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Aerial Experiment Association

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A BRIEF SKETCH OF THE PROGRESS OF THE ART OF AVIATION:- by Thomas Selfridge.

(A paper submitted by T. Selfridge, 1st. Lieutenant, 1st. U.S. Field Artillery, to the Aerial Experiment Association, May 17, 1908, with an account of the Association's experiments with their own machine, Aerodrome No. 2, subsequent to that date, revised for this Bulletin).

It was my intention, on starting this paper, merely to refer to those men who had actually been in the air in a dynamic flying machine. But I found on commencing that so much reference had continually to be made to the work of these men who actually laid the foundation for all that is now taking place, that I decided to go back to the beginning and sketch very briefly the whole subject.

The amount of thought, time, energy and money that has been expended is stupendous. I have only attempted to name the most prominent of those who have discovered and laid down the fundamental principles and laws upon which we are all now basing our experiments; and a few of the others, who, profiting by the work of the former, have actually made authentic flights.

It is an almost absolute fact that all men of any scientific attainments since the 14th Century, and even previous to that time, have dabbled in this fascinating subject, and hosts of others have tried to imitate the flight of birds since first these creatures were seen in the air by man.

A few of the earlier and best known scientists who we see continually referred to by the authorities, are Newton,

who probably did more harm than good through the erroneous hypothesis upon which he based his calculations; Robert Hook, and Sir Christopher Wrenn, working as members of the Royal Society of Great Britain, and Hutton. Of comparatively recent date is the work of Dines, Duchemin, Von Loessel, Smeaton, and Langley; while among those now actively engaged in the work are found Prof. A.F. Zahm, of the Catholic University of Washington, D.C.; Wood of Johns Hopkins; Todd of Amherst; Durand of Cornell; Octave Chanute of Chicago; A.G. Bell of Telephone and Graphophone fame, and James Means of Boston, Editor of the Aeronautical Annual.

We may divide the progress of Aviation into the following periods:-

1st. The Ancient or Semi-Legendary ending with the 16th Century.
Dansceus, Oliver of Malmesbury, Dante, etc.

2nd. The early Scientific, ending with the 19th Century.
Da Vinci, Hooke, Wrenn, etc.

3rd. The earyl Experimental, dealing largely with small models to 1890.
Stringfellow, Tatin, Penaud, Goupil, Hargrave, etc.

4th The later Scientific, or early practical machine from 1868 to 1893.

a. The sientific researches of Maxim, Langley, Tatin, Phillips, Goupil, Penaud, Renard, Zahm etc.

b. The practical motorless glider of Lilienthal, Herring, Pilcher, Chanute, and the Wrights.

c. The practical motor-driven machines, of Phillips, Maxim, Herring, Langley, etc.

5th. The present or the later practical motor-driven beginning at 1903.
Wrights, Farman, Aerial Experiment Association, Herring, etc.

The first authentic account we have of a man having actually traveled in the air for some distance with the aid of wings, and alighting without killing himself, is that of Oliver of Malmesbury, a Benedictine Monk, who, in the Eleventh Century, flew from the top of a tower against the wind, by the aid of wings, and alighted 125 paces distance. He fell, however, and injured himself badly. (See Chanute's Progress in Flying Machines, p. 78).

The next man to have fitted himself with wings and flown is J.B. Dante, a mathematician of Perugia, Italy. Toward the end of the 14th Century, he constructed a pair of artificial wings with the aid of which he glided over Lake Trasimene. An attempt was made to repeat this experiment at a wedding festival which took place in Perugia, by starting from the top of the highest tower in town and sailing across the public square. He is said to have stayed in the air for quite an appreciable length of time, but an iron forging which held one of his wings broke, and he fell on a church, breaking one of his legs. This terminated his aerial experiments. (See Chanute's Progress in Flying Machines, pp. 81, 82, 108, 208, 263).

The first scientist of note, of whom we have any authentic record, to devote much of his energies to the subject was Leonardo da Vinci who made copius notes on bird and man flight, as a result of keen observation of the former; and who, in 1500, designed a machine to be operated by man power, so arranged that the man could utilize almost every muscle in his body. He experimented extensively with paper screws which he was able to drive upward into the air, and among

his notes are found designs of one of 96 feet in diameter, made of iron and bamboo, and intended to lift a man. (See Chanute's Progress of Flying Machines pp. 11, 12, 49).

In 1569 we find that Paul Guidotti, an artist of Luccia, Italy, constructed wings of whalebone, covered with feathers, and used them several times with success. He then attempted a flight from an elevation and sustained himself in the air for about a quarter of a mile, but, becoming fatigued, lost control and fell on a roof, breaking one of his legs. (See Chanute's Progress of Flying Machines, pp. 82, 208).

The Royal Society of Great Britain, in the 17th Century, gave out among its members various portions of the problem dealing with the art of flying, papers upon which were later submitted and read before the Society, and may now be found among its proceedings. Some of the ablest of these were submitted by Robert Hooke and Sir Christopher Wrenn.

In 1678 a French Locksmith by the name of Besnier constructed a pair of oscillating wings hinged at the shoulders and worked by his hands and feet. The wings were arranged like folding shutters. He did not pretend to be able to rise or fly horisontally, but was able finally after much practice to glide considerable distances when starting from high places (See Chanute's Progress of Flying Machines, pp. 12,13).

All the flights mentioned so far were really what would now be called glides.

We next come to the work of the second period, or that of more recent investigators to whom we owe much of the

data upon which we base our present experiments. In 1784 Kaunney and Bienvenu of France built a model of superposed screws driven by a bow, and submitted it to the French Academy of Sciences. This flew successfully and they drew up plans for a larger man-carrying machine which, however, was never completed. (See Chanute's Progress of Flying Machines, pp. 50,55).

In 1842 H.F. Phillips of England constructed his first aerial machine driven by a Hero motor. He exhibited a model of it in 1868. He was the first man to investigate thoroughly the effects of curvature on the lift of various surfaces, and in 1884 patented a large series of curved shapes. Continuing he patented in 1891 what he considered the most efficient form of all. In 1890 he patented a machine resembling very closely a venetian blind, placed above a body designed to carry the engine and aviator. He is still at work on a modified form of this machine. The surfaces are very thin shallow planes of considerable extent constructed of wood and having the curvature of the form patented by him in 1891. He successfully drove this machine on a circular track from which it rose while confined by a cord to a pole in the center. (See Chanute's Progress of Flying Machines, pp. 50, 62, 157, 166, 172, 202, 218, 226, 254).

In 1851 Le Bris, a French sea captain, designed a machine to be lifted by two superposed screws turning in opposite directions. He continued his experiments, a description of which may be found in Landelle's "Dans Les Airs". He states that he patterned his later machine on the albatross which he had observed closely for some years. He had noticed a

distinct tendency of the wing of this bird to "Aspirate" when held in the wind. Construction was begun on his artificial bird in 1863. Two bird-like wings controlled by levers and a system of rigging were fastened to a canoe-shaped body 13 1/2 feet long with a maximum beam of 4 feet. A small inclined mast supported the pulleys. The wings were each 23 feet long, giving a total width of 50 feet and an area of about 215 square feet. The weight was 92 pounds. The tail was mounted on a universal joint. The front edges of the wings were mounted on a piece of flexible wood shaped like the front edge of an albatross' wings. The wings could be given a rotary motion and the surfaces given a different angle of incidence. This is the first mention of the application of this principle later used by the Wright Brothers. The aviator stood upright and operated the tail with foot pedals. He started the machine by fastening it to the top of a cart with a slip knot and causing the cart to be driven into a ten knot breeze. He attempted to rise, but the slip knot failed to work. The machine, however, showed a marked tendency to lift and finally tore away the rails of the cart. The horse was then moving at a gallop. The bird rose to the height of about 300 feet, carrying with it the driver of the cart who had become fastened to it in such a way that his weight acted very much as a tail of a kite. Le Bris, finding he had picked up the driver brought his machine gently to the ground after traveling forward about 600 feet into the wind. On releasing the driver he tried again to rise, but did not succeed. The machine was blown over on one side, damaging a wing. Upon completing his repairs, he erected a mast with a swinging yard on the brink of a quarry. The machine was fastened to this arm about

100 feet above the bottom of the quarry, facing the wind. Upon being released, it glided well at first, but dropping below the edge of the quarry, it was struck by a vertical gust which destroyed its equilibrium. Under Le Bris' manipulation the machine partially recovered itself, but fell almost vertically to the ground. It was badly smashed, the operator at the same time breaking a leg. It failed for lack of longitudinal equilibrium. He was able to control it laterally however, by flexing the wings.

In 1867 Le Bris completed his second machine which was lighter than the first, though provided with a moveable counter-weight which was intended to provide automatic equilibrium. One successful attempt was made in a light breeze by starting from the back of a stationary cart. He rose, probably a dozen feet and gliding about twice as far came down without mishap. After numerous other attempts, none of which were successful, and in many of which the machine was injured in starting, he finally succeeded in flying it as a kite with ballast, and once had it travel 200 feet against the wind at a height of about 50 feet. He was never able to duplicate this performance, and in one of his later experiments the machine was again badly smashed. His funds being exhausted, he gave up further attempts to solve the problem. (See Chanute's Progress of flying machines, pp. 21, 52, 81, 104 through to 110, 121, 166, 202, 208, 255, 263.

In July of 1863 a prominent photographer of Paris by the name of Nadar invited to his reception rooms the elite of the press, science, and artists, and treated them to a first

reading of his famous "Manifesto Upon Aerial Automotion" which appeared the next day in the press and was republished and commented upon throughout the whole of Europe. He expressed the opinion that the principal obstruction in the way of navigating the air was the attention that had been given to balloons; that in order to imitate nature, the flying machine must be made heavier-than-air, and that the surest way of success was the employment of the aerial screw. He proceeded to form a syndicate to promote aviation. A journal was founded, the first "Aeronaute", which failed after the fifth issue owing to lack of funds. The syndicate did considerable experimenting with screws with which they were able to lift 32 pounds per horse-power. (See Chanute's Progress of Flying Machines pp. 53, 54, 55, 253).

In 1866 F. H. Wenham of England published his paper on "Aerial Locomotion", in which he gives an account of the performances of a number of man-lifting kites. He invented a method of varying the pitch of a screw by constructing it of two cross arms mounted on a shaft with cloth stretched between the two arms. One of the arms was so mounted that by adjusting the screw could be given any desired pitch. Having noticed how thin a stratum of air is displaced below the wings of a bird in rapid flight, he patented in 1866 a method of superposing planes or surfaces one above the other so as to increase the supporting area without increasing the leverage. He built a machine of five planes, one above the other, each 16 feet by 15 inches, containing in all 100 square feet, and

a second of six planes each of the above dimensions, containing in all 120 square feet. With both of these machines he was able to glide short distances. These were the fore-runners of all present day superposed machines, the main difference being that the surfaces were not rigid. Hargrave, as we shall see later, was the next to adopt this plan, introducing several improvements. (See Chanute's Progress of Flying Machines, pp. 56, 59, 67, 99, 100, 103, 113, 174 to 177, 231, 253, 272).

A. Penaud, following in the steps of Launmoy and Bienvenue, in 1870, when but 20 years of age, constructed, in Paris, his small model of a helicoptere driven by two superposed screws actuated by twisted rubber by which they were turned in opposite directions. He was able to cause this to rise to a height of 50 feet. The device has since been widely copied and is the one upon which all such toys, as are now so often seen are based. In 1871 he constructed a model aeroplane which consisted of following surfaces, a forerunner of Langley's machine, that possessed automatic equilibrium. The lateral equilibrium was attained by bending up the wing tips, and the longitudinal by two small following planes which were set at an angle of 8 degrees below the horizon of the leading planes. The center of gravity was placed a little in front of the center of pressure, causing the machine to progress by sweeps. It was driven by a single screw turned by a twisted rubber band. In 1872 he built a model of a mechanical bird whose flapping wings were also driven by a twisted rubber band. The model flew 50 feet in 7 seconds. He accom-

plished a tremendous amount of work during the short time which was alotted to him. Among other useful devices, he invented a balloon valve, a delicate barometer, and a system of studying bird flight by means of instantaneous photography, afterwards carried out by Marey. He also contributed a number of valuable papers to L'Aeronaute, in one of which he mentions that ascending currents are not rare, and are quite sufficient to account for the soaring flight of birds. His last work was accomplished with the aid of a mechanic by the name of Gauchot. It was to construct a large two-man-carrying machine. The design was completed, but he was not able to negotiate the funds. He died shortly after, in 1880.(See Chanute's Progress in Flying Machines pp. 28, 40, 45, 55, 56, 99, 117, 118, 119, 120, 121, 122, 123, 124, 132, 138, 184, 189, 190, 224, 258.)

Commandent Renard of the French Aeronautical War Establishment at Chalais designed in 1873, and exhibited in 1879 a "Dirigible Parachute", which closely resembled a venetain blind somehwat similar to H.F.Phillips', of which the different members were flat planes superposed above an oviform body. in 1889 he also published the results of the propeller experiments performed in connection with the construction of the balloon "La France". He was one of the most eminent of the French contributers to the art of flying. He also conceived the idea of the hinged propeller which principle is embodied in the driving parts of both La Ville de Paris, and in the dirigible designed by Major von Parsifal of the German Army. (See Chanute's Progress in Flying Machines, pp. 70, 71, 164, 166, 170, 253.)

A French Engineer by the name of Victor Tatin constructed in 1876 a mechanical bird driven by a rubber band. In 1879 he built two compressed air model aeroplanes which flew successfully. He was able in these machines to lift 110 pounds per horse-power. He was also connected with Professor Marey in the latters work on the flight of birds; designed Count de la Vaulx's dirigible; and has acted as consulting engineer in the construction of the various French War Balloons. He also designed the heavier-than-air machine recently used by Count de la Vaulx, which was the first machine in France to fly at the first trial. This took place in 1907. He has done a great deal of valuable work on the subject, much of which may be found in the numbers of L'Aerophile, and still is actively engaged in promoting aviation in France. (See Chanute's Progress in Flying Machines, pp. 30, 41, 137, 139, 140, 141, 226, 254; also L'Aerophile for 1906, 1907, 1908).

Coupil, a distinguished French Engineer built a machine in 1883 for the purpose of studying the equilibrium of aeroplanes. He also constructed, about this same time, a steam engine weighing 42.5 pounds per horse-power. He has made many valuable contributions to this subject, many of which may be found in L'Aerophile, and is still actively at work. He, Tatin, and Commandent Renard are the three men to whom France owes most of her present progress in the art of flying. (See Chanute's Progress in Flying Machines, pp. 9, 40, 154, 155, 156, 157, 158, 186, 202, 262; also L'Aerophile).

F. W. Breary, The Honorable Secretary of the Aeronautic Association of Great Britain, in 1879 constructed a flying model driven by the wave motion of large and loosely stretched wings, very much on the same principle used by the skate in propelling itself through the water. He was first to use the "pectoral cord" in models driven by flapping wings. This was in 1865. (See Chanute's Progress in Flying Machines, pp. 84, 85, 143, to 147, also "Flying", an English publication).

Lawrence Hargrave began his work on flying machines in 1863, and read his first paper on "Trochoided Planes" before the Royal Society of New South Wales. Altogether he built eighteen models of increasing size, all of which flew. He does not believe in taking out patents, but as a general rule gives to the world any discoveries which he makes during his experiments. He exercises the greatest care in all his work making careful measurements of all parts and power, and also keeps very complete records. Up to June 7th 1893, he had read thirteen papers before the Royal Society. His first investigations were upon the motions performed by the propelling surfaces of birds and fishes, the waves these created in the fluids and the counter-action of these waves on the forms of the propelling surfaces themselves. With the data gleaned from the above, he constructed fifty models which were to produce horizontal flight. Some of these were driven by clock work. He selected the best and from their mean dimensions derived a standard form for a fresh departure. He then constructed ten various types, seven using flapping wings, one a single screw in front, one two screws in front, and one a

single screw behind. This last, proved to be the most serviceable and practical form of the screw driven models. He states that he finds screws and flapping wings to be about equally proficient, but prefers the latter. In 1890 he constructed a machine driven by compressed air actuating flapping wings on the principles laid down by Borelli in 1680. This flew about 368 feet with an expenditure of 870 ft. pds. It had about 6.43 square feet per pound of weight. The wings had elastic back edges, so as to obtain the best results from the torsion induced in them. He used long planes to obtain longitudinal stability, but states that there is a gain in efficiency by using two surfaces with a gap between. Lateral stability was maintained by the use of a slight dihedral angle between his surfaces and the center of gravity was placed below the center of support. He found some difficulty in causing the center of gravity to co-incide with the centure of pressure. His final conclusions were that the best position for the center of gravity of a continuous surface is .25 or .2 of the total length back from the front edge. In 1890 he constructed a second model which flew 343 feet. In this one he had shortened the plane. His next machine was driven by a three-cylinder compressed air engine turning a screw propeller. The speed of this model was 10.34 miles per hour. It utilized 7 square feet per pound of weight and carried 89.5 pounds per horse-power. Up to this time he had constructed sixteen models, ten driven by rubber bands and six by compressed air. His next work was an attempt to develop a gas turbine, but was unsuccessful. He also made a

model boat which was propelled into the wind by the wave action on its under surface, illustrating that peculiar property known as "aspiration". He then turned his attention to steam engines, and built one weighing 19.2 pounds per horse-power with which he drove his seventeenth model. A second weighing only 10.7 pounds per horse-power was constructed for his eighteenth model. No data on the flight of these last two models is given. To obtain data on surfaces, he next flew kites, and in 1892 conducted his experiments with cellular kites of various forms. He finally arrived at the form known as the box-kite in which he used both curved and plane surfaces. He gives credit to Wenham for suggesting to him the use of superposed surfaces in the latter's paper published in 1866. His box-kite is the model on which many of our superposed surface flying machines are based. (See Chanute's Progress in Flying Machines, pp. 218 to 226, 228, 230, 252, 254, 255, 258, 268).

Clement Ader, a Frenchman, constructed his first flying machine in the shape of an artificial bird, in 1872. With this as a basis, he continued at work on later models till he obtained recognition from the Minister of War with whose aid he completed, in 1900, at the expense of about $120,000, a large monoplane weighing 1000 pounds, driven by two propellers, carrying two wings which could be folded at the back. It was exhibited at the Paris Exposition of that year, and was also given a trial at which it succeeded in rising from the ground, but was so lacking in equilibrium

that it fell and was wrecked. (See Chanute's Progress in Flying Machines, pp. 306, 311 to 314, also Hildebrandts' "Airships Past & Present").

In 1888 Sir Hiram Maxim had completed his large aerodrome, built at the cost of $100,000, with an area of 3875 square feet, and weighing 7,000 pounds. It had taken him several years to evolve this creation, and it is due to the building of this machine that the present light weight automobile steam engines owed their early development. His propeller experiments have proved to be of the greatest value. The machine was tried on a circular track, so arranged that it could only rise to a very small height. It was made to lift on at least two different occasions, and the last time did so with so much force that it broke away the restraining rails and moved off across the field. By the time the power could be shut off and the machine brought to a stop, it had been very badly wrecked. The aeroplane was driven by two seventeen foot propellers turned by a steam engine. This work of Maxim's is by far the most ambitious in the field of aviation that has ever been attempted. Having exhausted the amount he set aside for his aerial experiments, he discontinued them. The tests took place in England. (See Chanute's Progress in Fly-Machines, pp. 38, 53, 68, 71, 73, 75, 84, 119, 133, 141, 154, 229, 233 to 246, 252, 254, 258, 267, also Aeronautical Annual of 1906).

Prof. S. P. Langley, third Secretary of the Smithsonian Institute at Washington, began his work in aviation in 1889. He published his "Experiments in Aero-Dynamics" in 1891

and his "Internal Work of the Wind" in 1893, two contributions which probably had more to do with the promotion of the subject than any others up to that time. In 1896 his model aerodrome No. 5, steam-driven, with two propellers, made two successful flights. A second and a longer flight of a quarter of a mile was made by his No. 6 machine on November 28th. He then proceeded to the construction of a large man-carrying aerodrome, and with the aid of Mr. E. M. Manley, completed it in 1903. It was driven by a 52 12 horse-power gas engine designed by Mr. Manley for this particular purpose, actuating two propellers revolving in opposite directions and weighing but 2 1/2 pounds per horse-power. This engine to-day remains unexcelled in its ratio of weight to horse-power, being in addition water-cooled. Mr. Manley claims to have run it on a brake for nine hours, and to have obtained the above stated horse-power from it constantly for this period. The large aerodrome was built at the expense of the United States Government, Congress having appropriated a special sum for this purpose. In 1903 it was given two trials, in neither of which it was properly launched. The first time was due to the failure of the launching device, and the second to the giving way of the guy wires which supported the engine bed. The connections of these wires had been greatly weakened by the racking they had been subjected to in the preliminary tests of the engine. The press of the United States, because Prof. Langley in accordance with the directions he had received, had persistently excluded reporters from his experiments, attacked him so violently, as a result of the failure of his machine

to get into the air, that Congress refused to appropriate any further moneys for the carrying on of his experiments. Prof. Langley never recovered from this disappointment which he experienced at this lack of confidence. He died in 1906, his death being hastened by the constant worry which these attacks had occasioned. His machine would unquestionably have flown had it been properly launched. It was a wonderfully well constructed piece of mechanism, and its design was absolutely correct, as has been demonstrated again and again by recent investigators. He has probably done more than any other one man to place the subject on a firm scientific basis, and his work, supplemented by that of Lilienthal, may indeed be said to have fairly launched the matter in a practical way and be largely responsible for the rapid and steady development it has since undergone. (See Chanute's Progress in Flying Machines, 3, 8 to 10, 73, 104, 119, 126, 234, 240, 251, 254, 255, Aeronautical Annual for 1896 and Smithsonian Publications).

Otto Lilienthal, a mechanical engineer of Germany, is the man whose example of actually traveling in the air put the whole subject on a solid practical foundation and inspired Pilcher, Chanute, Herring and the Wrights to follow in his foot steps. He began his work in aviation in 1861, at the early age of thirteen, and continued it from then on till his death in 1896. In his odd moments for 10 years with his brother's assistance he constructed numerous models of flying machines.

His serious work covered a period of 25 years. It be-

gan with the systematic analysis of the problem as it appeared to him, and was continued by careful investigation and experiment. He studied bird flight and the forms of bird wings and investigated carefully the resistance and reaction of air on various surfaces and the power necessary to maintain flight. His earliest out door work was to suspend himself from a spar in a machine which consisted of two wings, and gain experience by trying to exert a certain measure of control over the apparatus in comparatively high winds. This occurred in 1892. In 1893 he constructed another apparatus of 107 square feet, weighing 33 pounds. The surface of this was later reduced to 86 square feet, and its weight to 39.6 pounds. He first practiced jumping off a spring board set up in his garden. After acquiring considerable dexterity in handling his apparatus, he went to a nearby hill and practiced running down the slope with it into the wind. His relative velocity was about 23 miles per hour, but he was unable to handle the apparatus at first in a wind stronger than 11 miles per hour. Later he was able to control it in velocities up to 16 miles per hour. His most favorable glides were about one on eight, or seven degrees, and his longest distances about 200 and 300 meters. His first machine consisted of a single pair of wings with a curvature of about one in twelve supplemented with a vertical and horizontal tail. He later built gliders of superposed surfaces, completed plans for a motor-driven machine, and then constructed an engine weighing 88 pounds which would deliver 8 1/2 horse-power for four minutes. His intention was to have it actuate surfaces so that

they would imitate the rowing flight of birds. In August of 1896 he was experimenting with an old glider, which he intended very shortly to replace with this new machine, and which was said to be in such condition as to make continued use of it very hazardous. Although he had been warned of its condition by his assistants and its need of overhauling, he omitted to have it repaired. On the 9th while in mid-air, the machine, as had been predicted, collapsed, some of the guy wires parted and it fell with its operator from a height of about 45 feet, breaking Lilienthal's back, and an injury from which he died in a few hours He was the first experimenter to realise that learning to balance is the first great problem of flight, and is probably the greatest contributor to aviation, in that he himself demonstrated the feasibility of actual practice in the air. (See Chanute's Progress in Flying Machines pp. 196, 201 to 211, 214, 263, also Aeronautical Annual of 1896).

A contemporary of Lilienthal, and one of the first to follow in his footsteps, was Pilcher, of England, who in 1895 started to imitate Lilienthal's flights. He made several glides in Lilienthal's own machines in Germany; and was the first of the later workers to cause himself to be raised in his machine by having it towed as a kite. On reaching the desired height, he would cut the machine loose and glide down to the ground. Pilcher continued his experiments to 1899 and became very expert in handling his glider to which he found it very convenient to attach wheels to aid him in manoeuvring it on the ground. In this same year an apparatus which had developed certain structural defects collapsed with him in the air, and he was killed by the fall. As the result of his tests he discarded surfaces which were set at what is ordinarily known as the dihedral

angle for those which droop after the fashion of a gulls wing. This latter form he found more stable, particularly in high winds. These conclusions were later confirmed by Chanute, Herring, and the Wrights. (See Aeronautical Annual of 1896 and Moedebeck's Hand-Book).

Octave Chanute, one of the foremost civil engineers of this country, although a Frenchman by birth, published in 1893 his "Progress in Flying Machines", the only authentic and reliable work that has yet appeared on this subject and from which I have obtained most of the material for this article. In 1896 he set aside a certain sum of money, about $10,000, which he intended to devote to practical aerial experiment, and accompanied by the aid of Mr. Herring, and Mr. Avery of Chicago set up a company the sand dunes along the shores of Lake Michigan; the first really successful apparatus used was designed by Herring. They began with the Lilienthal type, but found it very unsatisfactory, and then tried multiple following wings, but very quickly replaced them with multiple superposed wings. In order to control the change of the center of pressure, the lack of which had proved disadvantageous in Lilienthal's apparatus, the wings were first made moveable. This corrected the difficulty to a certain extent, but it was not until the adoption of Herring's spring tail, which we also find on Langley's successful models and large machine, that they attained any marked success. From then on good results were obtained with the two superposed surfaces. Later in 1902, Mr. Chanute designed a system with pivoted wings which proved satisfactory. Hundreds of glides were made by these experimenters without a serious accident.

Their best apparatus weighed about 23 pounds. Since 1902 Mr. Chanute has not done any active work other than assist Herr Moedebeeck in the compilation of his hand-book, but he has devoted his extensive knowledge of the subject to the free assistance of all who have cared to call upon him for his advice and help. (See pp. 296 to 300 Moedebeeck's Hand-book; also Aeronautical Annual of 1895 and 1896 and 1897).

Professor Alexander Graham Bell took up kite flying as a pastime seventeen years ago, starting with cellular structures in the form of hexagons and parallelograms. He next tried triangles but being dissatisfied with the necessity of introducing guys to strengthen these forms, he finally turned to the tetrahedron as the most economical unit of all. Great difficulty was encountered at first in fastening these units, or cells together, but after persistent effort extending over a course of about six years, the present simple and efficient system was evolved. In the summer of 1907 he was ready to turn his attention to the problem of converting his kites which because of the great number of cells and dihedral surfaces are very steady flyers, into motor driven flying machines, and on December 6, 1907, sent up his large structure, The "Cygnet" consisting of 3393 cells covered with 184 square meters of silk, carrying Lieut. T. Selfridge, 1st U.S. Field Artillery. The kite was flown over the water, but was completely demolished on alighting, due to inexperience of the men stationed at the flying line. Important and full data were however obtained. In the latter part of July 1907, Prof. Bell suggested to Messrs. G.H. Curtiss, F. W. Baldwin, J.A.D.

McCurdy and Lieut. Selfridge that they associate themselves with him for the purpose of putting a practical aerodrome in the air, stating that Mrs. Bell had requested that she be allowed to furnish funds for the promotion of the experiments of some such body. As a result, the Aerial Experiment Association was formed on October 1st, 1907, with the above object, the funds for its investigations and experiments to be furnished by Mrs. Bell. Since its formation they have put up a man in a tetrahedral kite for seven minutes, built two aerodromes, No. 1 the "Red Wing", which made two flights of 107 yards and 40 yards, and No. 2 the "White Wing" which made five flights of 45, 53, 79, 205 and 134 yards: total, 679 yards, or 826 yards for both. They are now constructing their No. 3 machine.

A. M. Herring, whose interest had been aroused by Lilienthal's example, commenced experimenting in the early part of the last decade. He began gliding with a Lilienthal type of machine as early as 1893, and in that year also completed a very efficient model driven by rubber bands. He was one of Prof. Langley's assistants during the latter's earlier experiments, and later, in 1896 and 1897, joined Mr. Chanute in his work in the vicinity of Chicago. There he designed the party's most successful glider, which has since been erroneously known as the Chanute type. We find his spring tail, mounted on a universal joint, used in all of Prof. Langley's successful models, and in the best of the gliding machines used by Chanute. He was also the first in this country to use superposed surfaces built up in the form of an ordinary bridge

truss; as well as the first man, so far as is known, to have made a flight in a power driven machine; on the 11th and 22nd of October, 1898, at St. Joseph, Mich., he flew a distance of about 73 feet in a machine driven by two propellers actuated by a compressed air engine. This flight took place in the presence of witnesses, and an account of it appeared in a Chicago evening paper of a somewhat later date. This machine carried 162 square feet of surface, weighed 251 pounds, and was driven by a five horse-power motor. He is now under contract to deliver a two-man machine to the United States Government about the middle of August and has an order to build a similar one for Mr. McCoy of the Aero Club of America. (See Aeronautical Annual 1896 and 1897, Moedebeck's Hand-book and the May number of the American Aeronaut).

James Means of Boston published, in 1895, 1896 and 1897 the three volumes of the Aeronautical Annual which is the best, and one of most exhaustive reviews of the fourth chapter, or period of the progress of aviation. He is one of that small coterie of prominent men, Langley, Chanute, Bell, Maxim and himself who would have rendered the art an incalculable aid by the mere lending of their names to the subject, had they been content with that alone. He is now actually and energetically working in connection with Octave Chanute, A. Lawrence Rotch and Alexander Graham Bell in raising by August 1st next a $25,000 aviation prize for 1908.

Interest arroused by the report of Lilienthal's death in 1896, caused the Wright Brothers, Wilber and Orville, now of international fame, to take up the subject of aerial navi-

gation. Their first idea was to make a glider fly as a kite, so that they could remain in the air for some appreciable time, and thus become used to the sensation of being in the air, for on investigating the thousand flights of Lilienthal, they found that he had not spent more than a total of five minutes in the air. They did not complete their first practical apparatus until 1900, but following Lilienthal's death they devoted much time and thought to the matter and decided fully just what they wanted before they tried their man-carrying apparatus. The following radical changes from the type of glider designed by Herring and used by Chanute were made.

1. They decided to do away with the tail.

2. They provided for lateral equilibrium and steering to the right or left by a peculiar torsion of the main surfaces which is equivalent to presenting one end of the wings at a greater angle than the other. (First tried by Le Bris).

3. They introduced a front moveable plane with which to compensate for the moveable center of pressure, being the first advocates of this method now so generally adopted throughout the world.

4. They moved the forward main cross-piece to the extreme front edge.

They enclosed all members and ribs other than struss in the cloth of the plane.

5. They re-arranged the wiring so that all of the wires could be tightened by merely shortening two of them.

A slight conception of the work done by them between

1896 and 1900 may be gathered from the above, a great deal of which was original. Their glider was constructed so that it could fly loaded in an 18 mile wind. They found from the very first that the calculations of early investigators were going to be of little assistance, and between 1900 and 1903 they practically went over the whole ground in their own Laboratory. For their outdoor experiments they moved to the Kill -Devil Hills of North Carolina, where they spent their summers gliding from the tops of Sand Dunes. They continued this during 1901, 1902, and 1903. Their machine differed but little from that of 1900. Early in 1901 they tried increasing the curvature in their surfaces, but found that this detracted greatly from the longitudinal equilibrium possessed by their 1900 glider, whereupon they returned to that of the latter. In 1902 they added a vertical tail to augment the steering from right to left derived from their system of twisting the surfaces and to counteract the tendency of the machine to turn at each attempt to right it. Toward the end of 1903 they had practically completed their gliding experiments and had constructed a power-driven model carrying an engine of 12 horse-power. With this they made a flight on December 17th, 1903, the second men in the world to get in the air in a dynamic flying machine, and the first to fly in a machine supplying its own power. They continued their work on the subject in 1904, making short flights, and striving to overcome the many difficulties which they encountered. They did not attain any great measure of success until 1905, when, on September 26th, they made a flight of 11 1/8 miles with a

machine driven by a 25 horse-power gas engine. This motor was their third, their second being a 15 horse-power engine used in their 1904 experiments. On September 29th they flew a distance of 12 miles; on October 3rd, 15 1/4 miles; on October 4th 20 3/4 miles, and on October 25th 25 1/5 miles in 38.03 seconds. In 1906 when the relations between France and Germany were somewhat strained over the Morrocco question, France ordered a flying machine from them and put up bond of $9000. This she later forfeited upon the situations becoming less acute. They resumed their experiments in May, 1908, and are reported to have made a flight of eight miles at a speed of 60 miles per hour. The newspapers of recent date have contained numerous articles concerning these flights, but the accuracy of their statements must be seriously questioned, as the flights are said to have been observed by the reporters from a distance of not less than two miles. It is stated that in their last flight in which they covered eight miles, their machine was completely demolished by an untimely accident. The operator, however, sustained no injury. Many of these tests were made with the machine carrying two men. They are now under contract to furnish a machine to the United States Government about August 20th of this year. (See Smithsonian Publications and Moedebeck's Hand-Book).

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AN ACCOUNT OF RECENT EXPERIMENTS WITH DYNAMIC FLYING MACHINES.

William Kress, an engineer of Vienna, in June of 1901 constructed a very promising device which consisted of three sets of planes arranged in a form known as the Langley type which possessed 1000 square feet of surface. It was to be launched from the water, and for this purpose it was mounted on two narrow aluminum floats. These were constructed for use over ice and snow as well. It was driven by an 18 horse-power Daimler motor weighing 840 pounds. In the trial it attained considerable speed over the water, but on attempting to turn it was capsized by the wind that was then blowing, and so badly damaged that it was abandoned, being picked up several days later on the shore. It did not succeed in rising. (See Hildebrandt's "Airships Past & Present").

Earnest Archdeacon, the man to whom more than to any other is due the tremendous activity recently displayed by the French, formed a Commission of Aviation in the Aero Club of France in 1903. In April of 1904 he had built a gliding machine very much like that used by the Wrights, with which he conducted numerous experiments. In the same year he put up a cup for the first machine that would travel over 60 meters. This was won by Santos Dumont, on October 13th, 1906. With Henri Deutchede la Meurthe, he put up the Grand Prix of Aviation of 50,000 francs ($10,000) for the first aviator to travel a kilometer in a closed circuit. This was recently won

by Farnam on January 13th, 1908, when he covered between 1500 and 1800 meters, returning to his point of departure. In March of 1905 he flew his glider as a kite, carrying a load of sand to represent the weight of an operator. It came down unexpectedly and was badly injured. Later in the same year, he built another which was flown over the waters of the Seine. It resembled closely a two-celled Hargrave kite. It flew 400 meters, carrying Gabriel Voisin, being towed by a motor boat which was traveling about 18 miles an hour. Toward the end of the flight he cut the flying line and descended gently to the water. In September this same kite was flown over Lake Geneva. Its total weight was 300 kilograms; pull 60 kilograms; speed 10 meters per second; horse-power expended eight. These experiments demonstrated beyond question the practicability of the motor-driven aeroplane in the light of recent developments in the construction of gasoline engines. Archdeacon has since given up practical experimenting on his own part and is devoting all his energies to popularizing the art, and with what wonderful success the work accomplished in recent years and still being pushed with tremendous energy in France, attests. (See L'Aerophile 1906 and La Revue de L'Aviation, 1907).

Early in 1906, Vuia of France started work on his flying machine, and during the summer of that year is said to have made a few short flights. His frist public demonstration, however, took place on October 8th, when he made a flight of eight meters. He is conceded to be the first man in Europe to have left the ground in a power-driven machine, though

Santos Dumont made his first official flight on September 13th of this same year. On October 14th, Vuia again succeeded in leaving the ground. This earlier machine was driven by a carbonic acid engine designed and built by himself. It proved to be most erratic, and was undoubtedly the cause of his early failures to make long ~~flights~~ flights. He continued his experiments on January 26th, 1907, and also on March 26th, and March 27th, still using the same motor. On all of these dates he made flights none of which exceeded four meters. He then decided to discard this engine, and bought a 24 horse-power Antoinette motor which he installed in his new No. 2 machine. With this he made a short flight on June 21st, and on July 25th succeeded in flying 20 meters. The machine came down unexpectedly and was damaged, at the conclusion of this flight. No further reports have been received regarding him, although it is inferred that he is still at work. His aeroplane weighs 213 kilograms, including the operator and had 13.5 square metres of surface.

Santos Dumont, the second man in Europe and the fifth in the world to travel in the air in a practical flying machine started experiments in July 1906 with an aeroplane which he suspended first from a balloon and then from a wire cable stretched between two points. This was subsequent to work he performed in the same year on a helicoptere that gave so little promise of success that he discarded it in favor of the aeroplane. When he felt he had gained sufficient control over it, he had an engine installed, and September 13th, 1906, at Bagatelle, he made a flight of from 7 to 8 meters. On

* Some variation in the weight.
probably must to be 80 Kg.

October 13th he won the Archdeacon cup for a flight of 60 meters This first aeroplane was his No. 14, had a surface of 52 square meters, weighed 300 kilograms and attained a speed of 30 kilometers per hour. He used a propeller two meters in diameter with a pitch ~~one~~ one meter weighing eight kilograms. He traveled about 100 meters over the ground before rising. On October 23rd, after he installed a 50 horse-power motor, and reduced his surface to 50 square meters, he made a flight of 100 meters. On November 12th, he made flights of 40, 60, and 220 meters. He later built a second machine with which he had but little success, of 14 square meters, weighing 200 kilograms, and having a 50 horse-power motor. On November 16th, 1907, in his No. 19 or third aeroplane, which was made of bamboo and metal covered with varnished silk, driven by a 17 horse-power motor, had 10.2 square meters of surface, and weighed 110 kilograms, he covered at the third attempt 200 meters. On November 17th, he made three flights of 100 meters, 50 meters, and 100 meters.

On the 30th of March 1907, the Voisin Brothers completed an aeroplane designed by Leon DeLagrange very much along the lines of the kite flown by Archdeacon over Lake Geneva. On this date Charles Voisin, one of the builders, made two flights one of 25 meters and the other of 60 meters, and on April 8th, the same operator flew 50 meters. DeLagrange ordered a second machine which he first took out for trial on January 30th, 1908, and in which he made his first flight of 100 meters. On March 21st after a flight of 1500 meters, DeLagrange ~~[illegible]~~ took Farman in the machine for a flight of 50 meters, the first two-man flight in France. On April 10th after constant practice

he covered 2500 meters in a circle, and on April 11th 3920 meters in 6 minutes, 30 seconds, thereby winning the Archdeacon cup from Farman, whose best flight of 2005 meters was made on March 21st. Delagrange himself, was, however, the ninth man in France to get into the air. He is now making flights in Rome . (See L'Aerophile and Current Publications).

In October of 1906, Bleriot and Voisin tried their first machine over the water. It was unable to rise. Bleriot then ordered a new apparatus which was completed in time for him to make short flights of five and six meters on April 6th and 7th, 1907. On July 11th he flew 25 to 30 meters and 78 meters in his No. 3 machine; On July 25th he covered 180 meters and 150 meters; on July 31st, 125 meters; on August 1st 100 meters; on August 6th he made two jumps in a continuous run, of 120 and 143 meters, and on August 10th he made a flight of 80 meters. All these flights were accomplished with a 24 horse-power motor.He now replaced it with a 50 horse-power motor, driving a four-bladed propeller, from which he obtained a pull of 286 lbs.With this new machine, on September 5th, he flew 200 meters; on Spetember 11th, 90 and 100 meters; September 12th, 100 meters; September 17th, 134 meters; November 16th with still another machine, No. 5, he made a short flight at a speed of about 80 or 90 kilometers per hour. He broke his wheels on landing. On November 29th he flew 150 meters; December 4th 90 to 200 metrs and December 6th he twice flew between 400 and 500 meters, and also completed a turn in the air. On December 18th he flew 145 meters, but later on the same day smashed the machine badly in another trial. Altogether he had

nine machines built for him.

September 30th 1907, Henry Farman made his first flight of 30 to 60 meters in a machine built for him by the Voisin Brothers along the same lines embodied in Delagrange's. He practiced constantly and on October 15th flew 300 meters; October 19th, 100 meters; October 23rd 170 meters, and keeping at it daily he succeeded on October 26th in covering 771 meters. He had now totalled 2.6 kilometers. On November 1st and 2nd he made short flights, and on November 5th, he flew 300 and 400 meters. On November 9th, he was able to execute a turn, and on November 10th, in a flight of 800 meters, he completed 3/4 of a circle. He still continued to practcie at every favorable opportunity, and on Januray 11th, 1908, he was twice able to return to his starting point. On January 13th he won the Deutche-Archdeacon prize of 50,000 france by flying between 1500 and 1800 meters and returning to starting point. He made his longest flight to date, of 2005 meters on March 21st 1908. March 27th he had aserious accident while practicing curves, in which his machine was badly smashed. He escaped from the wreck with but slight injuries. On May 9th he is reported to have flown 700 feet with his father as a passenger, and carrying eight gallons of water for cooling the motor, and 2.6 gallons of alcohol for fuel. (See L'Aerophile and Current Publications).

Robert Esnault-Pelterie, early in 1903, began gliding experiments with a machine very similar to that used by the Wright Brothers, and acquired considerable facility in handling it. He continued experimenting and finally on October 22nd

1907, had completed a power-driven monoplane of 18 square meters surface, weighing 230 kilograms and carrying a 35 horse-power motor, with which he flew 150 meters on that date. On October 26th, he flew 100 meters and turned in the air. On the 27th he again flew 100 meters. He built a second machine of 16 square meters surface, weighing 300 kilograms with which he made short flights in November. To date his machines are by far the best constructed and most scientific. He is said to now have four more machines which he is keeping in reserve all of which he hopes to try out this year. Two of these machines are of 30 horse-power and two of 60. One of the latter is to carry two people. (See L'Aerophile and Current Publications). The motor which he designed himself consists of seven cylinders, operating two cranks, four on one and three on the other. It is light and said to be quite efficient.

Pischoff completed his two-surface aeroplane in time to make short flights on December 5th, and 6th, 1907. On January 15th, 1908, he made three flights of 30, 40 and 60 meters. He is still experimenting (See L'Aerophile).

Count de laVaulx in a machine designed for him by Victor Tatin of 40.6 square meters of surface, weighing 400 kilograms and driven by a 40 horse-power motor actuating two propellers two meters in diameter with a pitch of 2.2 meters, which was, however, remodeled so as to consist of 13 square meters of surface and carry a 24 horse-power motor, flew 50 and 70 meters on December 18th 1907; In the latter flight, which was made before a very heavy wind, the machine collapsed in the air, but fortunately, with no harm to the operator. (See L'Aerophile and Current Publications)

The Gastambide-Mengin machine was flown by Boyer for a distance of several meters on February 8th 1908? It weighed 350 kilograms, had 24 square meters of surface and was driven by a 50 horse-power motor. On February 12th it made flights of 100 meters and 150 meters and on February 14th it flew 60 meters, but struck one wing and turned a complete somersault, damaging the machine badly. No front control was used, the height being regulated entirely by the speed of the motor. (See L'Aerophile).

Ellehammer, a Dane, is said to have made a number of short flights during 1906, on the Island of Holm. He used at that time a nine horse-power motor mounted in a single surface machine. Altogether he has tried three types of aeroplane: a mono-bi- and tri-plane. His second apparatus had 37 square meters, weighed 34 kilograms without the operator, and used a 30 horse-power motor to drive a four-bladed propeller at 900 revolutions per minute. Its total weight in flight is 205 kilograms. On July 24th 1908, he made an unofficial flight of 175 meters, and on February 13th with his last machine of 27 square meters, he made an official flight of 300 meters. Altogether, he is said to have been in the air 200 times. (See L'Aerophile and Current Publications).

In Bohemia, Messrs. Ettrich and Wels conducted gliding experiments in 1907. Their best glides are said to be about 200 meters, at a speed of about 12 meters per second. They have since built a motor-driven aeroplane, but no reports have yet been received concerning it. (See L'Aerophile).

The Breguet Brothers, on September 29th, 1907, were able to lift an operator in their heliceptere to a height of 1.5 meters. This was their second success, the first taking place on September 16th when the machine rose to a height of 60 centimeters. The are the first experimenters to have built such a type of machine which was able to get off the ground with its motor and aviator. (See L'Aerophile and Current Publications).

On August 30th, 1907, the Cornu Brothers caused their helicoptere to lift itself and engine. On September 27th they lifted 235 kilograms and on November 13th, the machine lifted itself and operator to a height of 30 centimeters, and descended on account of the belt slipping. On the same day it is said to have also taken up two men, or 328 kilograms, but being unblanced, descended without attaining any great height. It consists of two screws arranged in the same plane, driven by a belt which is connected with a 24 horse-power Antionette motor.

There have been numerous other aeroplanes, helicopteres, and ornithopteres constructed in Europe, but the above mentioned ones alone have made authentic flights.

In this country the only public flights so far made have been those accomplished by the Aerial Experiment Association with its two machines, "The Red Wing", and "The White Wing". The former consisted of two superposed tapering aeroplanes arranged in the form of a spar shaped truss. It was driven by a 40 horse-power motor which, however, did not turn its propellers whose diameter was 6 feet, 2 inches with a

pitch of four feet, more than 1000 revolutions per minute, thus delivering at the time not more than 20 horse-power. The apparatus was provided with a front control and a tail, and had 385 square feet of supporting surface. Its total weight with operator was 570 pounds. This apparatus was constructed and ready for trial in just seven weeks. On March 11, 1908 it was run over the ice, and its steering gear thoroughly tested, but not attempt made to fly. On March 12th, it made a flight of 318 feet, 11 inches, carrying F. W. Baldwin of Toronto, Canada in the aviator's seat. On March 17th Mr. Baldwin again made a flight in the machine, covering a distance of 120 feet. In the first flight, the aeroplane traveled about 200 feet from the start before rising, and only 30 feet in the second attempt. The machine was badly damaged when landing after this second flight, and it was decided to build another structure rather than repair the old one, as it was intended to make numerous changes. The new machine was commenced March 23rd, and was ready for trial on May 9th. The form of the machine which was known as aerodrome No. 2, or "The White Wing", was much the same as "The Red Wing", the only radical change being the addition of movable wing tips which were expected to aid in the control of the lateral equilibrium. There were numerous improvements made in the details of construction. This second machine made its first flight on May 18th, guided by Mr. Baldwin. It covered about 40 yards. The runing gear proved defective, and no further flights were attempted that day. On May 19th Lieut. Selfridge made two flights, one of 35 yards, and the

other of 79 yards. The greatest height was attained in this last flight, being being between 30 and 40 feet. On coming down, the front plane was damaged, and the running gear broken. The machine was again ready for flight on May 22nd, when, under the guidance of G. H. Curtiss, it covered a distanne of 339 yards lightly touching the ground however, after it had traveled a distance of 205 yards. This occurred late in the evening, so that experiments were given up for the rest of the day. On the 23rd, the machine, carrying Mr. McCurdy, made a flight of 183 yards, at the end of which one wing touched the ground, causing the machine to strike its nose and turn turtle. This accident badly damaged the apparatus which however, is now being re-built and should be ready for trial in about two weeks. Aerodrome No. 2 proved to be most satisfactory, considering that it was never using more than 23 horse-power. Its average speed was about 38 miles per hour, at which it fully demonstrated the practicability of its controlling gear, the accidents all being due to the inexperience of the operators, and not to any defect developed in the aerodrome. Its area was 408 square feet, and its greatest weight 650 pounds with the operator.

Since 1906 the following machines have been under cosnrtcution:- "This list is merely presented to give some idea of the tremendous activity which is taking place in the wesld in the promotion of aviation. There are doubtless numerous machine which are not mentioned here, these being only those which have been announced in recent publications".

IN FRANCE we find the aeroplanes of

No. 1 Vuia, two machines,
No. 2 Santos Dumont, three machines,
No. 3 Tatin, two machines,
No. 4 Pompeien Priaud, four machines,
No. 5 Bleriot, nine machines,
No. 6 Kapferer, two machines,
No. 7 Ferber, one machine,
No. 8 Delagrange, two machine,
No. 9 Zens, one machine,
No.10 Seux, one machine,
No.11 Esnault-Pelterie, six machines,
No.12 Farman, two machines,
No.13 Barlatier and Blanc, one machine,
No.14 Gilbert, one machine,
No.15 Reiszner, one machine,
No.16 deDion, one machine,
No.17 Belles, one machine,
No.18 Dardelet, one machine,
No.19 Vinet, one machine,
No.20 Blanc, one machine,
No.21 Auffin and Ordt, one machine,
No.22 Gasnier, one machine,
No.23 Jacquelin, one machine,
No.24 Pischoff, one machine,
No.25 Bourdariat, one machine,
No.26 Bellecq, one machine,
No.27 Goupil, one machine,
No.28 Castambide-Mengin, one machine,
No.29 Thuau, one machine.

The following helicopteres have been, or are being constructed in France:-

No.30 Santos Dumont, one,
No.31 Cornu Brothers, one,
No.32 Breguet, one,
No.33 Leger, one,
No.34 Jules Felipe, one,
No.35 Bertin, one.

The following are French Ornitheptereas:-

No.36 Bazin, two,
No.37 Collomb, one.

Making a total in France of 61 machines.

IN ITALY the Government ordered in 1907, a glider of the Herring type, from the Voisin Brothers.

1. Vincenzio Florio has ordered a machine from the Voisin Brothers.
2. Salviotti, an ornithoptere,
3. Henry Savage Landor, a machine of original design at his country home, making a total in Italy of 3.

IN GERMANY there are three aeroplanes of

1. Etrich-and Wels, one,
2. Ceanda, one,
3. Suring, one,
4. Zatho, one,

Making a total of 4.

IN SWITZERLAND:

The Dufux Brothers an aeroplane.

IN DENMARK:

Ellehammer, three aeroplanes:

IN RUSSIA:

Shabsky, one aeroplane.

IN ENGLAND:

Phillips, an aeroplane,
Bellamy, an aeroplane,
Dunn, an aeroplane,
Roe, an aeroplane,
Moore-Brabazon, an aeroplane,

Making a total in England of 5 aeroplanes.

Altogether IN AMERICA the following power driven machines have been, or are being built:

Herring, two aeroplanes, one for the Government, and one for Mr. McCoy in 1908.

The Wright Brothers, three aeroplanes, one of which is for the Government.

C. C. Jones, three aeroplanes for the International Vehicle Company.

The Aerial Experiment Association, two aeroplanes.
Beshon, one aeroplane,
Beach and Whitehead, one aeroplane.
Bowland, one aeroplane.
Gammeter, an ornithoptere.
Myers, two ornithopteres.
Luyties, helicoptere.
Kimball, helicoptere.
Williams, helicoptere.

Making a total in America of 19 machines.

This makes a grand total of 97 machines, and is not, I believe more than 60% of the whole.

Twenty-five of these, or over 26% have actually flown, or left the ground, and have carried into the air 22 different men who are:

1. Herring, 1 machine.
2 Orville Wright
3. Wilbur Wright 1 machine.
4. Vuia, 2 machines.
5. Santos Dumont, 2 machines.
6. Ellehammer, 3 machines.
7. Charles Voisin, 1 machine.
8. Bleriot, 4 machines.
9. Farman, 1 machine.
10. Breguet, helicoptere, 1 machine.
11. Renault-Pelterie, 2 machines.
12. Cornu, helicoptere, 1 machine.
13. Puscheff, 1 machine.
14. Count de la Vaulx, 1 machine.
15. Delagrange, 1 machine.
16. Beyer (Gastambide-Mengin) 1 machine.
17. F.W. Baldwin, 2 machines.
18. Furness, (With Wrights).
19. Farman (Father and Henry Farman).
20 Lieut. T. Selfridge.
21. G. H. Curtiss, Aerial Experiment Association.
22. J.A.D. McCurdy

Nor must we forget that in addition to the above there were Maxim's, Herring's, Ader's, Kress' and Langley's machines all built on rational lines and all probably capable of flying.

This activity is manifesting itself in the United States, England, France, Germany, Italy, Russia, Denmark, Switzerland, Austria, in all nine different countries. The two leading manufacturers of aeroplanes to date are the Voisin Freres of France and the Curtiss Manufacturing Co., of Hammondsport, New York, U.S.

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