious details of perfecting a practical passenger carrying machine are forgotten. Even the previous successes of which you have seen reports mean nothing and with one leap the imagination builds on this one positive fact which your eyes are seeing, a whole superstructure of world locomotion. You think of the plovers that hatch their young in the summer of the Arctic Circle, teach them to fly in Labrador and spend the winter with them in the Argentine to return again over Mexico in the Spring. You remember the flights of homing pigeons that cover 500 miles in eleven hours and these suggest strange visions of great fleets of airships crossing and re-crossing both oceans with their thousands of passengers. In short we cast aside every pessimism and give our imaginations free rein as we stood watching the weird bowed outline pass by.

Oh, why does he go so high? Do you think he's going to make it? These cries from Mrs. Curtiss, who was standing by us, reminded us of the dangers of the flight and of the fact that out in the meadow a half mile away there was a red flag which marked the end of the course. Would he pass over it?

The machine which was twenty feet or more above our heads seemed to slowly descend until it was not more than ten or fifteen feet high, but it did not go lower. Directly over the stake it steered, rising higher as it went, and away it soared over the fences turning to the left and settling gently down in a pasture over a mile away from where it left the race course. Yells and cheers and screams from the groups of spectators announced the fact that the trophy was handsomely won and then, over potato fields, through vineyards and oat fields and down the railroad crowds of men ran to cheer the successful navigator and to bring back to its tent the uninjured "June Bug".

In one minute and forty seconds Mr. Curtiss had ridden with fashion astride a motor driven broom stick, as it were, eighty feet more than a mile through the air and used up in the flight less than a quart of gasoline.

One thing was missing, the presence of the great American advocate of heavier-than-air machines, Mr. Alexander Graham Bell, whose success as a pioneer in another field makes his prophecies sought for in this. He is the originator, organizer and financial backer of the Aerial Experiment Association of whose activities this gigantic "June Bug" is the latest production. The Association has been carrying on two sets of experiments, one at Mr. Bell's Nova Scotia laboratories with tetrahedral kites, and the other at Mr. Curtiss' shops in Hammondsport with gliders and horizontally placed aeroplanes. In the "June Bug" the younger members of the Association, Mr. Curtiss, Mr. Baldwin, Lieut. Selfridge and

Mr. McCurdy, have been given more or less a free hand and they have combined in it as many as possible of the valuable points of previous experimenters adding some of their own and working out the details with great care.

The excitement of the flight being over, we began to ask seriously what the "June Bug" could be counted on to accomplish, and get the clearer perspective of such students of the new art as Herring, Manley, Baldwin and the members of the Aerial Experiment Association. It is an infant now of course and in the still air stage; a gust of wind presents difficulties which have not been mastered. "When I strike a gust of wind its like hitting a steep grade on a motor cycle; its as solid a reality as that", says Mr. Curtiss.

This weird new craft had made sixteen flights recently with occasionally a wing broken or a mishap to the steering gear, and when we asked Mr. Curtiss as we walked back, pushing the awkward aeroplane before us through the long grass, whether it wasn't nerveus work and if he wasn't exhausted, he said, "Its no more nerveus than running a motor cycle, and I don't feel any unusual exhaustion, and in still air I don't think there is any more danger, but I don't know enough yet to handle it in a breeze. There is no especial difficulty in landing if I can keep up my headway, and this time I came down on all three wheels as easily as anyone could wish to".

There are many who have looked on an aeroplane as something which only an acrobat could manage. There is truth in the statement that one must know how, but when it is considered that in fourteen trials Mr. Curtiss mastered the art

sufficiently to sail a mile without difficulty, all the insuperable difficulties in the way of a pleasure aeroplane have disappeared and one is forced to the conclusion that aeroplaning as a sport, for those who can afford it, is really on the program.

The power for the "June Bug" has been found in an eight cylinder, forty horse-power, air-cooled engine, weighing only 200 pounds, acting on a six feet long by eight inches wide wooden propeller. Two horizontal curved planes 42 feet long by 6 feet wide of spruce lumber braced with wire and covered with strong cotton cloth filled to make it air-tight, a horizontal cloth covered controller in front to steer it up and down, a vertical rudder behind, to steer it from side to side, with the necessary net-work of wire cables, gas pipe and sink sockets to hold the whole together, these make the "June Bug". Of course, the curves of the surfaces and the cross sections of the framework are according to carefully worked out formulae.

The difficulties of flight have been difficulties arising from our idea that the air is a gas and not a solid. But as Herring expresses it, "If you rotate a plane surface rapidly enough in the air it is held between the upper and lower air masses as rigidly as though you ran it along a crack in a brick wall". "Hit the air hard enough and it reacts like a solid", is one of Prof. Langley's statements, I believe, and as you stand behind the propeller of the "June Bug" when it is revolving at 1200 turns to the minute you

realise the truth of this discovery. The moter boat propeller which revolves 400 times a minute, sending you through the water at a rate of 15 miles an hour, requires a powerful engine but you do not wonder at this. It is an education in physics, however, to find that to turn this narrow 6 feet propeller 1200 times a minute in the air takes a 25 horse-power engine.

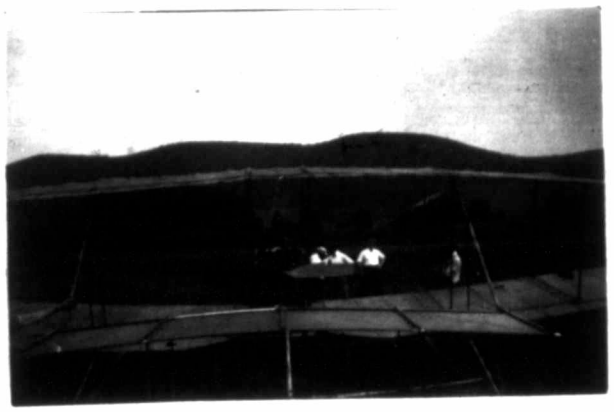
The engine of the "June Bug" is a Curtiss moter, the work of a master mind who has risen out of one of the thousand of little bicycle shops which the advent of that strange vehicle created all over the world. The Curtiss bicycle shop is still standing on the Park Square of Hammondsport and its former owner has erected on the hillside among the peach trees of his father's place perhaps the most unique set of machine shops in the world for the manufacture of moter cycles and airships moters. The factory buildings, make-shifts of boards, show the rapid developments of this new industry and to-day the airship constructors and operators of the country come to Curtiss for their engines and to test out their ideas. His aerodrome, a shed looking like a deserted ice house, accommodates the debris of all sorts of abandoned airship dreams.

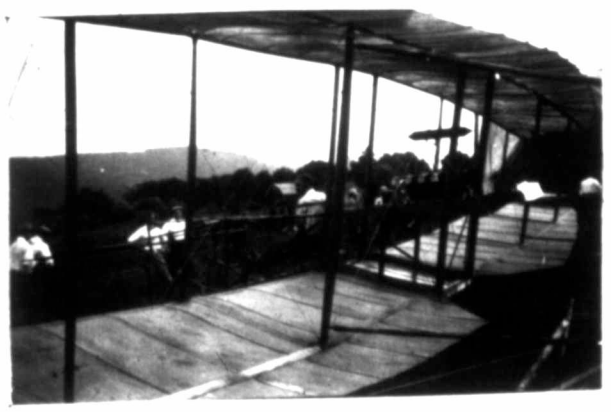
Hammondsport has become, as it were, the Airship Town of the world, and one must visit it to get the airship fever, just as one has to visit a mining camp to get the gold fever. It is in the air, and the children's toys are on wings, their teachers despair of getting them to learn their book lessons when an experiment is in progress.

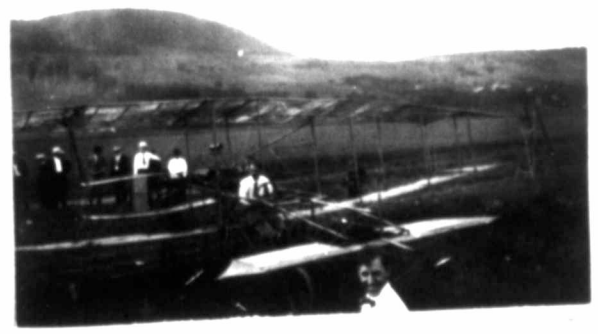
It may perhaps be unwise to navigate the upper air in our imagination before we have actually much more than gotten

off the ground, but it is much easier for men to follow the trail than to blaze the way and what has been done by a few men will soon be attempted by thousands.

Before inventors gave the world a bicycle no one could believe that it was possible for a man to balance himself on a revolving wheel. As soon as a single man showed it to be possible thousands followed and the bicycle era came. Independent inventors have now given us the winged motor cycle and have driven it through the air, and we seem to be on the verge of the winged cycle era. Besides, things happen quickly now-a-days and with the War Department contracting for aeroplanes which can stay an hour in the air and carry two men, with the Wright Brothers' statement that they fly in an 18 mile breeze, with Delagrange's public flights before the King of Italy, with Count Zeppelin's colossal(aluminum) dirigible that carried twelve people for hours at a time, it seems as though the day of practical experiments in flying had arrived and that the chances of success have been increased to the point where speculative capital will invest in this new mode of locomotion.







A METHOD OF OBSERVING AIR DISTURBANCES PRODUCED BY THE BEATING OF THE WINGS OF A HOVERING FLY WITH A PROPOSED APPLICATION TO OUR WORK: by N.A. COBB.

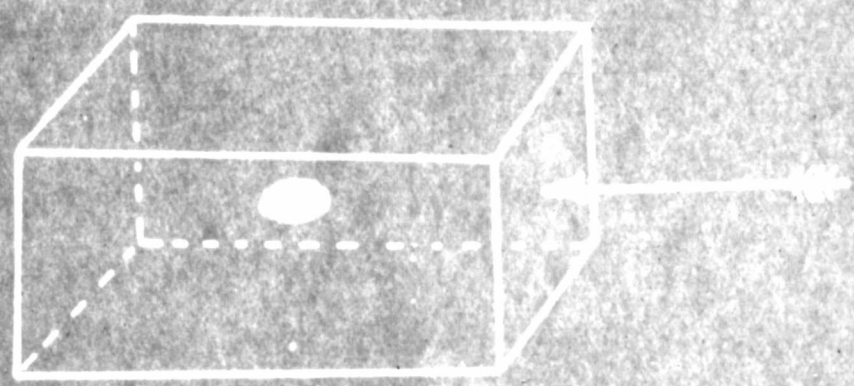
(Dr. N. A. Cobb of the Department of Agriculture has been visiting at Beinn Bhreagh and has kindly consented to dictate a few notes for the information of the members of the A.E.A. concerning his method of observing the air disturbances produced by the hovering of a peculiar fly found in the Hawaiian Islands. He thinks that the method may possibly be of assistance to us in our work by enabling us to ascertain the nature of the disturbances produced by a rotating propeller etc. A rough diagram is appended illustrating the fly-box used by Dr. Cobb. The top and four sides of the box were of glass upon a baseboard of wood. The fly hovered in the middle of the box for considerable periods of time without touching the sides. The box was taken into a dark room and held in the path of a beam of sunlight admitted through a small hole. The arrow-head represents the beam of sunlight which passed through the box, and was received upon a screen of black absorbing material. Chalk-powder was then introduced into the box so as to make a smoky atmosphere. The diagram indicates the vacuous space observed surrounding the hovering fly. Dr. Cobb has thrown his notes and suggestions into the form of a letter as follows:-A.G.B.).

Beinn Bhreagh, Aug. 31, 1908:- Dear Dr. Bell:- I am writing this as the result of a suggestion following on one of our recent conversations.

Whether these remarks have any interest and value in aeronautics depends on how important it may be to have an accurate knowledge of what is taking place <u>in the air</u> during flight.

Up to the present our observations have been confined largely to the <u>machine</u>, that being the one thing that was easy to see, and, to a limited number of actual navigators, to feel.

During my observations on the flight of flies, as I have told you during our conversations, I chanced to notice a fly of the genus <u>Volucella</u>, standing still in the air under a tumbler in which it was held captive. This was a sort of



Dr. Cobb's chalk-powder box for observing the disturbance of the air produced by the wings of a hovering fly.

hovering, as we term it in birds, but one of these insects can stand so still in the air that it is possible to examine it with a reading glass, and thus decipher the antennae and other minute features, if one has the good fortune not to frighten the insect away, or has it in captivity as I had. I mention this reading-glass observation to give an idea of the steadiness of the insect as it stands still in the air. Needless to say its wings are all the time vibrating several hundred times a second .

The tip of a fly-wing seven millimeters long probably travels at the rate of 5 to 10 meters per second when the wings are vibrating at the rate of two to four hundred times per second. I am assuming that the "figure eight" described by the wing-tip in one vibration is equal in length to the circumference of a circle of seven millimeters radius. Of course this is only an approximation, but it serves to bring out the fact that the rate of motion of the parts of an insect wing are in some instances comparable with those of the propellers now being used in flying machines, at any rate when the latter are being used at their lower speeds.

One conception of the fly when poised in the air is that of a partial vacuum of which the fly is the "nucleus". Of course this partial vacuum, together with its insect nucleus has the same specific gravity as the surrounding air.

In form this vacuum is what would be expected from the action of the wings, i.e., it has a bilateral symmetry. From observations I have made, and speaking from recollection, it

appears to have somewhat the form of an ellipsoid of revolution (around the short axis of the ellipse as a fore-and-aft line), though my observations were far from complete and satisfactory

Measured in inches, a vacuum two by two by one would appear to be ample to support a fly of ordinary weight, say of from seventy-five to one hundred milligrams.

Another conception of the poised fly is that of an object supported by reaction in a column of downard moving air. This conception is supported by some of the evidence rendered by my dark box contrivance, the illuminated particles in which are seen to move downward more than in other directions.

Almost everyone must have noticed the motes floating in sunbeams seen against a dark back ground. A refinement based on this simple observation enables one to observe, to some extent the motions of air currents. If a sunbeam be passed through a darkened glass-sided box into which fine chalk-dust is injected, the white particles of chalk become strongly illuminated, if the room is darkened and the beam is caught on black velveteen or otherwise absorbed. As the motions of the dust coincide approximately with those of the air, it is possible, after a fashion, to observe the directions and intensities of the currents. By variously altering the apparatus it is possible to arrive at definite results, up to a certain point.

I believe it would be an interesting, and very likely profitable investigation to study, in such a box as I contrived the action of air currents under various conditions. The study of an insect poised in such a box would, I am positive from what I have already seen give valuable data, and as a matter

of fact I only await the right opportunity to repeat and extend my observations. Small meters in action in such a box might, I should think, yield results of value.

The particles move so rapidly that there is considerable difficulty in making the necessary observations and in getting the experience necessary to interpret the phenomena. Striking instances for first observations are the results when a cloud of dust slowly rolls, by, or up to, the region of disturbance. By piecing together observations of this kind much can be made out.

I have thought that a fine black wire lightly painted with glycerine if placed in the region of disturbance and allowed to be bombarded with chalk or other dust, might yield graphic records of value, but I have not tried this.

An instrument perfected on these lines should be called an "Anemograph". When made quantitative, it would naturally be called an Anemometer, but as that term is already preempted for the instrument used to measure ordinary "horizontal" winds, it might be necessary to invent a new term. Probably a small and sensitive aneroid could be used to help in the interpretation of the anemograph until one became accustomed to its use. Have you ever wired an aneroid into various position in your kites and tried to read the pressures from a distance with an opera-glass? I have an opera-glass that focusses down to six feet for such purposes. If you have not tried this and should have a curiosity to know what the air is doing in among the coils of the kites, I believe it would be possible to find out something this way. Again, if a kite of celluloid or

membranous cells were exposed in an artificially dusted wind, a graphic record might be obtained by first painting all the parts with glycerine. The same might be done on a smaller scale but more accurately with artificially created currents in the Laboratory.

It is a fact long since observed that the wings of insects, notably those of the best fliers, are usually covered on both surfaces with very minute hairs. I do not know that it has been experimentally proved what the function of these hairs is.

The hairs have their apices directed outward i.e., distally, though toward the inner margin of the wing they are deflected somewhat backward, using this term to indicate a direction at right angles to the principal vein of the wing.

It is perfectly obvious that that wing will be most efficient that will threw the air farthest. I more than suspect that the hairs on the surfaces of insect wings have the function of enabling the wing to get a better "bite"on the air or to a better "seize" and direct the air, so as to throw it as far as possible. It might be thought that these minute structures would be too fine for this purpose, but it must not be forgotten that an insect's wings in action are sometimes moving in a rarified medium, the rarifaction being due to their own action. It might be a good idea to test on rapidly moving blades of air propellers the effect of surfaces similar to these on these insect wings. If it is desired to do this there are natural vegetable surfaces that could be veneered on propeller blades. Thus the surface of the sheaths of certain grasses, say those of some varieties of maize might prove suitable.

MR. RUSSELL THAYER'S PROPOSITION TO PROPEL A BALLOON BY WIND PRESSURE AGAINST GYROSCOPIC RESISTANCE.

To Dr. A. G. Bell,
President of Aerial Experiment Ass.,
Baddeck, Nova Scotia.

Philadelphia, Pa., Aug. 12, 1908:- Knowing your great interest in modern Physics as practically applicable to the wants and benefit of man, I desire to submit to your consideration and candid criticism a discovery that I have recently made in regard to the Gyroscope and Airships.

In order to explain this matter simply and concisely I take pleasure in enclosing a copy of one of my Patents, which briefly explains the discovery.

At your convenience I should be much pleased to hear from you on the subject.

Russell Thayer.

(M. Am. Soc. C.E.).

To Mr. Russell Thayer,
Broad and Arch Streets,
Philadelphia, Pa.

Baddeck, N.S., Aug. 24, 1908:-Your note of the 12th instant received. Your Patent 887,443 contains a great thought, the practicability of which should be tested by experiment. It will give me pleasure to bring the matter to the notice of my colleagues in the Aerial Experiment Association.

Alexander Graham Bell.

NB. A copy of Mr. Thayer's Patent No. 887,443 is appended.

No. 887,443. PATENTED MAY 12, 1908.

R. THAYER.

DIRIGIBLE BALLOON.

APPLICATION FILED DEC. 26, 1907.

2 SHEETS—SHEET 1.

FIG. I.

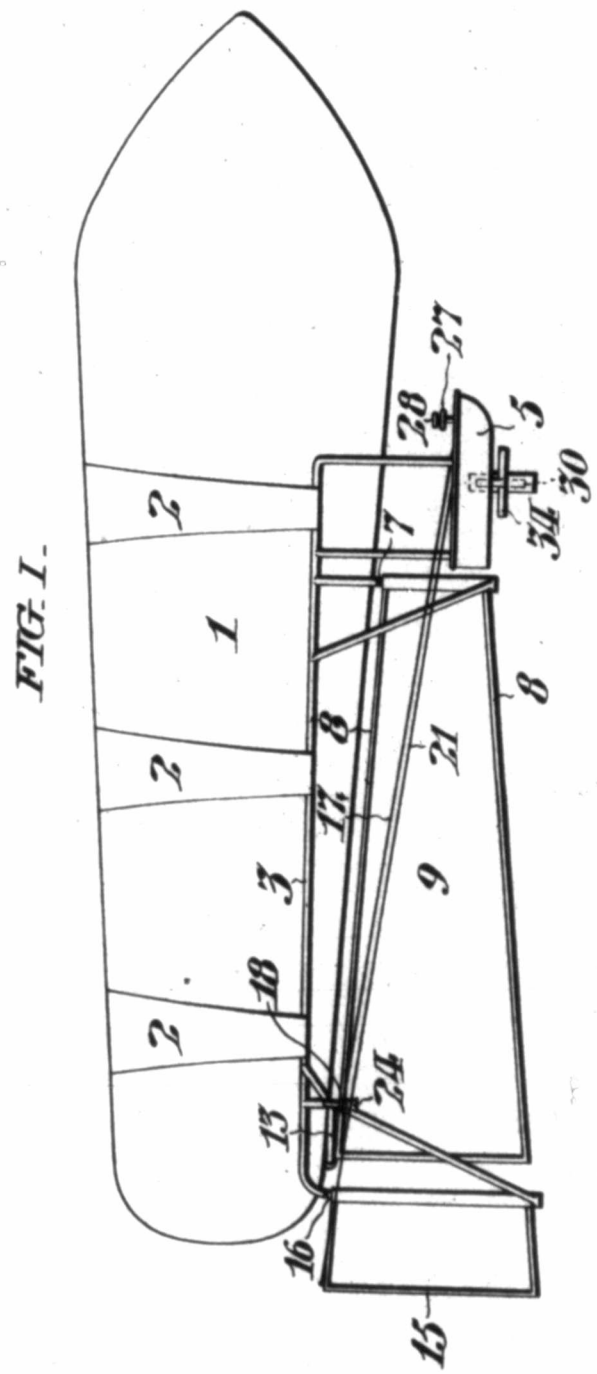
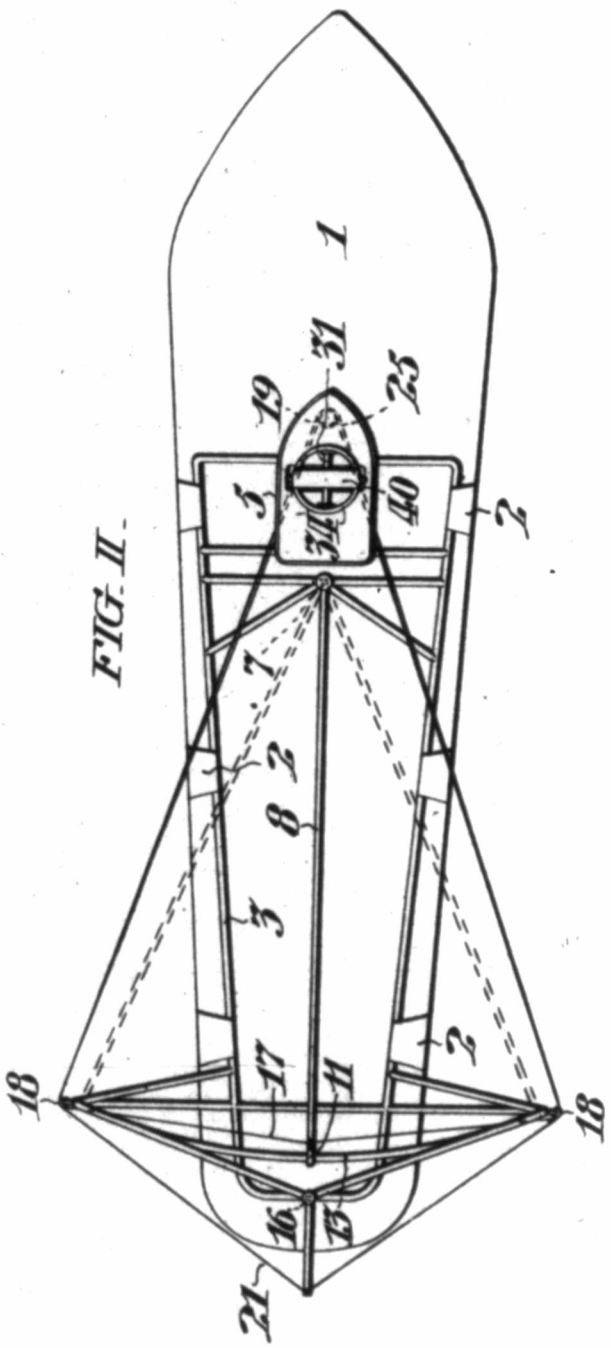


FIG. II.



WITNESSES:

Clifton C. Hollowell

Morris L. Jensen

INVENTOR:

RUSSELL THAYER,

by Stillman E. Paige

Atty.

No. 887,443. PATENTED MAY 12, 1908.

R. THAYER.

DIRIGIBLE BALLOON.

APPLICATION FILED DEC. 26, 1907.

2 SHEETS—SHEET 2.

FIG. III.

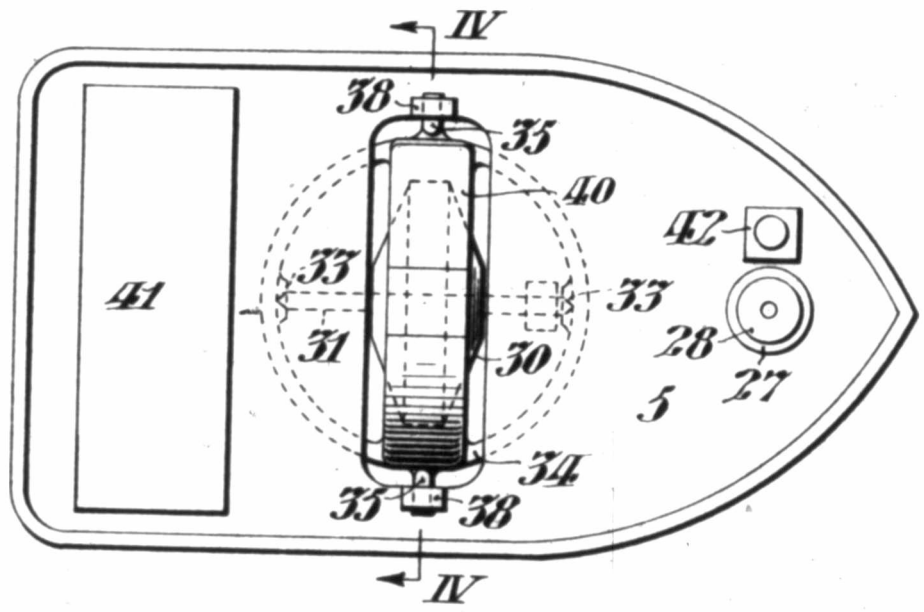
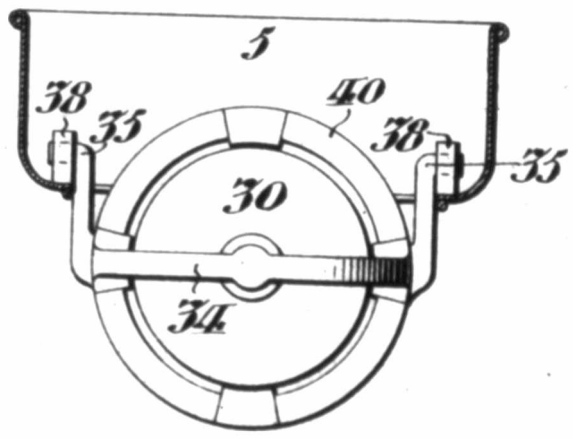


FIG. IV.



WITNESSES:

Clifton C. Hollowell

Morris L. Jensen

INVENTOR:

RUSSELL THAYER,

by Atty. E. Paige

Atty.

UNITED STATES PATENT OFFICE.

RUSSELL THAYER, OF PHILADELPHIA, PENNSYLVANIA.

DIRIGIBLE BALLOON.

No. 887,443. Specification of Letters Patent. Patented May 12, 1908.

Application filed December 26, 1907. Serial No. 408,002.

To all whom it may concern:

Be it known that I, RUSSELL THAYER, of Philadelphia, in the State of Pennsylvania, have invented a certain new and useful Improvement in Dirigible Balloons, whereof the following is a specification, reference being had to the accompanying drawings.

In sailing a marine vessel, the effect of the wind pressure is controllable by utilizing the reactive effect of the water upon the vessel whereas, in ordinary balloons, there is no equivalent for the reactive effect of the water, and consequently such balloons must go with the wind unless provided with more powerful propelling means.

Therefore, it is an object of my invention to provide a balloon with means whereby a reactive force may be created and controlled local to the balloon, at the will of the operator, so as to be similar in effect to the reactive force of the water upon a marine vessel, in that by properly utilizing it, the balloon may be progressed, solely by wind pressure, in directions oblique with respect to the direction of the wind.

I have discovered that by utilizing the reactive gyroscopic force manifested upon any attempt to change the direction of the axis of a rotary body, in combination with the wind pressure upon a balloon floating in the atmosphere and carrying said body; that the movement of the balloon may be variably determined and controlled by correlation of the force developed by the gyroscope and the force of the air current. In other words, my invention provides means whereby wind pressure tending to diverge a balloon from a predetermined direction of traverse may be variably opposed by the gyroscopic effect of a rotary body carried by the balloon, under control of the operator, so that such wind pressure may be utilized to propel the balloon, in directions oblique to the direction of the wind pressure, as in ordinary marine navigation.

The gyroscopic reactive effect above contemplated is due to the fact that a rotary body tends to maintain constant its plane of rotation and consequent direction of its axis of rotation, such effect being increased or diminished in correspondence with the speed of rotation of the body. However, it is important to note that to render such reactive effect available as herein contemplated it is necessary to so mount the rotary body that its axis of rotation is free to oscillate, to a limited extent, in a direction parallel with the direction of said axis, for, when a body rotating upon a principal axis is subjected to a force tending to produce another rotation not parallel to the former, the resultant effect is such displacement of the axis of the original rotation, with respect to its support, as is most favorable to the parallelism of the two rotations, and, such displacement is at right angles to the direction of the disturbing force.

In a balloon constructed in accordance with my invention as hereinafter described, the force due to the natural air drift, and the gyroscopic force created by controlled rotation of a suitable body carried by the balloon, may be so correlated, at the will of the operator, as to propel the balloon solely by the wind pressure, and in any direction except that directly and approximately opposed to such pressure.

I am of course aware that gyroscopes have been employed for many years and in various arts to balance or maintain the level or equilibrium of structures connected therewith, and therefore note that the gyroscope element of my invention has no such function or effect in the arrangement and operation which are characteristic of my invention as herein defined. I am also aware that it has been proposed to provide a marine vessel with gyroscopic wheels, but such wheels have been designedly arranged to maintain the horizontal planes of the vessel substantially stable, without opposing changes in the direction of traverse of the vessel. In other words, such devices of the prior art have been employed for a purpose radically different from that herein contemplated, and have been so constructed and arranged as to be incapable of the effects which are characteristic of my invention.

My invention comprises the various novel features of construction and arrangement hereinafter more definitely specified.

In the drawings; Figure I, is a side elevation of a balloon conveniently embodying my invention. Fig. II, is an inverted plan view of the balloon shown in Fig. I. Fig. III, is a plan view of the car shown in Fig. I. Fig. IV, is a transverse sectional view of said car, taken on the line IV, IV, in Fig. III.

In said figures; the gas envelop 1, which is of circular cross section, diminishing toward its stern, is conveniently connected by the bands 2, with the main frame 3. Said

frame supports the car 5, and has the vertical shaft 7, which supports the frame 8, of the sail 9, in a vertical plane. Said sail frame 8, comprises the bearing 11, mounted to slide on the boom bar 13, so that said frame 8, is supported for transverse oscillatory movement with respect to the main frame 3. The rudder frame 15, is mounted to oscillate transversely on the vertical shaft 16, in said frame 3. Said sail frame 8, is provided with flexible connectors 17, which extend around the pulleys 18, at the outer ends of said boom 13, to the rotary drum 19, in the car 5, and, the flexible connectors 21, extend from the rudder frame 15 around the pulleys 24, to the rotary drum 25, in said car. Said drums 19, and 25, are respectively provided with the hand wheels 27, and 28, whereby, said sail and rudder may be independently adjusted to different angles with respect to the longitudinal axis of the balloon.

Although I have shown the balloon provided with a sail and rudder which are adjustable with respect to the longitudinal axis of the balloon, at the will of the operator, as above described, so as to receive wind pressure in variable angular relation, it is to be understood that the balloon may be propelled in the manner described, without the employment of such adjunctive devices and solely by the wind pressure upon the balloon itself, and in this connection it may be observed that the envelop 1, is rendered more effective for its progressive movement by having its exterior converged toward its stern.

The rotary body 30, whose mass may be in any desired proportion to the mass of the balloon, is carried by the shaft 31, which normally extends substantially horizontal and parallel with the longitudinal axis of the balloon, and consequently parallel with the normal direction of traverse of the balloon. Said shaft 31, is mounted to rotate in the bearings 33, of the gimbal frame 34, and the latter is provided with oppositely extending trunnions 35, having a common axis of oscillation extending transversely above the center of gravity of said wheel and frame. Said trunnions 35, are journaled in the bearings 38, and so constructed and arranged that the oscillatory movement of said body is limited to approximately fifteen degrees. Said bearings are supported by the car, and may be adjusted and secured in variable relation with the longitudinal axis of the balloon, by any convenient means. The rotation of said body 30, may be effected and controlled by any convenient means. However, in the form indicated, said wheel comprises the armature of an electric motor having the field frame 40, carried by the gimbal frame 34, and said motor is energized by suitable connections with the source of power 41, controlled by the switch mechanism indicated at 42. It is to be understood that said body 30, may be rotated at variable speed, to produce and control its gyroscopic effect, so that said effect may be opposed to any force tending to turn the balloon from a path coincident with its longitudinal axis, and, that consequently any wind pressure upon the balloon so received as to tend to change the plane of rotation and direction of the axis of said body 30, may be opposed by the gyroscopic effect of said wheel, so that such wind pressure may be utilized to effect the forward movement of the balloon in a direction oblique with respect to the direction of the wind, if desired, the direction of propulsion being also variably determinable, at the will of the operator, by adjustment of the angular relation of said sail and rudder with respect to the longitudinal axis of the balloon.

I do not desire to limit myself to the precise details of construction and arrangement herein described, as various modifications may be made therein without departing from the essential features of my invention, as defined in the appended claims.

I claim:—

1. In a balloon, the combination with levitating means; of a rotary body having its axis substantially horizontal; and means supporting said axis, permitting free but limited oscillatory movement thereof in a direction parallel with said axis; whereby wind pressure tending to turn the balloon from a predetermined direction of traverse, may be opposed by the gyroscopic effect of said rotary body, so that such wind pressure may be utilized to propel the balloon in directions oblique to the direction of the wind pressure.

2. In a balloon having its longitudinal axis substantially horizontal, the combination with levitating means; of a rotary body having its axis substantially horizontal and disposed transversely with respect to the longitudinal axis of the balloon; and means supporting the axis of said body, permitting free but limited oscillatory movement thereof in altitude; whereby, wind pressure tending to turn the balloon from a predetermined direction of traverse, may be opposed by the gyroscopic effect of said rotary body, so that such wind pressure may be utilized to propel the balloon in directions oblique to the direction of the wind pressure.

3. In a balloon having its longitudinal axis substantially horizontal, the combination with levitating means; of a rotary body having its axis substantially horizontal; means supporting said axis, normally preventing azimuthal movement thereof while permitting free but limited altitudinal oscillatory movement thereof; whereby, wind pressure tending to turn the balloon from a predetermined direction of traverse, may be opposed by the gyroscopic effect of said rotary body,

so that such wind pressure may be utilized to propel the balloon in directions oblique to the direction of the wind pressure.

4. In a balloon, the combination with levitating means; of a rotary body having its axis substantially horizontal; means supporting said axis, permitting free but limited oscillatory movement thereof in a direction parallel with said axis; and, means adjustable with respect to said axis, arranged to receive wind pressure in variable angular relation, whereby wind pressure tending to turn the balloon from a predetermined direction of traverse, may be opposed by the gyroscopic effect of said rotary body, so that such wind pressure may be utilized to propel the balloon in directions oblique to the direction of the wind pressure.

5. In a balloon, the combination with a rotary body; of electrical means to rotate said body at such speed as to produce a gyroscopic effect; and, means supporting said body, so that it has a freedom with respect to an axis eccentric to the axis of rotation of said body, substantially as set forth.

6. The combination with a rotary body; of means to rotate said body at such speed as to produce a gyroscopic effect; and, means supporting said body, so that it has a freedom with respect to a horizontal axis eccentric to the axis of rotation of said body, substantially as set forth.

7. The combination with a rotary body; of means to rotate said body at such speed as to produce a gyroscopic effect; and, means supporting said body, so that it has a freedom with respect to a horizontal axis eccentric to and above the axis of rotation of said body, substantially as set forth.

In testimony whereof, I have hereunto signed my name at Philadelphia, Pennsylvania, this 24th day of December 1907.

RUSSELL THAYER.

Witnesses:
EDWIN J. MOLE,
HIRAM BARNES.

AGREEMENT TO ORGANISE THE AERIAL EXPERIMENT ASSOCIATION.

WHEREAS, the undersigned Alexander Graham Bell of Washington, D.C., U.S.A., has for many years past been carrying on experiments relating to aerial locomotion at his summer Laboratory at Beinn Bhreagh, Near Baddeck, N.S., Canada, and has reached the stage where he believes that a practical aerodrome can be built on the tetrahedral principle driven by an engine and carrying a man, and has felt the advisability of securing expert assistance in pursuing the experiments to their logical conclusion and has called to his aid Mr. G. H. Curtiss of Hammondsport, New York, an expert in motor construction, Mr. F. W. Baldwin, and Mr. J.A.D. McCurdy of Toronto, Engineers and 1st Lieut. T. Selfridge, 5th Field Artillery, U.S.A., Military Expert in Aerodromics, and

WHEREAS it has been thought advisable that the undersigned should work together as an Association in which all shall have equal interest, the above named gentlemen giving the benefit of their assistance in carrying out the ideas of the said Alexander Graham Bell, the said Alexander Graham Bell giving his assistance to these gentlemen in carrying out their own independent ideas relating to aerial locomotion, and all working together individually and conjointly in pursuance of their common aim "to get into the air" by the construction of a practical aerodrome driven by its own motive power and carrying a man.

Now therefore we the undersigned, Alexander Graham Bell, G. H. Curtiss, F. W. Baldwin, J.A.D. McCurdy, and T. Selfridge do hereby agree to associate ourselves together under the name of the "Aerial Experiment Association", for the purpose of carrying on experiments relating to aerial locomotion with the special object of constructing a successful aerodrome.

We agree that the "Aerial Experiment Association" shall be organised on the first day of October, 1907, and shall exist for the term of one year from the date of organization unless otherwise determined by the unanimous vote of the members.

We agree that the inventions relating to aerial locomotion made by the members of the Association during the lifetime of the Association shall belong to the Association; and that any applications for letters patent for such inventions shall be made in the names of all the members as joint inventors.

We agree that inventions relating to aerial locomotion made by the members of the Association before the organization of the Association shall belong to the inventors, and not to the Association, unless specially assigned; and that only such prior inventions shall be claimed by individual members as shall be substantiated by the production of written memoranda, drawings, photographs, or models existent before the date of the organization, so that the proofs of prior invention shall not rest on recollection alone, or upon verbal statements unsupported by documentary or tangible evidence of earlier date than the organization of the Association.

The said Alexander Graham Bell agrees to place his Laboratory at Beinn Bhreagh, Near Baddeck, Nova Scotia, at the disposal of the Association for the purpose of carrying on experiments relating to aerial locomotion, together with all the buildings, tools, materials, and appurtenances belonging to the Laboratory, without charge, so long as the Association desires to carry on experiments at Beinn Bhreagh: Provided that the running expenses of the Laboratory, including the salaries of the Superintendent and men employed shall be paid by the Association during their use of said Laboratory, the number of men employed other than the Superintendent to be at the discretion of the Association, and that any new material or apparatus not in the Laboratory at the date of the organization which may be desired for the use of the Association shall be acquired at the expense of the Association.

We, the undersigned agree to appoint one of our number as Director of Experiments to be our medium of communication with the Laboratory.

We agree that the Laboratory workmen shall receive their instructions from the Superintendent of the Laboratory alone, that the Superintendent of the Laboratory shall receive his instructions from the Director of Experiments alone, and that the Director of Experiments shall receive his instructions by vote of the Association of which he is a member.

We agree that the headquarters of the "Aerial Experiment Association" shall be at Beinn Bhreagh, Near Baddeck, Nova Scotia, and that on or before the first of January, 1908,

the headquarters of the "Association" shall be removed to some place yet to be determined within the limits of the United States.

This agreement can only be modified by unanimous vote of the undersigned.

Witness our hands and seals at Halifax, Nova Scotia, this thirteenth day of September, A.D., 1907.

(Signed) Wm. L. Payzant,
Notary Public,
Nova Scotia.

(Seal)

(Signed)
Alexander Graham Bell (Seal)

(Signed)
G. H. Curtiss (Seal)

(Signed)
F. W. Baldwin (Seal)

(Signed)
J. A. Douglas McCurdy (Seal)

(Signed)
T. Selfridge (Seal)
1st Lieut. 5th F. A., U.S.A.

Authenticated by David F. Wilder, Consul General of the United States, September 30, 1907.