BULLETINS

OF THE

Aerial Experiment Association

Bulletin No. XXV Issued MONDAY, DEC. 28, 1908

MR. McCURDY'S COPY.

BEINN BHREAGH, NEAR BADDECK, NOVA SCOTIA

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Beinn Bhreagh, Near Baddeck, Nova Scotia.

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THE NEW EPOCH IN AMERICAN AERONAUTICS.

SECOND PART.

By Karl Dienstbach.

One of the most remarkable appearances in American Aeronautics of the present day is the Aerial Experiment Association. Formerly there has been given information in this journal about the so interesting and well subsidised labors of Dr. Alexander Graham Bell, and his tetrahedral principle of construction for flying apparatus. During all the past years Dr. Bell has endeavored to turn one of his gigantic tetrahedral kites into a motor-driven aeroplane. However, he found this task so difficult and complicated, especially as he wished to proceed systematically and to leave nothing to chance, that it was evident that outside assistance would be necessary. He chose to assist him two young engineers who has just graduated from the Toronto University in Canada, Messrs. McCurdy and Baldwin. The former had been for long years a friend and almost a member of Dr. Bell's family - the house of his father was next to Dr. Bell's country place at Beinn Bhreagh, near the town of Baddeck in Nova Scotia, Canada, and Mr. Baldwin was introduced by him. Both are youthful, vigorous types of the Canadian Scotch as it has preserved itself surprisingly pure in the north of the New World. The real language of the country there is Galic, an old Celtic. Dr. Bell, himself, is of Scotch descent. On his search for the right men to construct his motor, Dr. Bell could finally hardly fail to become well acquainted with Glen

Hammond Curtiss. This latter, a son of the well-to-do old picturesque country town, Hammondsport, in the north of the State of New York, near Buffalo and Niagara Falls, at the beautiful Keuka Lake, of which the high shores, covered with vineyards and woods, with the substantial stone built wine cellars, remind one of the Rhine, has turned within a few years a small shop for bicycles into a thriving factory for motorcycles, in the three buildings of which about 90 workmen are employed. In its ideal seclusion, Hammondsport has just proved itself an especially fertile ground for aeronautical ideas, and the light and strong Curtiss motor was early valued as a motive power for airships. Thus was driven by a Curtiss motor the first California Arrow, Capt. T. Baldwin's creation, and soon these motors were sought, not only by the latter's imitators, but also by many would-be inventors of dynamical flying apparatus. Curtiss is endowed with that happy practical insight, which let him find the simplest construction and the most serviceable measurements; His motorcycles have proven to be solid and speedy, and excel, especially in an original belt transmission which is also to be tried out in the newest flying machine; a built up leather belt touches only both sides of a conical groove in the pulleys, and, therefore, a slip is not liable to occur even on small pulleys.

Dr. Bell, in the summer of last year, had summoned Mr. Curtiss to Beinn Bhreagh, the scene of the newer tetrahedral experiments, and hardly the latter had made there the acquaintance of McCurdy and Baldwin, when Lieut. Selfridge arrived. Lieut. Selfridge was a young officer of artillery

who had made a special study of aeronautics, and had therefore been sent from Washington as an official observer of Dr. Bell's experiments. He was received with open arms. Dr. Bell's gifted wife suggested then that all the above named should legally organize themselves into an "Aerial Experiment Association", in return of which she would give a considerable sum for the sole purpose to put any sort of dynamical flying machine, as fast as possible, into the air. Such good advice was immediately taken and in the beginning of winter the whole new "Association" followed Mr. Curtiss to Hammondsport where he was called back by his business.

Dr. Bell's family was included, and so the "Capitol" of Hammondsport, yonder steep hill surmounting the whole village, which is crowned by Curtiss' house and the factory buildings, became a most unique stronghold of aeronautical enterprise. For a long time past the Mecca of more or less adventurous inventors, it now became an aim for the pilgrimage of more serious promoters of the art of flying, Augustus Post and Prof. Wood might be named as visitors for several days, and Herring and Manly belonged to the pilgrims' flock of the Aero Club of America which was drawn there by the flight for the prize of the Scientific American.

In Nova Scotia the Association had taken up Prof. Bell's own experiments. Lieut. Selfridge was made there a long flight above water, aboard the gigantic tetrahedral kite "Cygnet", which was towed by a steamer. Then it became apparent that the accumulation of so many thousand cells, which of course necessitated the placing of hundreds of them

directly behind each other, marred the lifting effect. Whole masses of cells which seemed hardly within the reach of air current appeared to be solely useless ballast.

On the working program for the winter in Hammondsport, therefore, was placed the search for a more advantageous grouping of the cells, the program being carried out mainly by the younger element. Gliding experiments were suggested, which were taken up with enthusiasm. Faithful to the aim set by Mrs. Bell, viz., to arrive at real flight on the shortest route, there were soon rather eclectic proceedings, and thus a gliding machine was adopted, which came next to that of the brothers Voisin in France. In appearance it resembled the Herring-Chanute apparatus, but the most important part of that, the automatic steering tail, was replaced by a rigidly connected surface behind the wings. As wind vanes, small vertical planes at both sides behind the wing tips, were employed. The results of these gliding experiments resembled those of most of the epigons of the old able school. The obligation was missing to overcome the initial difficulties. And the light motor showed itself in too alluring a proximity. Lilienthal, Herring and the Wrights attained such enjoyable results, just because for the time being they were not at all able to see more than the gliding problem and were therefore given to the subject with heart and soul. It is rather an impediment for true progress, that gliding is more difficult in the beginning than dynamical flight, for the simple reason that it becomes so uninteresting and laborious in a calm, that "flying in the wind" is simply a necessity. Nobody has as yet

approached that degree of mastery which Lilienthal once acquired by an iron perserverance in practicing with his primitive apparatus. What would he say to-day at the almost superstitious fear with which Farman and Delagrange are trying to evade even the least breath of wind. He, who once judged Maxims' machine so severely only "because it could not fly even in a light wind"! It is worth while, by the way, to remark that Lilienthal's apparatus, exactly on account of its primitive simplicity was decidedly superior to the Farman type. The dihedral angle of the supporting surfaces and the large rear cell of the latter render its flight in a calm unusually easy, but are such a hindrance in a wind, that with those machines it becomes altogether a riddle, how and when the art of flying in a wind (without which a lightning fast flying machine has less practical utility than the smallest slow moter balloon) will be learned! For Farman's machines this seems altogether impossible, because, for instance, the enormous leverage of the rear cell would paralyze the efforts of the front control to fight the wind gusts. Lilienthal's surfaces were simply neutral, without help and without hindrance, for the stability. His displacement of the center of gravity was a too tiresome method of balancing, but nobody has yet flown so boldly and so grandly in a strong wind, as he, and the brothers Wright needed only to replace the shifting of heavy masses by the lightning fast movements of steering surfaces to turn the Lilienthal machine in principle into a far greater perfect flier, indeed, their ambitions were only attained because of a Lilienthal-like perseverance!

If the machine is thus based on the right principle, it should indeed be possible to acquire mastership without gliding by endlessly repeated short flights in winds of steadily increasing force, and so we may hope the best for the future of the Aerial Experiment Association in Hammondsport, because logical developments of its eclectic method has led it finally to the veritible Wright type! But let us return to that interesting development!

The above mentioned Hammondsport glider was smashed in the end by an awkward landing, in attempting to fly it as a kite, and was not again rebuilt. Instead, the "Red Wing" was constructed (Dr. Bell has given pretty characteristic names to all his apparatus - they indeed facilitate classification).

This was really principally an imitation of Farman's then so triumphant a machine. The only difference being that according to an idea of Mr. Baldwin's, the upper surface, (across the direction of flight) was curved upwards, and the lower one downwards. Near the wing tips the mutually approaching surfaces had therefore to be made narrower in the direction of flight, and thus resulted a natural approach to the shape of a bird's wing, which was still accentuated by triangular wing tips. This form has been steadily preserved, and indeed justly, as it seems, for it prevents partly the disturbing lifting effect of a side gust, which at the worst would have a sidewise shoving effect, which latter might just neutralise that one-sided lift because it

might call for a certain lift on the opposite side in return.

Like Farman's, was a rear cell but of one surface with a vertical rudder, hinged on its top. It was smaller in proportion and was much lower than the principal cell. The wing profile was peculiar in the shape of Turnbull's S curve. (The curve reversed in the rear).

It had been adopted eclectically in the interest of stability. This machine, mounted on sleigh runners, was tried on the ice of the frozen Keuka Lake. It was provided with that 40 horse-power, air-cooled, Curtiss motor which had been judged so favorably by experts at the second exposition of the Aero Club of America, and has been illustrated and described in the article of last year's issue of this journal. Indeed, the fear expressed at that time that air-cooling would not be sufficient for full power was found to be only too well founded, with this accumulation of eight cylinders. In flight full power can be counted upon only for about three minutes. Taken over from the French was also the mounting of a small propeller directly on the motor shaft. This machine unexpectedly flew up and away during a trial which was only to test its dirigibility on the ice. At a second successful flight, there being no method employed to control the lateral stability, the machine capsized, fell down sidewise on the ice and smashed. Officially, Lieut. Selfridge had been its builder. A second machine, the "White Wing", succeeded it immediately with the great innovation of the "wing tip control".

The twisting of the Wrights' wings was here imitated in principle, but two special horizontal rudders on the ends

of every surface were substituted. This had the great advantage that there rudders in normal flight were set horizontally while they thus did not participate in the flying angle of the supporting surfaces, in action the left rudders could be set positively at exactly the same angle as the right ones negatively and vice versa. The mechanism always operated in this way, and thus there resulted no turning tendency from the righting tendency, like with the Wrights, which would have had to be compensated by the vertical rudder. In a clever way these safety surfaces were worked by the inclination of the upper body of the sitting operator. If the latter would incline, like Lilienthal, but with hardly the tenth part of the effort, towards the side which happened to be too high, he would set instantly these surfaces at the corresponding angles by means of a fork which surrounded his body, and the machine would at once right itself again. Like Farman, the steering wheel for the vertical rudder was used at the same time to work the frontal horizontal rudder by being shoved fore and aft. The "White Wing" was provided with three wheels like those used for the Curtiss motorcycles. They could not set themselves automatically in the direction of flight (in relation to the ground) like those of Farman, and also did not have any springs. In turn, though, they were considerably lighter, and the center of gravity of the machine could thus also be brought into greater proximity to the ground. The shortcomings mentioned have, however, never been felt before, although the practicing grounds were rather unfavorable, fields and meadows, with trees on two sides and a railroad

track with telegraph poles and wires on the opposite side, and half crossed by a very disturbing vineyard, in which an emergency landing would have been excluded. It was formed by the broad valley which is the continuation of the elongated (and farther up forked) Keuka Lake. Hammondsport itself occupies its left side at the Lake shore, and the practicing grounds are over three kilometers distant from the town. The necessary first run was taken on a rectangular race track with rounded corners, which though more resembled a German "fieldroad". Therefore, it was found necessary to place a wheel under the framing of the front control which would be moved by the steering wheel simultaneously with the vertical rudder, because the latter alone was not efficient in keeping the apparatus on the track during that preliminary run. It should yet be mentioned that the uprights posts between the surfaces were sharpened after scientific rules, and that all details of construction were of a very practical nature such as sheet steel connections for the wooden posts etc., all these machines were unusually light for their size. The "White Wing" was tried successfully several times by Selfridge and Curtiss, but came to grief at the first flight Mr. McCurdy ever took, because the latter leaned out of the fork of the tip control and thus could not prevent the machine in the end from striking the ground sidewise with full force and be smashed to pieces. He was fortunate enough to escape with but a slight wound on the arm. The "White Wing" had been officially the work of Baldwin and now came Mr. Curtiss' turn. His design was very similar, but the execution was more solid and deliberate.

He left off, after having benefitted by experience, the vertical surfaces of the rear cell. Thus he attained greater speed, and when finally all of the cloth surfaces were varnished, the lifting effect was considerably increased. It has already been told, in a preceding article by Moedebeck, how Mr. Curtiss won with this machine the beautiful silver trophy of the Scientific American on the Fourth of July, by a flight of one kilometer. The machine has made since then many more and longer flights, and in the worst case has only been slightly damaged. During some repairs, though, it passed through significant development. During the prize flight the position of the center of gravity was not correct, the horizontal rudder had to be depended upon to continually counteract the "bucking up" of the machine by a negative angle. On the day after the prize flight the first complete turn was at last successfully negotiated, but a second short turn would have had to follow it at once to clear that fatal vineyard, and for that too much speed had been lost during the first turn, thus the tip control lost its effect, and the machine in its inclined turning position begun to glide down sidewise, and the right wing and also the front end were damaged. The latter was then longthened and the seat for the pilot could be placed at the same time a little further towards the rear, to thus gain advantageous leverage of the inertia against tipping over. The frontal horizontal rudder was at the same time somewhat increased in size. Later the horizontal tail surfaces were taken off with another resulting gain in speed and capacity for control, without any loss of stability. The surfaces

were then varnished once more and the machine, alas, lost its flying power. That unfortunate dispute about the question: "plane or curved suraces" appears really very superfluous if one has seen how the bending straight of the too light ribs with the increased tension of the cloth resulting from the re-varnishing, had turned the curved surfaces into straight ones, disenabling the machine to rise from the ground. New ribs were then manufactured with a still more efficient single curve without the S curve, glued from four blades in place of three, and therefore preserving better form. Thanks to a favorable principle of construction, these ribs only needed to be inserted into pockets of the cloth from which the old ones had been removed, and the surfaces were again possessed of a most efficient curvature.

The motor was then provided with an extra lubricating apparatus, which allowed the cylinders to flood with oil and which kept them cool considerably longer. At the first steering test with all these improvements, even the last horizontal surface was torn off the tail and the machine would now fly more obediently than ever. It was then simply natural, to take off the useless empty frame of the rear cell altogether and to hold the vertical rudder directly by means of four bamboo poles the vertical rudder being made shorter and higher at the same time. Finally the plan of the machine was completely in accordance with all the best features known to ensure steady flight, one important feature being the increased power of the first control. It was made of two big superposed surfaces and at the same time shifted farther towards the front. These changes made it

easier for the trained operator to maintain stability, in that it became much more obedient, and finally, on the 29th day of August, Mr. McCurdy was able to describe with the machine a closed figure eight, covering a distance of more than three kilometers, in three minutes, and at a height of some eight meters. He landed at the starting point in the middle of this figure. There was a light wind. At the last practicting flights, heights of 20 meters and more had already often been reached. Thanks to the tip control and the narrow wing tips, much shorter turns may be made than are possible for the Farman type, for which latter the practicing grounds in Hammondsport would probably be altogether useless. A new improved machine is almost completed. This was named "Silver-Dart", because its surfaces are covered with Capt. Baldwin's new silver grey rubber impregnated silk which weighs much less and is absolutely air-tight. The wings are somewhat narrower and over two meters longer. By their slender curve they resemble the wings of a gigantic albatross. Of course, two passengers are here counted upon. The construction is extremely elegant. Skill and experience gained were put to use. Of course the rear cell is now absent, and the rudders have become as powerful as possible, both big surfaces and both mounted at the end of long lever arms. Practically this is a "Wright machine", only with several good orginal features. A water-cooled motor of 50 horse-power with radiator is under construction for that machine, which, with all accessories and a passenger, is to be placed into a fish-shaped central body. The surface of the four triangular tip controls

has likewise been increased. Trial flights will soon take place. Officially, this is Mr. McCurdy's machine, and that with so much the more right, as only Curtiss was there to help, as Selfridge has been recalled to service at Washington, for the tests of the Government air craft, and Dr. Bell, with Mr. Baldwin has again eluded the summer heat by going to Nova Scotia. Good work has also been done there. Numberless scientific ascensions of teatrahedral flying machine to a shape which was adopted for a giant tetrahedral flying machine, now under construction. The design is very different from "Cygnet" for between the groups of cells empty spaces have been left to allow free access to the air currents everywhere. On account of the great natural stability of tetrahedral flying apparatus, there is needed only a horizontal rudder in front and a vertical rudder behind the propeller. This flying machine is intended to be towed by a steamer as a kite, and motor and propeller will become operative only after it is in the air.

NB. At the request of the Secretary, this article was translated from the German by Mr. Dienstbach, so ti could be incorperated into the records of the Association.

J.A.D. McCurdy.

Blanchard to Bell.

To A.G. Bell,
Baddeck, N. S.

Baddeck, N.S., Oct. 24, 1908:-As I promised you, I send you a verbatim extract from that famous book of mine. "Mr. White" is one of the inhabitants of the days of A.D. 1837 and the man using the "first person singular" is the person who is a survivor of A.D. 1899 telling his experiences after he awoke in A.D. 1937:- only 38 years of a jump. That thought of "concurrent inventions" I know of to my own sorrow. I once in Montreal applied to a patent lawyer to patent the glass ball and socket castor. Imagine my surprise when he told me he had patented it for another man within three months past, which was I found, a fact. This is an invention whose principles are as old as the leg joints of an animal body.

I send you a picture of the "Dragon Fly". It would not fly as a kite and develop its basic principle. For its stability, it depends on its speed whereby the impact, or rather projective force comes into play to sustain it in its line of direction. You will note that only a part of the tail vanes incline for steering. The major part remain parallel to line of direction to feather or steady the machine, and I think similar small steadying vanes in same parallel (not inclined) distributed along the shaft line, would be an advantage to act like a keel or centerboard. You know the difference between rowing a smooth bottom dory and a keel boat.

I will send you detail of turbine motor as soon as I can get to it. This letter and the extract is for the Bulletin if you wish.

(Signed) H. Percy Blanchard.

The "Dragon Fly"

Illustrating Mr Blanchard's article.

A VIEW AHEAD FROM THE LAST CENTURY
by H. P. Blanchard

Just then, skimming over a low hill-top about a mile away, and perhaps a hundred and fifty feet above the ground, Mr. White pointed out to me the mail courier.

I had been looking with some expectation away up in the clouds, trying in vain to resolve an imaginary dot or distant bird into a flying machine. So I was a good deal surprised to see the reality in the direction indicated. It was not what I had expected.

I had fancied I might see a huge elongated baloon, some way or other propelled, or maybe a great expanse of horizontal canvas, a big aeroplane, perhaps a double or a triple decker slicing the clouds as it swooped down from the heavens. Instead, as this dragon fly thing approached, decidedly with swiftness, the view from front showed the line of an isosceles triangle inverted, its apex a very obtuse angle.

Its spread was about twenty feet, and from this base or crosstie to the lower angle was, I should judge, six feet. In the mathematical center of this traingle was a spindle, on the forward tip of which two tandem fans or propellers whirled in opposite directions. Suspended below was a light, square framed cage in which the driver sat. I had no time for further observation before the machine, keeping its speed close to the ground was almost on us; and then I saw the driver with some effort strongly press a lever down. The result was that a level sail or plane hinged at its front edge to the upper cross-tie, took an angle of some thirty degrees out of the horizontal, pointing forward and up, and the

machine, with a little lilt and rise, checked itself quickly, and gracefully settled to the ground.

The wide rimmed wheels at the extremity of four elastic shafts pointing forward and aft like the extended legs of a galloping horse, took up the small remaining motion, and, the propellers stopped, the thing was at a standstill within twenty feet of the spot where it had alighted. I had now a very welcome opportunity for examining the affair. The driver, an intelligent and agreeable young fellow of about twenty, while he waited the postmaster's pleasure, undertook to explain to me the mechanical construction of the machine.

Built above the narrow oblong cage intended for the driver, were a succession of light metal triangles shaped as I have described, and stayed with cross-wires. Their lower angles were in a line so as to form a prismatic framework, its ends inverted isosceles triangles, and its three sides rectangles about ten feet long. The under surface of the sides (except a strip about two feet wide adjacent the central bottom edge) was covered with a thin hard material like celluloid; and, over against this veneering, the inner side of the ribs, to avoid unnecessary friction, were coiled with oiled cotton or silk.

The front triangle frames graduated larger and their lower angle more acute, with the result that the upper forward points had a very jaunty little forward tilt. A stiffened sail or mat about ten feet square occupied the middle of the rectangular level or top of the prism. When the aero was in motion, this latter plane had sustaining power, but its special use was to check the forward motion of the machine,

and give it ease in lighting.

In its flight I had not observed the, to me, extraordinary length of what I have called the spindle which ran from front to rear through the mathematical middle of the triangular framework. This spindle was fully sixty feet long, three-quarters of it abaft and one-quarter of it forward the centre of the aeroplanes. On the stem, as before mentioned, were the propellers. On the tail end were four thin surfaces about five feet long and about two feet wide, two horizontal and two perpendicular, set like the feathers of an arrow. These planes were further extended but were flexible and moved sideways or up and down as a double rudder according to the desire of the steersman.

Probably to prevent vibration, as well as for further strength, this spindle was trussed with wire, and also was firmly affixed by braces to the prismic aeroplanes. That part of the spindle inside the prism was swollen like a bulb or of torpedo shape, and at its largest diameter measured about two feet through. I could not see into it, but the driver told me that it was cellular inside like a honey-comb, and contained compressed air at a pressure of about four hundred pounds. This compressed air could be supplied either from the power-houses, or, as an auxiliary, a small cylinder of liquid air could be clamped on and utilised. The driving machinery was very simple.

The forward propeller was on a solid shaft that ran right through the bulb from end to end. For about eight feet of its length, inside the bulb, some fifty sets of little flat metal chisel teeth, two inches long, projected like suc-

cessive rows of spokes from a hub, but all like small propeller blades, turned at a certain angle in one direction. Toward the stern, these blades were a little longer and had a shade less pitch than at the bow. They were in sets and between each annular set, was a clear space of about two inches.

The spindle of the cgher driving fan (this was a little larger and went somewhat slower than its fellow about two feet further aft) revolved on the same centre as the other, but its shaft was a tube which fitted closely on the shaft of the other. When this outer shaft or tube reached the interior of the bulb, it expanded into a larger diameter, forming a cylinder six inches through. From the inside of this cylinder, like spokes from a wheel rim, when the hub is removed, projected also a multitude of these thin chisel blades, but with a pitch counter to those bristling from the inner shaft, and in sets to occupy the vacant rings. Collars and flanges on these two shafts took up all lateral motion but allowed them both to revolve freely.

To start the power it was only necessary to open a throttle valve, and let the expanding air through the forward box at the front end of the contra toothed cylinders. As this air under pressure forced its way to the external opening at the further end, it drove the intervening little propellers to left or right, and sent the both shafts spinning in opposite directions. As the compressed air in its reservoir would become somewhat exhausted, the throttle valve would be opened wider to compensate. The little mail bag had now arrived and was put with the other trifling freight in a canvas saddle or jacket slung around the bulb. We waited to see the machine

start.

The driver (who also was captain, engineer, purser, postman and the crew) first gave the rear of the upper horizontal hinged plane a tilt of about ten degrees downward. Then his tiller turned the rudder tail to an opposite but even more decided slant. The spectators seemed to understand the coming manoeuvers and gave a clear right away.

As the throttle opened, slowly the fan propellers began to swirl, then swifter, as the aero gently started forward, acquiring speed at every yard, until at last from a slight elevation in the roadway it disdained the ground, and like a white winged bird with outstretched pinions on its native element it soared aloft and quickly floated far away from sight.

The first fact that occurred to me, and which I remarked to Mr. White as we were waking homeward, was that, taking the machine all for all, there was not a single mechanical principle nor motive force that was not perfectly familiar to our inventors, years before the beginning of the century. "That is so". "Well, how comes it that the flying machine then was not in use long before 1912?" "There are two reasons. Leaving aside any theory to the effect that inventions, like other inspirations, are only given to mankind when on the Almighty's calendar the time is ripe; and that the Ruler of the Universe removes the scales from some ones eyes and discloses, as its hour arrives, some combination maybe of simple principles common to the race for perhaps a thousand years; and which theory has been advanced to explain why two inventors continents apart, honestly and without collusion discover or

uncover the same idea at the same moment;- leaving this theory aside, you will notice that, while machinists had the mechanical principles, they had not perfected in union the arts of balancing. I say in union, because the several and separate ideas were well understood. The Scientific possibilities of the aeroplane were thoroughly comprehended. The metal-pointed, feather-tipped arrow had made us Saxons victors in the far days of Cressy. When Mechanics properly combined the arrow and the aeroplane, then was the flying machine. For years, it is true, the wings had been perfected; they forgot entirely the tail. Without the latter, the aeroplane dived here and there, was uncontrollable. It was folly to attempt a canter through the clouds on such an unbroken pegasus. Even with the weighted wings, the further mistake was made of suspending the burden and driving power like a keel instead of centering it.

By putting the main weight and propellers in the middle between the planes, the air resistance or surface friction on the planes was always balanced on the center of impact and propulsion. A very light pendulum would serve to keep the airship in an even keel. Instead, with the balance not respected, an eddying gust or varying wind would continually increase or diminish the friction on the light aeroplanes; while the energy or inertia of the heavier parts suspended would not feel a corresponding start or stoppage; and the top-heavy, or rather, top-light affair would loose its equilibrium. But, with the arrow centered within its sustaining wings, the solution was found. None the less, you might hand a perfect bicycle to a skilled mechanic; it would be one thing to un-

understand its subtle principles, an altogether different thing to ride and master it. So with the air-cycle; only that with the latter a tumble or an accident meant death.

Experiment thus was circumscribed. However, with the wireless telegraphy, a steering gear with valves like an pneumatic organ under compressed air was easily constructed. By his corresponding tiller safely fixed on Mother-earth the manager through his conjoining electric force could steer his model air-ship high above.

After many failures, and much delicate material smashed to atoms; ultimately the proper proportions and right methods were discovered; and then, with heart of oak and triple brass the first bold captain on the Etherial sea launched out, and the motor airship was in being."

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