Invention in Aeronautics*

Is America Going to Attain Commercial Supremacy in the Air?

By Frederick W. Barker

AS the nobler sensibilities of mankind have always found expression in words of upward import, and human constructive unrest has employed those language terms which pertain to things and conditions above the earth, it is only natural that inventive endeavor through the ages should have been so largely directed toward solving the problem of flight by man, to which the final touch that changed probability to success was given by the Wright brothers in 1903.

I recall to you the wondrously poetic and masterly review by the Honorable James M. Beck, given before the Aeronautical Society of America on the decennial anniversary of the Wright's success, in which the struggles of inventors through the centuries to conquer the air were described in silver-tongued oratory. This address will I know always be fresh in the minds of our members and needs no traversing.

In our almost immediate times it was Sir Hiram Maxim, brother of a past president of the society, Professor Langley and Octave Chanute who contributed some of the real pioneer work which enabled the Wrights to take their power glider into the air and to control it laterally against falling.

The principles of lift and drift for sustentation of an aerofoil were appreciated and applied before the practical demonstration in 1903 of compensating means for variable pressures which gained the victory and discovered to the world mechanical means for maintaining the stability of a flying machine.

Here then was born the invention of the airplane, involving actual, competent material for a basic patent. Basic in the sense that the principle of balance control was first demonstrated. The means employed—flexible wing portions to be warped in a helicoidal fashion—were not ideal, but they were practical and they served the purpose.

The Wright patent has been the subject of too much discussion by patent experts, and its sustainment by the Appellate Court has apparently so completely closed all controversy that more than mere comment would be out of place.

The particular point in the Wright patent that has always appeared puzzling is, why the broadest claim in the patent was couched in the restricted language employed. The claim reads like this:

"In a flying machine, an airplane having substantially the form of a normally flat rectangle elongated transversely to the line of flight, in combination with means for imparting to the lateral margins of said airplane a movement about an axis lying in the body of the airplane perpendicular to said lateral margins, and thereby moving said lateral margin into different angular relations to the normal plane of the airplane."

The method of expressing the idea of varying the wing surfaces for lateral control could have been better expressed as follows:

"In an airplane, a supporting aerofoil, and movable portions arranged at opposite sides thereof to respectively increase and diminish pressure resistance, for lateral balance."

Then the claim would have been in better shape for judicial endorsement, which the splendor of the Wright brothers' achievement warranted, without requiring to lean upon sympathetic consideration of the court, which to my mind was the determining factor in its favor.

As matters stand however the Wright patent is the foundation patent in the art of aviation with respect to movable wing portions of ailerons, and there is nothing to prevent the present owners of the Wright patent from enjoining other unlicensed users of this balancing feature.

The Wright patent does not cover *any* means of compen-

sating for variable side pressures, and there are not wanting other inventors who have sought and are seeking to devise different means for enabling an airplane to fly with lateral balance. The art is necessarily enriched by such attempts of a more or less practical character.

Since the heavier-than-air machine, as thus far evolved, comprises a supporting aerofoil, longitudinal and lateral control ailerons, and a directional rudder, development will be mainly through refinement of these elements, and in the creation and refinement of the thousand and one accessorial devices which naturally result from intensive work and study.

Other types of flying machines, such as the helicopter and ornithopter still in the womb of invention's laboratory, cannot receive the assistance of engineering ability until they at least assume the condition of fledgelings, to offer some basis for scientific development. But the airplane has today a recognized structure composed of coördinated elements which interact to supply all the necessary functions for controlled flight.

A new art is thus born into the world, having vast potentialities for expansion, now occupying the minds of inventors in all civilized lands, whose interests will grow with each unfolding feature until aviation becomes actually an exact science that shall place its protective mantle over the greatest industry that has ever been known.

America, following her brilliant initiative in blazing the way for flight by man, fell behind other nations in progressive work, while England, France and Italy produced advanced examples of flying machines—though these have been mainly of military types. But the native inventive genius of Americans is again coming to the fore, and it is certain that the next few years will show the most radical improvements to be of American origin.

This therefore seems to be an opportune time to offer a suggestion or two to aeronautical engineers and others as to the part patentable invention is bound to have in bringing about a perfected state of aviation.

From time immemorial we have had vessels that could float on water because the density of that medium permits buoyancy, and the air also was found to give buoyant support since the days of the hot air balloon; but the real conquest of the air came only when a controlled airplane was caused through speed of its movement to pack the air before it sufficiently to convert the tenuous atmosphere into a weight sustaining medium. Even as the child first learns to walk totteringly upright, and gradually with the aid of his intelligence, under practice and with increasing strength, walks firmly and then can run, all with perfect assurance and grace, so will man improve his new winged vehicle to the extent that it will eventually satisfy all his needs of aerial navigation.

Of course it is the internal combustion motor which rendered possible the flying machine, and we have to thank the automobile industry and the engineering profession for the numerous refining influences they brought to the motor and thus gave the airplane its opportunity to come into being. But it must not be overlooked that the automobile motor has also proven the most serious handicap that aviation has had, simply for the reason that we have sought to apply to a new, more arduous duty an instrument that had been perfected along lines suited only to an older and less difficult task.

Invention has still its most important field in the production of a thoroughly reliable aviation power plant, and this will come through designs providing sturdy construction wherein the weight is kept within bounds, with more efficient temperature control, continuous and thorough lubrica-

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tion, an ignition system that can be absolutely depended upon, and propelling means that will develop a maximum of thrust. Patents which improve these and allied features to help the power plant in the delivery of continuous high power output over an extended period will do more than anything else to advance the cause of commercial aviation. This progress will be gradual and tested out at every step. But inventors and aeronautical engineers must get completely away from the intermittent and low duty form of motor which is good enough for the automobile, and strive to meet the sterner conditions of a flight sustaining power plant.

The scope for inventive ingenuity in this field alone is so vast and the reward for success in every detail so sure and generous that its attraction is irresistible and will be responsible in the next few years for innovations which will easily differentiate the aviation motor from the automobile motor.

Invention also will show the way to take off an airplane without a starting run over the surface, and to alight and stop wherever desired. The natural forces to serve these ends are available, and even now are in process of harnessing.

Here and there will stand out some bold concept whose deviser may achieve more fame and receive greater emolument than others, but ancillary devices, marking various stages of development, will result as the contribution of many inventors who attack the problem involved from different points of view.

There was published recently in the Journal of the Patent Office Society a report by J. H. Colwell, one of the principal examiners in the Patent Office, of the more important subjects treated of by inventors, and this report, in so far as it relates to aeronautics, is so succinct and comprehensive that I am introducing Mr. Colwell's account in this paper. It reads thus:

"The importance and the application of heavier-than-air craft to military purposes is obvious and self-evident.

"The attention of the country immediately centered on this new form of vehicle, and it was natural that the minds of experts and inventors were directed to improvements in and devising new forms of aeroplanes, as well as to numerous related auxiliary devices, with the result that the Patent Office was flooded with applications bearing on aeronautical devices.

"There is believed to be no exaggeration in asserting that the advance in the development of heavier-than-air craft made during the past five years would have taken from fifteen to twenty years under normal circumstances; 'Necessity is the mother of invention.'

"In so far as the development of a practical machine is reflected in the Patent Office, no new principle or mode of air-sustained flight appears to have been evolved. The aeroplane of the present day is based on the same principle and involves the general structure as first employed by the Wright brothers in their successful air flight in the first decade of this century. Notwithstanding this, however, there is a wide gap between the air craft of today and that of 1914 as regards the general efficiency, inherent stability, carrying capacity, motive power, controls and radius of action, as well as in various accessories, including instructional and training devices.

"The improvements show a general tendency to widen the range of use by anticipating larger load carrying capacity, necessitating increased engine power, and improved motor construction. Different types of modern planes are now equipped with engines ranging up to over 1,200 h.p., including multiple engine units with reserve power.

"There is no reason to suppose that the limit has been reached, but, on the contrary, the air navigation is still in its infancy.

"Increased power calls for increased strength in frame construction without too great a sacrifice of lightness, as weight is a vital factor. This brought to the fore forms of bracing, struts and trussed wing beams. To overcome ex-

cessive wind resistance of exposed parts, which cause a useless waste of power and speed, attention was turned to fairing and stream-lining all such parts, as struts, spars, engine housings, fuel tanks and radiator casings, as well as landing carriage frames. As at high speeds comparatively small areas exert by their wind resistance a greater relative detrimental influence, stream-lining the guy and brace wires has even been resorted to.

"To secure increased strength with the necessary lightness, resort is had to hollow metal tubing, but more generally to various forms of laminated wood framing, as embodied in struts, wing beams and ribs, as well as the fuselage and pilot's car itself. With methods devised and means of uniting and arranging the grain of wood laminate, it is possible to construct a wing rib lighter than one of steel of the same strength. Various materials, as aluminum and other metals, and compressed and treated fibrous structures are constantly being devised, as substitutes for linen in the supporting wings, and also, various substances and compositions commonly termed 'dope,' for treating the wing surfaces.

The hulls and pontoons of hydro-aeroplanes and flying boats are constantly being increased in size and strengthened to make them more seaworthy in withstanding rough water, and the shock of alighting thereon. This has led to the creation of what might be considered a distinct branch in marine ship building, to some extent following the lines of the earlier hydroplane or speed boat. Increased strength necessitates the introduction of longitudinal and transverse hull framing, providing bulkheads for ballast and other compartments, analogous to that in ship building with variations to resist special strains resulting from the peculiar demands.

"A system of aeroplane construction which is being developed and particularly adapted to large craft, appears on its face, not only interesting, but plausible and practical, provided the location of the weight is not detrimental. Broadly stated, the system comprises a hollow plane merged into the fuselage so that the large trussed wing spars, the engine housings and fuel tanks, as well as the pilot, are enclosed within the lifting surface itself. The center of the plane between the upper and lower walls is deep, while the wings taper to small depths towards the tips. The entire machine, including the pilot's car, is practically a part of the lifting surface, thereby necessitating comparatively few external wind resisting parts.

"Among other devices which are being continually received are detaching means for readily releasing bombs, mail bags and other articles, steering devices and automatic controls, wind pressure vanes for automatically regulating the speed, maintaining a constant angle of incidence and preventing the machine from being pointed dangerously upward, to exceed the critical angle and thus cause stalling, with a resulting fatal tail spin.

"Knock-down aeroplanes for ready transportation and assembling, telephone and telegraph accessories, and wind fans or mills for driving electric generators, and air and fuel pumps have received considerable attention.

"The merits of a heavier-than-air craft capable of hovering in the air, or stopping in flight, and also of descending and rising vertically have been fully appreciated, both for military and other purposes. The advantages of such a machine are obvious; among them is the necessity of only a limited or small area of ground space for landing and launching. Numbers of machines designed to possess these qualifications have appeared, the most common type being the helicopter or horizontally rotating screw propeller for exerting thrust. Some of these have no lifting plane, relying solely on the helicopter thrust, while others propose to use the helicopter in conjunction with the ordinary aeroplane, and so to arrange the power transmission that the tractor or pusher propellers can be cut out and power applied to the helicopter, or both operated simultaneously.

"Although it appears that, as yet, no practical and successful machine of the above type has been evolved, it is by no

means improbable that this problem will be solved in the near future, in view of what has been accomplished and the great strides in development along these lines by keen minded men of mechanical experience.

"In view of the constantly increasing altitude being reached in air navigation, numerous systems are being developed for obviating the ill effects of the highly rarified atmosphere, both on the pilot and in the functioning of the motor. These comprise various arrangements for compressing air, including wind fans, or motors otherwise operated. Some utilize the exhaust of the main engines for driving a turbo-compressor. By this means, a constant supply of air at uniform pressure is received, which is automatically regulated in accordance with elevation."

It will have been noted from the foregoing report that the sphere of invention has already widened out to an extent that admits the thoughtful endeavor of experts in many avenues of research, and proves that the inventive world is surrounding aeronautics with an association of arts, which, while each borrowing from one or more older arts, is itself of special character, and all of these new arts are interrelated through the science of aerodynamics, to whose dominant influence all aeronautical arts must be subservient.

The growth of the automotive industry in the past score of years to its present colossal proportions has undoubtedly robbed thoughtful persons of doubt concerning the possibilities before the flying machine, though still there are timid ones who prefer that others, and not they, should invest money in aviation enterprise, or that others, and not they, should venture to fly. Were all men so shortsighted there would be no progress, but that America does not lack boldness of spirit, alike in its captains of finance and in the masses of its people, to guarantee the adoption of aerial transportation, and the support of worthy aeronautical undertakings, is beyond question.

Though today, to the man in the street, there seems to be a lag in visible production of aircraft in America, that is only the surface view. The surest sign of the times is in the Patent Office, where inventions in the aeronautical arts already surpass in number those of many older arts. With invention rife, the meaning is that demand exists even though that demand is in as intangible form as invention itself. For invention springs from super-mentality, creating something new to satisfy an unprecedented condition.

Vision and courage only are needed in America to enable her to win commercial supremacy in the air—such vision and courage as the warring nations of Europe had in 1914 when they improvised, under fire, different types of aircraft for different military usages. True, expense was a minor consideration then, for the existence of nations was at stake. Now, America's honor is involved, for she is behind other nations in the production of up-to-date passenger and merchandize-carrying machines. This slumbering giant of potential productiveness must be pricked, and perhaps the golden guerdon dangled before it, to rouse it into its instinctive desire to out-distance all others.

The American inventor is doing his part in aeronautics, as he has ever done in other arts and sciences, enriching the world with new thoughts and ideas which need only application to crystallize into further development; and this is actually the epochal period when the judicious investment of money and business endeavor stand to realize the most glorious harvest that has ever been gleaned in industrial fields.

CONTROL AND MEASUREMENT OF ALTITUDE RECORDS.

It is of great importance that the performance of typical aeroplanes should be accurately known, and that methods of precision should be adopted for determining the actual path of a machine during a test flight. For this purpose Lieut. Robin writing in *L'Aérophile* of October, 1919, suggests the use of a barograph and a recording thermometer. An ex-

planation is given of the method of reduction of the records, based upon the formula of Laplace, and an illustrative case is worked out.

The barograph is a very simple aneroid type. The pressure gauge consists of a series of thin cylindrical metal boxes, each of which has its base fixed to a spring beneath. Each box is exhausted, and its deformation under external pressure is limited by the spring, so that the deflections are proportional to the atmospheric pressure. A system of amplifying levers and a clockwork recording drum complete the outfit.

The thermometer is of the Fournier type. It consists of a cylindrical reservoir containing a small quantity of light, volatile liquor at its upper closed end. The remainder of the reservoir, together with a communication tube, and a flexible, crescent-shaped tube with one end fixed, are filled with a denser liquid. An amplifying device (and needle moving over a rotating drum) enables the movements of the free end of the flexible tube to be recorded. The movements registered are due to the expansion and contraction of the saturated vapor of the liquid at the top of the reservoir which acts as the thermometer bulb.—Abstracted by *The Technical Review*.

STEREOPHOTOGRAPHY FROM AN AEROPLANE.

OBSERVED from a sufficient altitude, the ground appears like a two-dimensional map, and nearly all plastic effects are lost. Stereophotographs, however, give us good ideas of level distribution, and, with the help of the stereo-comparator accurate measurement of height can in certain cases be obtained. These photographs are thus of the greatest utility for surveying purposes.

Several methods for obtaining stereophotographs are given by W. Klemperer, in *Zeitschrift für Flugtechnik und Motorluftschiffahrt*, October 15, 1919. The easiest way is to use two aeroplanes flying at the same height on the same course or on a parallel course. By photographing one aeroplane from the other on a special camera, the distance between the aeroplanes can be determined.

Besides this "distance" camera, both aeroplanes are equipped with a stereocamera proper, whose optic axis is suitably inclined. The inclination will depend on the focal length of the camera, the altitude of flight and the distance between the planes. This inclination will also settle the degree of plasticity obtained.

In the case of the aeroplanes steering a parallel course, the camera axis is inclined across the direction of flight so that a stretch of country lying midway between the two aeroplanes is photographed from two points of view. In case of the same course being steered, the leading machine has its camera inclined to the rear and the following machine to the front, so that the same stretch of country is again photographed from both machines. If only one aeroplane is available, two flights are required.—Abstracted by *The Technical Review*.

BOY MECHANICS FOR THE BRITISH AIR FORCE.

THE Air Ministry has recently instituted a new scheme to secure the entry of well-educated boys for training as skilled craftsmen.

Under this scheme, boys will be entered between the ages of 15 and 16 years for a period of ten years' color service in the Reserve. During the first three years they will undergo a course of educational and workshop training, graduating them to the rank of Leading Aircraftmen in one or other of the skilled trades.

Those who show most promise during their training will be chosen for an additional six months' course of higher instruction, being promoted at once to the rank of Corporal. From among these, some may be selected for the grant of a commission, and will proceed to the Cadet College for training as flying officers.—Abstracted from *Aerial Age Weekly*.