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The Race for Speed from the Beginning of Aviation to the Present Day

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THE RACE FOR SPEED
FROM THE BEGINNING OF AVIATION TO THE PRESENT DAY *

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INTRODUCTION.

For the general public and since a long time, Aircraft has become the fastest way of traveling. Speed has therefore appeared to be the noblest Aircraft performance, which might explain why the major aeronautical countries have always sought to conquer the world speed record.

Of course there are commercial considerations, the publicity given par the press to the records serves to promote those manufacturers who have designed the succesful aircraft.

However, it is paradoxical to note that, during this heroic pioneers era, the greatest glory was achieved not by the speed level but simply by the flight itself, and that today the quality of an aircraft is not judged solely on its maximum speed.

It was interesting to take advantage of the 14th ICAS Congress to survey the history of the world speed record from its beginning to the present day.

This history can be divided into two major phases: the first one relative to propeller driven Aircraft and the other to jet Aircraft. It is well known that the extraordinary technical progress over 80 years can be also caracterised by the various periods corresponding to a particular state of the art.

There is no doubt that, at least during the propeller aircraft era, the race for the record and the different speed races were factors of progress in engine as well as in airframe design.

We shall see in the second part that this is less evident for the modern jet Aircraft because their considerable development cost, both for Airframe and for Engine, and no manufacturer has the capacity of launching such studies outside an official request for proposal.

At the end of this paper are given several summary tables giving the list of the speed records recognised by the FAI (Fédération Aéronautique Internationale) since 1906:

- Table I: Propeller Aircraft Speed Records,
- Table II: Jet Aircraft Speed Records,
- Table III: Evolution of the FAI sporting code.

1 - THE RACE FOR SPEED WITH PROPELLER AIRCRAFT.

Speed performance obtained by Propeller Aircraft from 1906 to 1979 are illustrated Figure 1; their power and drag characteristics evolution was impressive, as shown on Figure 2.

The heroic era of the pioneers.

Historically the first world speed record recognized by FAI was established by the Brazilian Alberto Santos Dumont, in Paris on November 12th 1906, with his legendary aircraft, type XIV bis (photo 1).

Without doubt the Wright brothers should have been the first, but it must be remembered that their last flight in 1905 was on October 5th and that the FAI was established only 12 months later; it is well known that, after this last flight, the Wright's did not take their Flyer out of its hangar until 1908.

Therefore Santos Dumont is honoured as the first on the list of speed records with 41.292 km/hr, a rather disappointing speed if compared with those already reached by motorcars during the same period! In fact, the major problem at that time was not how to fly as fast as possible, but how to simply fly.

It is not surprising that, nearly one year later, Santos Dumont's record was broken by 11.4 km/hr by Henri Farman with a Voisin Aeroplane.

The name of Wright appears officially in this not-yet very exciting race with the next record - the third on the list - thanks to Tissandier who, on a Wright "Flyer B" aeroplane, fitted in France with a Barriquant and Marre 35 HP engine, beat Farman by 2 km/hr and carried the speed record to 54.810 km/hr, at Pau, on May 20th, 1909.

The sport developes.

However, after these calm three years, things are going to become serious on the occasion of the Reims Meeting where, in August 1909, the "Speed Grand Prix" and the Gordon Bennett Cup for Aeroplanes are going to be the focus of international competition.

By the middle of 1909, practical aviation was finally under way, as demonstrated by the number of registrations: 34 Aircraft, of which 4 were from Foreign countries; amongst those is the American Glenn Curtiss, who is going to compete with Blériot: Glenn Curtiss will win the first Gordon Bennett Cup and break the Tissandier record with 69.821 km/hr on a Wright Aeroplane (photo 2).

However, Louis Bleriot with his "type XII" will break the record twice, the second time with 76.995 km/hr (photo 3).

This "American - French" contest is the first in a long competition between the two countries for the world speed record, from 1909 to 1937, when Germany will come in the forefront.

It is also in 1909 that Col. Roche established the first school for aeronautical engineers, which later on, will be the well known "Sup Aéro".

(*) *Lecture given at the 14th ICAS Congress, Toulouse, Sept. 1984 and published in French in Aéronautique et Astronautique n° 115 (6-1985)*

For the time being, the record stayed with the french , who disputed it between themselves - at a rate of four times a year - with the Antoinette and then with the Blériot XI; this aeroplane was derived from the one which crossed the Channel but with increasingly powerful engines, up to the 100 HP. Gnome , in 1911. These Aircraft, in spite of being all monoplanes, were still poorly designed for speed: their fuselages were uncovered and their structure fitted with a lot of struts and stays.

The first to deliberately break with this total reliance on power was Edouard Nieport - called Nieuport - who broke Leblanc's record of 111.8 km/hr (established at Pau in a 100 HP Blériot XI) with a small machine of only 35 HP. For the first time, the fuselage was completely covered and the stays were reduced to a minimum; he himself designed everything, including the engine, the propeller, the spark plugs and he flew at 119.76 km/hr; then, with a 50 HP Gnome, he will go to reach 133.136 km/hr (June 21st, 1911); he will be the 14th holder of the title (photo 4).

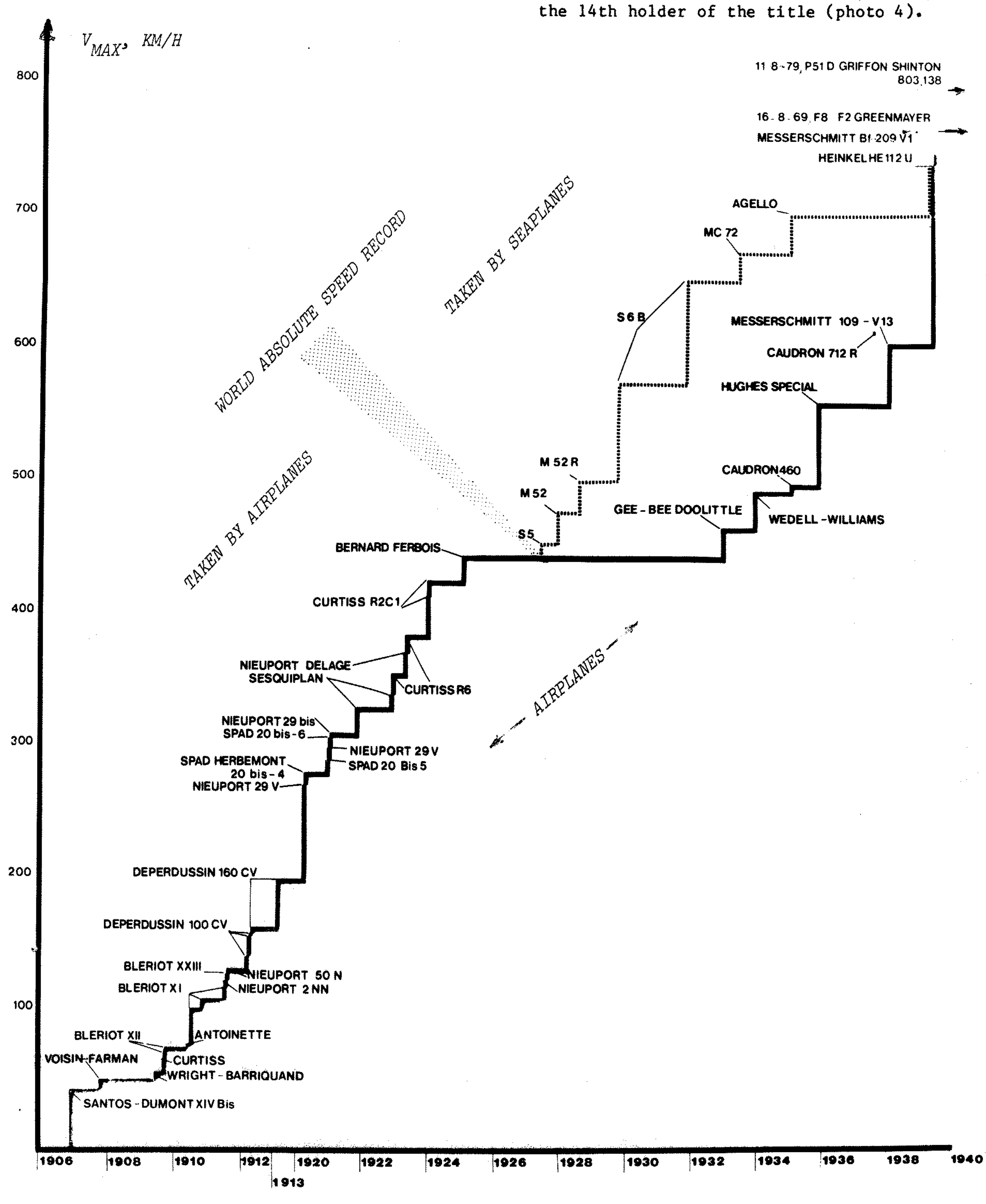

FIG. 1 - F.A.I. WORLD SPEED RECORDS, PROPELLER AIRCRAFT

Photo 1 - Santos Dumont XIV bis, Bagatelle, Novembre 1906

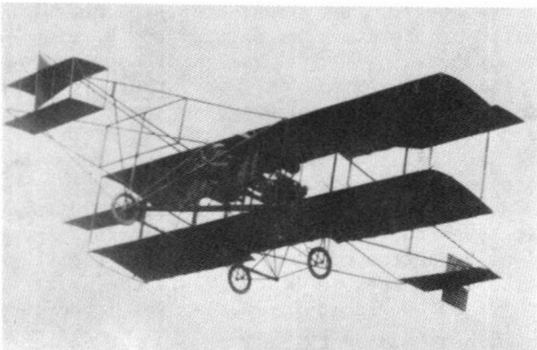

Photo 2 - Curtiss de Glenn Curtiss, Reims, Août 1909 (69,8 km/h)

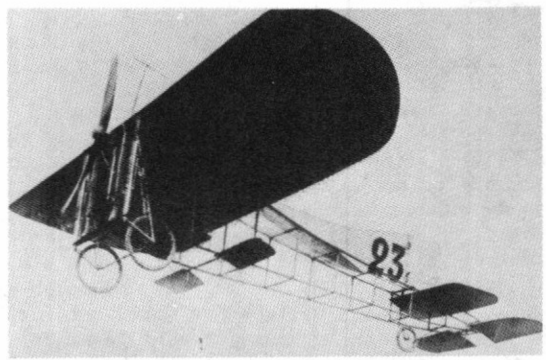

Photo 3 - Blériot XII, de Louis Blériot, Reims, Août 1909 (77 km/h)

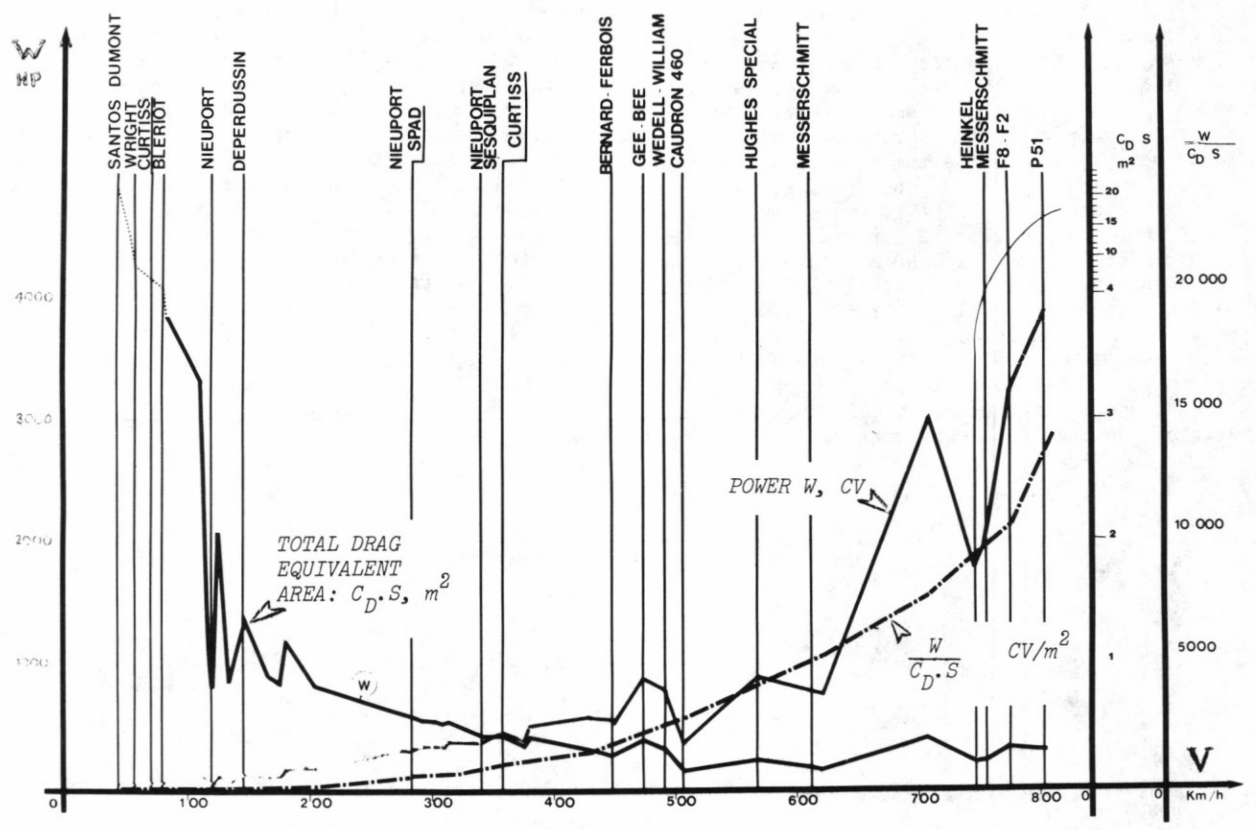

FIG. 2 - POWER/DRAG CHARACTERISTICS OF THE LEADING PROPELLER AIRCRAFT

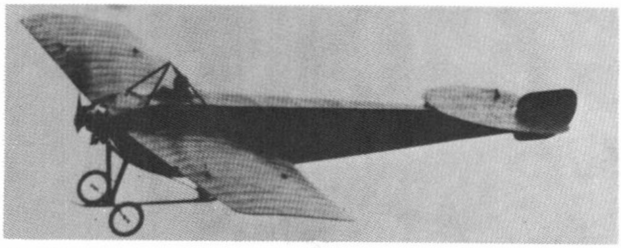

Photo 4 - Nieuport 2-N de E. Nieuport, Chalons, Juin 1911 (133 km/h)

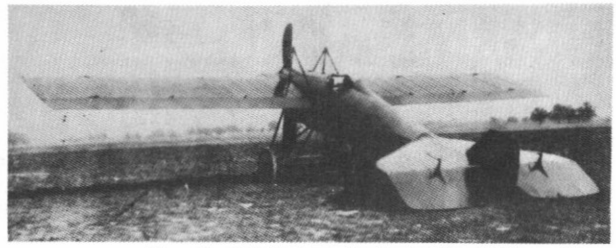

Photo 5 - 100 HP Deperdussin de Jules Védrines, Chicago, Septembre 1912 (174 km/h)

The lesson will be understood, and from now on, whilst benefiting of progress on engines, care will be taken to gain every advantage on airframe design.

Edouard Nieuport was prematurely killed in a flight crash in 1911.

During the same year, Bechereau (who will design the famous SPAD of the First World War) became the designer inside the Deperdussin Company: in January 1912, Vedrines, on a Deperdussin Aeroplane designed by Bechereau, and powered by a 100 HP Gnome engine, won the title with 145.161 km/hr; in the same year, he beats his own record three times, to 166.821 km/hr, using the same 100 HP double-star rotary Gnome engine (photo 5).

Finally, at Reims on the 29th of September 1913, Maurice Prevost, during the Gordon Bennett Cup (which he will win) took the world record with 203.85 km/hr thanks to a new type of Deperdussin - Bechereau Aeroplane, fitted with the latest 160 HP Gnome engine (photo 6): the streamlined shape of this Aircraft announces future post-war designs.

For the time being, the 1914-18 war stops the sporting enthusiasm for more tragic objectives.

In summary, since Santos Dumont, and during nearly nine years, the speed record was 19 times broken and a 200 km/hr speed has been exceeded. During the same period, the Gordon Bennett Cup for aircraft had been run five times and had been won twice by America (in 1909 by Curtiss, with a Curtiss Aeroplane, and in 1911 by Weymann with a 100 HP Nieuport), once by Great Britain (in 1910 by Graham White with a 100 HP Blériot), and twice by France (Vedrines on a 100 HP Gnome - Deperdussin at Chicago in 1912, and Prevost on a 160 HP Deperdussin at Reims in 1913).

After the Armistice in 1918, the world only wanted to forget the terrible war through which it had just lived and the aviators only thought about reinstating the pre - war competition.

The speed prestige.

The war had greatly changed our world and Aviation had achieved considerable progress. The military staffs had finally accepted Aviation as the new weapon, and many countries now wished to develop an air-force as part of their defence. The manufacturers, who had produced enormous quantities of airplanes, saw their order books empty and looked for a way of attracting potential buyers for their products. A speed record was still an efficient publicity and many skilled pilots were available.

However, one must wait until 1920 to have a first opportunity for racing, during the sixth Gordon Bennett Cup organised over a distance of 300 km, at Etampes in France. This Cup, very famous over the world before the war, provided an excellent way for going back to the competition.

For the French pilots, winners of the last two Cups, a third victory would guarantee permanent possession of the Cup; thus five Aircraft are engaged: two Nieuport - Delage, two Spad - Herbemont (photo 7), designed by this engineer, and a Borel. All these aircraft used the same Hispano - Suiza 300 HP V8 engine, the best one at that time, based upon the same design than the famous HS - 180 - 220 HP during the war. On the airframe side, they were the derivatives of the latest fighters designed in 1918 which, should the war had continued, would have been able to replace the Spad XIII. The most up- to- date way of increasing speed was to reduce the wing area and the aircraft weight.

Great Britain was present with the Martinsyde, powered by a 300 HP Hispano engine, and derived from a military Aircraft, just like the french ones. Two other airplanes, a 300 HP Hispano british Nieuport and a Sopwith with a 400 HP british Jupiter engine, could not be prepared in time.

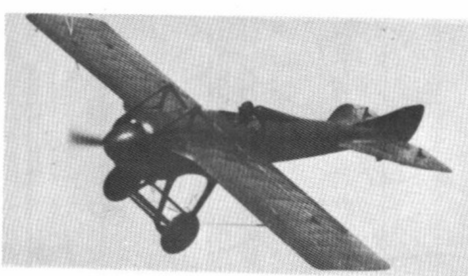

Photo 6 - Deperdussin de Maurice Prévost, Reims, Septembre 1913 (203,8 km/h)

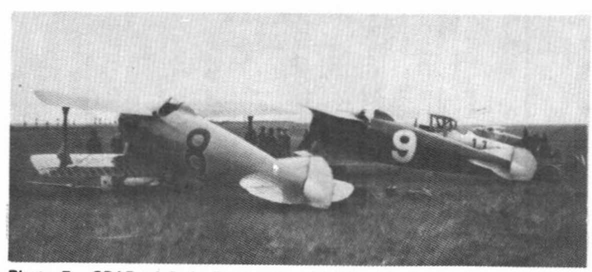

Photo 7 - SPAD n° 8 de Romanet et SPAD n° 9 de Casale, coupe Gordon Bennett, Etampes 1920

United States, like their allies, had chosen a military Aircraft, the Verville, with a rather heavy 500 HP Packard engine, but also two innovative configurations: a Curtiss-Cox powered by a Curtiss 430 HP C12, and a Dayton - Wright fitted with a 250 HP, 6 cylinder Liberty engine; this aircraft had a retractable undercarriage and a very original variable-camber wing. The Curtiss had been designed for a speed of 345 km/hr and appeared to be the favorite, but the aircraft could not be tested in the United States with its new wing and arrived in France only ten days before the date of the Cup. Then, on the first flight test, the take-off proved to be so long that the Aircraft continued past the official runway on a neighbouring field before getting airborne. The pilot was not discouraged and maintained the full power of the engine; however, when reaching about 300 km/hr the Aircraft became subjected to so strong longitudinal oscillations that the pilot was forced to land straight-ahead. Happily the Beauce plains are very flat, and he was not injured.

During the next night, the engineer Mike Thurston designed a new wing and a new tailplane, which Morane agreed to build at Villacoublay. The Aircraft was ready on the eve of the race but it had to get from Villacoublay to Etampes for the start. The take-off from Villacoublay proved to be very rough because there had been not enough time to fit shock-absorbers to the undercarriage; on a rebound, the aircraft became airborne. However, on landing at Etampes, the wheels, which had suffered, broke and the aircraft overturned and broke in two parts; by a miracle, the pilot escaped, but the Curtiss was out of the race.

The Verville engine ran so hot after departure that flames came out of the exhaust pipes; the pilot was forced to land immediately in order to avoid a fire. As for the Dayton, without doubt, it was also too new and insufficiently developed: it appeared that an adjustment error in the mechanical linkages prevented it from turning left.

The U.S. teams learnt some hard lessons from the race but highly profitable, enough for returning in force with Curtiss, some time later.

Finally the only British representative, the Martinsyde Airplane, was let-down by a cracked pipe and could not complete the circuit.

The French were more lucky: Kirsch, in a Nieuport, who made the best 100 km circuit of the Cup, at 279 km/hr, was the only one forced to land following misfiring caused by spark-plugs oiling up. Sadi Lecointe, on a Nieuport Airplane, won the Cup with 271.547 km/hr; Romanet was second, victim of an oil-leak, which obliged him to stop for half an hour and which reduced his speed to 181 km/hr, although, during the trials, he was faster than the Nieuport Aircraft.

Photo 8 - Nieuport 29V de Sadi-Lecointe, Villacoublay, Octobre 1920 (302,5 km/h)

Thus only one aircraft covered the distance without incident. The Cup, being won for the third time, stayed permanently in France; there would never be another Gordon Bennett Cup for aircraft. We shall see that the children of Deutsch de la Meurthe, the well-known patron, will offer a new cup bearing his name and with a very similar format to that.

The French appeared again ahead in speed, when, on February 7th 1920, Sadi Lecointe, on a 300 HP Nieuport (photo 8) broke the pre-war Prevost record (203 km/hr) with 275.862 km/hr. Then, during three years (up to the US record in october 1922 by General Mitchell), the speed record was broken nine times between French pilots (Sadi Lecointe, Casale and Romanet) with Nieuport and Spad Airplanes. Sadi Lecointe was the first to exceed 300 km/hr (200 MPH) and, finally, 341 km/hr in September 1922.

But, if pilot's qualification and skill played a major role in this race, the technical level of their machines was also determinant.

Only limited improvements were possible at that time, either on their wing surface, or location on the fuselage; to solve the problems of take-off and landing, there were no high lift systems, nor retractable undercarriage or variable pitch propeller, which will appear only in 1934 with the Delmotte's Caudron 460!

The biplane, which had practically been the exclusive configuration during the war, had the advantage of being of a well experimented design. For a modest weight, it allowed the use of reasonably thin and cambered wing sections, allied with a wing loading in the order of 70 to 80 kg/sq.m. This could explain why, during the preparation of the Nieuport biplane, Sadi Lecointe made several emergency landings without damage.

The competition began between two biplanes, the Spad of Romanet and the Nieuport of Sadi-Lecointe. The latter will be the first to cross the 300 km/hr mark, with 302.529 on October 20th 1920. On November 4th, Romanet reached 309.012 km/hr on his 14 sqm biplane thanks to removing his windscreen and lowering his seat inside the fuselage! In turn, Sadi-Lecointe decided to close his cockpit with a plywood panel (external vision was limited to small lateral windows), to remove one of the two Lamblin radiators and to reduce his fuel capacity to 80 liters...; the result was a new record: 313.043 km/hr on December 12th. Obviously, on a biplane and with the 300 HP Hispano, one could not go much further.

A new airplane design.

That is why the Nieuport Company completely rethought the problem around the only available engine, the 300 HP Hispano which delivered 320 HP at 1800 rpm. They selected a monoplane with a 12.7 sqm wing and, although the wing section was calculated for its low drag, a slight camber was included in order to improve the CL at angles greater than 5°. The wing loading was limited to 77 kg/sqm and the take-off speed to 107 km/hr. For maximum speed, they expected mainly to reduce the interactions inherent in the biplane and they designed a better fuselage. But, because the worry about the elasticity of the structures, the aircraft had to be very stiff and a design load factor of 12g was chosen. 12% was adopted as relative thickness of the wing, which allowed strong spars: the wing was completely covered in plywood which contributed to its strength, and oblique struts were retained. In accordance with the usual Nieuport practices, the fuselage was monoshell and fitted with a very robust undercarriage (photo 9).

On September 26th 1921, Sadi-Lecointe pushed the record to 330.275 km/hr whereas, three days before, Romanet was killed during the prototype Monge Airplane's flight tests.

The Deutsch de la Meurthe Cup began at Etampes on October 1st, 1921: during his first circuit, Sadi-Lecointe saw his propeller bursting in the air, at a measured speed of 314 km/hr; he managed to land his aircraft in a field but, although he escaped quite safely, the aircraft was broken.

The Italian Brack - Papa, on a 700 HP FIAT Airplane, covered the 100 km at 298.7 km/hr - a new world record over this distance - but, because of a failure, he could not finish the race.

The British Herbert James, on a Bamel - Mars biplane, powered by a 450 HP Napier engine with a reduction gear propeller, showed a considerable range of speed for a racer. Unfortunately, the cloth on its wing began to rip, and he was forced to land.

Only two French pilots, Lasne on a Nieuport biplane, and Kirsch on a sesquiplane, were still in the race and they prudently positionned themselves: Kirsch won with 278 km/hr, Lasne was second with 257.42.

Finally, on September 21st 1922, Sadi-Lecointe pushed the world record to 341.233 km/hr: the progress was achieved on the Hispano engine, which had its compression boosted to 6, and reached 1900 rpm thanks to the use of benzol: the result was an increased power: 370 HP.

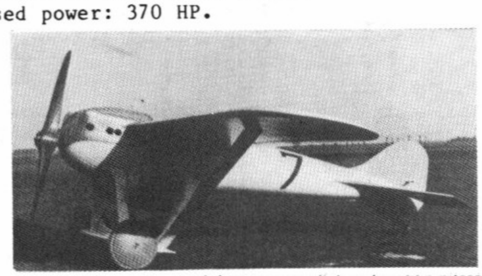

Photo 9 - Nieuport sesquiplane avec radiateur Lamblin piloté par Sadi-Lecointe, Etampes, Septembre 1922 (341 km/h)

The 1922 Deutsch Cup saw the return of Brack - Papa who completed a circuit at 286 km/hr before stopping, victim of a ruptured pipe. Sadi Lecointe was also obliged to interrupt his race because a ruptured spark - plug and an incident during landing, which slightly damaged his airplane. Lasne, on a Nieuport biplane powered by a boosted 300 HP engine will be the winner with 289.4 km/hr.

Four days after the race, in an attempt for the speed record, the Gloucestershire Bamel - Mars biplane fitted with a 500 HP Napier - Lion engine reached 341.423 km/hr; however, the difference between that figure and the one achieved by Sadi Lecointe did not exceed the required 1% imposed by the FAI and the record was not registered.

But the french, too self - assured, because they had not followed closely enough what was happening in the United States, were very surprised to lose the record which seemed to belong to them.

The American breakthrough.

At Detroit, on October 13th 1922, Brigadier General Mitchell broke the world record, on a Curtiss R6, powered by a 450 HP D-12 engine, with 358.836 km/hr.

It was a biplane derived from the Curtiss CR1 race - the Navy winner of the 1921 Pulitzer trophy with 283 km/hr - fitted with a Curtiss CD12 400 HP engine. In fact, the R6 was an aircraft completely redesigned around the Curtiss 12 cylinder, 60°V, D12 engine which was designed to offer the minimum frontal area and to be light whilst giving large power; this engine was the result of a long design enterprise with the Curtiss AB from 1916 and after successive important improvements to the original concept. By 1922 the D12 was finally giving the expected results.

However, a great deal of care was taken with the aerodynamics of the R6 whilst conserving the biplane formula which, at that time, offered the best compromise between the search for lower drag and the strength required for a racing Aircraft.

The rounded fuselage cross-section did not exceed 1.12 m. in height and 0.84 m in width; the french biplanes were always more "comfortable" with rounded shape, the Spad Herbemont having a 1.36 x 0.9 m. section and the Nieuport 29 limited to a 1.02 x 0.95 section.

The fight against parasitic drag had even lead for the first time to the use of integrated radiator surfaces in the upper wing structure; studied for over two years; this improvement was successfully used on the R6.

It is interesting to note that the Navy, after the difficult take-offs with the Curtiss-Cox during the 1920 Gordon Bennett cup already commented, had imposed a maximum take-off speed of 120 km/hr (75 MPH): that is why the R6 wing area was increased to 13 sqm to limit the wing loading to about 63 kg/sqm. The overall result was the design of a marvellous little biplane.

The awakening of the French.

Suddenly it was discovered in France that Hispano Company had not made much progress with its ideas since 1916; furthermore, it was realized that the Wright Motor Co, under license with Hispano for the 300 HP had improved it, up to obtain more power than the parent company.

Immediately, a 300 HP Wright - Hispano, giving 410 HP at 2000 rpm, was ordered from the US; the Lamblin radiators - used by Curtiss racers until 1922 - were withdrawn and replaced by new-ones developed by the Moreux Company, which were fitted under the wings with a modified biconvex airfoil.

The last version of the Nieuport sesquiplane had the wing area further reduced from 12.7 to 11 sqm. In this condition, giving a stalling-speed out of ground effect of 117 km/hr, the overall aircraft 100CD in flight was reduced from 3.28 for the first sesquiplane to 3.09 (notice that the Mitchell R6 had a 100CD of 3.19 with a 13 sqm wing area and a stalling speed of 109 km/hr out of ground effect).

At Istres, on February 15th 1923, Sadi-Lecointe returned the record to France with 375 km/hr, but for a short time only, because, on March 29th 1923 at Dayton, Lt Maughan regained the record with 380 km/hr, on a Curtiss R6 fitted with a Curtiss D12 engine boosted to 507 HP (photo 10).

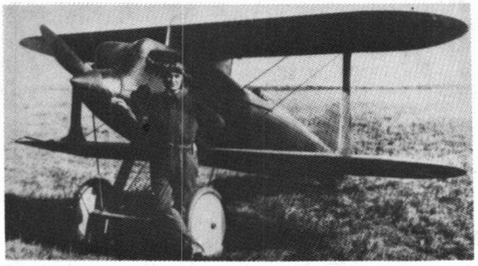

Photo 10 - Curtiss R-6 du Lt. Maughan, Mars 1923 (380,7 km/h)

1923: the American year.

Dr Reed had designed an entirely metallic fixed-pitch propeller which incorporated very slim blade tips; this allowed it to work with great effectiveness at higher rpm, despite the speed reached at the blade tip. The Maughan's D12, like all the engines of this period, directly drove the propeller. This type of Reed propeller, which became world-wide success, allowed the engines to run faster: it mainly explained why Maughan succeeded.

But that was not the end of the story: a new type of carburettor would allow the D12-6A to run at 2500 rpm.

What had happened with the Spad - Herbemont biplanes was going to come again with the Curtiss Airplanes; in order to reduce the interaction drag, the upper-wing surface was going to be placed high above the fuselage. Curiously, for the R2C1, Curtiss adopted the wing configuration of the 1920 Spad - Herbemont and not the Spad configuration successfully developped in 1922. The 100CD of the R2C1 was remarkably low for this period - 2.39 - but the wing area was slightly increased to 13.75 sqm (stalling speed: 113.5 km/hr).

The Curtiss engine was one of the D12A type, rated at 500 HP; lighter than the D12, but with a larger cylinder capacity, it was boosted for the record up to about 600 HP.

For two days, Lts Bow and Williams battled against each other on the same type of Curtiss R2C1 Aircraft; finally the world record holder had been Lt Bow with 417.078 km/hr on November 2nd, 1923; on Novenber 4th, Lt Williams beat again with 429.095 km/hr (photo 11). But William's last run nearly turned into a catastrophe as, only by a miracle, he avoided crashing into a patrol of bombers: the Navy Command stopped the competition.

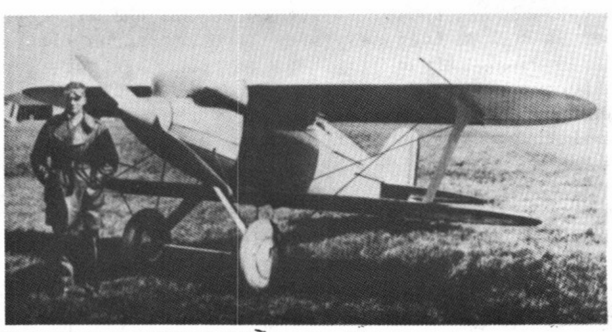

Photo 11 - Curtiss R2C-1 de Williams, New York, Novembre 1923 (429 km/h)

The French coming-back.

In France, the Hispano Company was very disturbed by the american results; it was clear that its engines no longer had sufficient power. Consequently, its director, Mr Birkight, decided early in 1923 to begin the design of two 12 cylinder engines: one of three rows of 4 cylinders in W and one in a 60°V (like the D12). However, both of them have retained the same characteristics, proven in the 300 HP, to insure endurance and reliability.

The most powerful and the lightest is the "W", which is going to be used by a newcomer, Mr Hubert, of the Société Industrielle des Métaux et du Bois managed by Mr Bernard; that is why the new Aircraft was named "Bernard - Ferbois".

For the first time in the history of the speed race, Hubert have designed a true cantilever monoplane of about 13 sqm to limit the landing speed. He took the french speed record with 375 km/hr. Then, taking advantage of those good results, he reduced the area to 11.5 sqm (stalling speed of 125 km/hr).

The aerofoil was a unsymetrical biconvex section, 15.7% thick at the root and 8% at the tip. The French Service Technique Aéronautique, conscious of the novelty of this monoplane concept, have requested a limit load factor of 20! This explains the weight of this Aircraft which, constructed in wood, reached 1175 kg.

The radiator was an unconventional flat Lamblin one, with small size and low drag, located under the lower surface of the wing. The Reed propeller, built under licence by Levasseur, allowed the Hispano "W" to run at 2100 rpm and to develop 560 HP.

The aircraft was well streamlined, after a careful wind tunnel study. Despite the large frontal area of the "W" engine, and thanks to the new Lamblin radiator under the wing, the Bernard - Ferbois's Airplane had a 100CD = 2.42, just a little higher than the 2.39 value for the R2-C1, but with a wing area of 11.5 instead of 13.75 sqm. The total equivalent drag area (CDxS) was reduced from 0.329 for the Curtiss to 0.279 for the Bernard Airplane; thus for about the same power (580 compared to 560 HP), the advantage was for the Bernard.

At Istres, on December 11th, 1924, Adjudant Florentin Bonnet broke the world speed record with 448.171 km/hr (photo 12).

This "absolute" speed record was only broken on September 26th, 1927 by Webster's Supermarine S5 seaplane, thanks to a Napier Lion VII engine (fitted with a reduction gear) of 875 HP, with 453.282 km/hr; but the Bernard-Ferbois held the speed record for aeroplanes until September 3rd, 1932, when J.H. Doolittle, on a 900 HP Gee-Bee-special, reached 473.8 km/hr.

Such a long gap deserves some explanation.

In fact, the Bernard had some interesting characteristics. We said earlier that it had a new 450 HP W-Hispano engine boosted to 560 for the record; if that power compared favourably with that of the Curtiss D12-A, by contrast the engine itself was less developed: it had a cylinder capacity and a weight 1/3 greater than the Curtiss; furthermore, its frontal area was quite larger. That is why the engineer Hubert had to find a better aerodynamic formula.

He was the first one to choose a true monoplane solution without any struts or stays (the only other monoplane, the Nieuport Sesquiplane, retained a strong oblique strut and a small plane between the wheels). To keep low the landing speed,the wing aspect-ratio was increased to 8.16 for 13 sqm area, with oblique tips. The wing was fitted mid - way on the fuselage and flushed to avoid the problem of recess angles. The streamlining and surface finish were excellent. Despite the handicap of a huge engine, Hubert succeeded in designing an airframe nearly as small as that of the Curtiss R6.

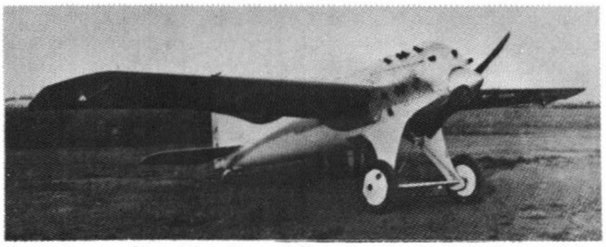

Photo 12 - Bernard-Ferbois SIMB V2 de F. Bonnet, Istres, Décembre 1923 (448 km/h)

This machine, equipped with a wooden Regy propeller, easily succeeded in taking the French speed record to 393.340 km/hr on November 8th, 1924, while the world record was held by William's R2C1 at 429 km/hr. But the stalling speed out of ground effect of the Bernard did not exceed 117 km/hr (113 for the R2C1).

Then Hubert decided to shorten the central section of the wing in order to reduce the area to 11.5 sqm; he also fitted a Reed metallic propeller. The cantilever monoplane wing had an aspect - ratio reduced to 7.2; it was the largest aspect - ratio of any of the record breaking aircraft and the only one to exceed 7; the more usual value was between 4.5 and 5.5.

On December 11th,1924, the modified Bernard put the world record to 444 km/hr.

It was clear that with the same engine, the Bernard had some potentiel for improvement: with a better adapted propeller, one could increase efficiency and engine power; without doubt it would be possible to lighten the aircraft, further reduce the wing area by 1 sqm and improve the streamlining (wheels, tailskid). One could have imagined that this machine would have been capable of reaching 480 or 490 km/hr without much difficulty: it was that level of performance that will be achieved by Wedel - Williams on September 4th 1933...

Finally, the Bernard was an Aircraft specially conceived for the speed record; it was probably that fact which, for the moment, discouraged the rivals. It was, in any case, what brought the Navy to cancel spending money on the development of any new aircraft without any direct military application; it preferred to put its efforts in the Schneider Cup by transforming its Curtiss Racer into a seaplane with floats.

During the same period, an important change in the Navy's engine policy developed in the United States: deciding that liquid cooled engines were too heavy and too vulnerable in combat, it pushed for the design of air-cooled radial engines. The President of the Wright Company, seeing which way the wind was blowing and feeling the need to radically change the company engines, resigned in 1924 and founded a new engine firm from the Pratt and Whitney Tool Company which he bought. In December 1925, the first 9 cylinder, 450 HP PW Wasp was produced; it had the same power as the Curtiss D12 and weighed 100 kg less; the D12, and its even more brilliant successor, the V1400, will never get over it.

The Schneider Cup.

This speed cup for seaplanes, founded in 1913 by the French patron Jacques Schneider, was competed for regularly every year; the speeds achieved stayed far below those speeds reached by aeroplanes because of large drag inherent to maritime' ancillary equipment. It is in 1923 only that appeared specialized machines: the CR3 derived from the Curtiss R6, won the cup that year with 285 km/hr (land based Airplanes attained 375 km/hr at that time).

In 1924, the Americans were the only participants to the race and, very sportingly, they postponed the trial until 1925 to give other countries a chance to prepare the race.

Great - Britain have introduced a remarkable machine - the Supermarine S4 - derived from the CR3 formula for floats, from the Bernard-Ferbois for aerodynamics: a cantilever wing fixed at mid-height, a Lamblin radiator and a streamlining of its Napier Lion VII W engine (a 680 HP improved derivative). Above all, it was the first to be equipped with landing flaps and, until 1934, remained the only racing aircraft to use high lift devices.

The aircraft reached 364.6 km/hr shortly before the 1925 race, during its first flights. Unfortunately, it was destroyed a few days before the cup, due to control-surface flutter, or to a stall at landing, or to a wing flutter; it was not possible to determine the real failure.

The 1925 winner was a Curtiss R3C2 derived from the R2C1 (photo 13).

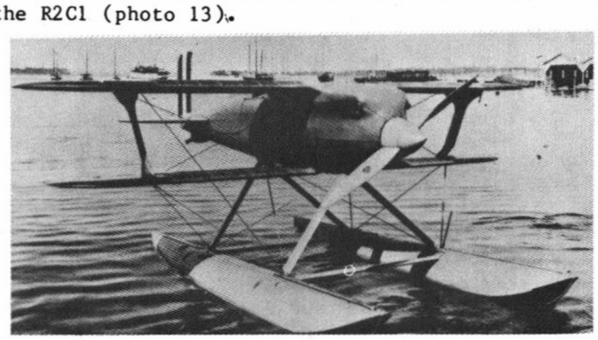

Photo 13 - Curtiss FR3C-2, hydravion vainqueur de la coupe Schneider 1923 (285 km/h)

However in 1926, the Italians won, with the Macchi M39 (photo 14) which became the archetype for all Schneider seaplanes: two catamaran floats, low - wing fixed rigidly to the airframe and allowing for a thinner aerofoil section; the engine was liquid - cooled with Curtiss type radiators; the propeller was all metal and fix-pitched.

It is interesting to notice that, for six years, this configuration remained unchanged: landing - flaps, or variable pitch, or closed cockpit were never seen anymore! In fact, the aerodynamic effort will be reserved only to improve the shape and the surface finish of the airframe. However, considerable progress were accomplished on liquid engines by Rolls Royce, Fiat and Isotta Fraschini manufacturers.

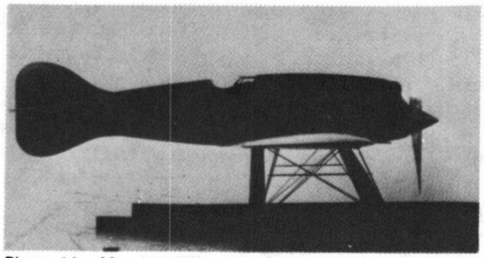

Photo 14 - Macchi M-39 vainqueur de la coupe Schneider 1926

It was essentially the competition for this prestigious Cup which lead to the development of reduction - gearing, of high rotationnal speed, of compressors, and even the use of exotic fuels, to the point where they contained no petrol at all. Therefore, at Rolls – Royce, the R type with 36.7 litres of cylinder capacity and 1900 HP at 2900 rpm growed to 2650 HP at 3200 rpm, that is to say, from 51.7 to 72.2 HP/litre for a weight increasing from 695 to 740 kg. Fiat, who worked on four successive engines in six years, progressed from a 800 HP, 31.4 litre V at 2300 rpm, to a 25.1 litre with approx of 1000 HP at 3200 rpm, and to the famous Agelo twin-engine (709 km/hr in 1934), of 50.2 litres giving 3000 HP at 3300 rpm, driving two contrarotating propellers (photo 16).

From 1927, the absolute speed record became the fact of the seaplanes (S-5, ph.15).

Photo 15 - Supermarine S-5, détenteur du record absolu de vitesse, Venise, Septembre 1927 (453 km/h)

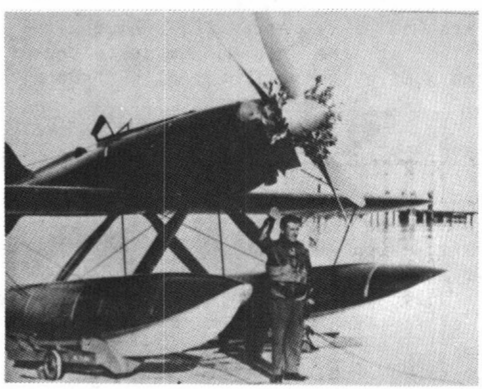

Photo 16 - Macchi M-72 à hélices coaxiales : record de vitesse absolu à 709 km/h en 1934

The main reason was the constant increase in wing - loading accompanied by the growth in power. In 1926, the winner of the Cup was the Macchi 39 (800 HP) loaded to 102 kg/sqm. The S5 in 1927 - the first to win the absolute speed record - was equipped with a 875 HP engine and loaded to 138 kg/sqm. The S6 in 1929 (1900 HP) will use 194 kg/sqm wing - loading, with a 100CL max hardly exceeding 1.1; that took the S5 to a stalling speed (without ground effect) of about 160 km/hr; the S6 in 1929 stalled at 191 km/hr!

Furthermore, the exclusive use of fixed-pitch propellers, adapted to maximum speed, resulted in low power during take - off. That is why the hydroplaning of these aircraft greatly exceeded one minute despite their excessive power. For the MC-72, which had the best directional stability thanks to its double propeller, it was possible to reduce the size of its floats, therefore more deeply immersed, and the hydroplaning clearly lasted more than two minutes.

It is clear that, due the airfield conditions available at this time, not only would the shock absorbing sytems of aircraft not allow such wing loadings, but such long take-off runs were not acceptable with enough safety. This explains the success of the seaplanes between 1927 and 1939.

New start for the aircraft speed record.

All the records have to be broken.

The ball was in the american camp and it was natural that the race for the land-based aircraft record should come from there.

On September 3rd, 1932, J.H. Doolittle succeeded in breaking the old record (set up by Bonnet in December 1924) on a Gee-Bee R1, fitted with a 800 HP Pratt and Whitney Wasp Senior radial engine, boosted to 900 HP (photo 17).

It was a monoplane with a low braced wing with thin biconvex profiles, greatly influenced by the general conception of the Schneider formula; in order to keep a reasonable stalling speed (132 km/hr), one needed a stiff construction as light as possible, hence short stays and a stubby shape.

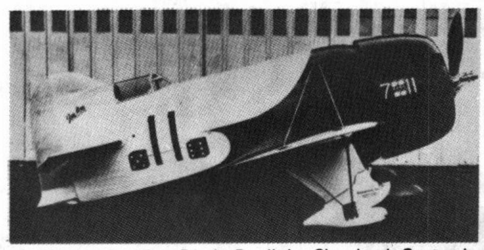

Photo 17 - Gee-Bee R1 de Doolittle, Cleveland, Septembre 1932 (473,8 km/h)

But the air-cooled engine had a large diameter and the fuselage was relatively monstrous (1.55 in diameter). Hence the aircraft drag gave a large 100CD = 4.075 (against 2.42 for the Bernard). Despite its 900 HP and its lightness (100 kg less), it was only able to beat the Bernard by 25.6 km/hr, when reaching 473.8 km/hr.

The following year, thanks to a better designed aircraft, equipped with a 550 HP Wasp Junior boosted to 800 HP, Wedel, in his Wedel-Williams, reached a speed of 490.8 km/hr on September 4th, 1933. Its design was based on the same formula: fixed - wing monoplane and great lightness; aerodynamically, the Aircraft was more successful with a 100CD = 3.03 (photo 18).

Obviously, the progress were very slow because the inability to adapt these Aircraft to the strong power formula of the Schneider Cup.

It was necessary to find something else.

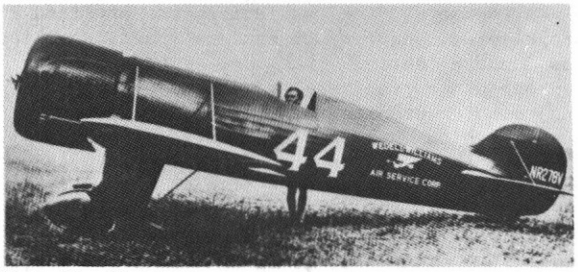

Photo 18 - Wedell-Williams de James Wedell, Chicago, Septembre 1933 (490 km/h)

The last French record.

The new format of the Deutsch de la Meurthe Cup, which was inaugurated in France in 1933 over a 2000 km course with an obligatory stop and an engine capacity limitation to 8 litres, revealed the talent of a great engineer, Marcel Riffard. He was chosen by Mr Renault to be the technical director of the firm Caudron - Renault which had just been founded following the purchase of the old Caudron Company by Mr Renault.

From 1934, the Caudron Airplanes, designed by Riffard, have won all the Deutsch speed records. It was natural that he would think of preparing one of his Aircraft for the world speed record.

Starting from the C450 (8 cylinder engine) with a fixed undercarriage, he built along the same lines the C460 fitted with an air cooled Renault 9.5 litre inverse 6 cylinder engine developing 370 HP; the Ratier metallic propeller had two pitch settings of which the second was automatically engaged in flight. The aircraft had a retractable undercarriage and trailing edge flaps (photo 19).

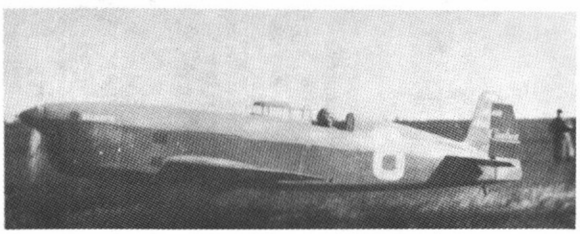

Photo 19 - Caudron 460 de Raymond Delmotte, Istres, Décembre 1934 (505 km/h)

The wing had a 6.6 aspect ratio, the largest value in the history of speed records after the Bernard. It was fitted low on the fuselage without any recess angle with no need for a Karman fairing; the main fuselage section was located a little aft of the trailing edge of the wing. The aerofoil was a symetrical biconvex section with 12% thickness at the root and 6% at the tip.

The pilot's head was protected by a closed glass canopy having a very small size.

The aircraft was constructed in wood with some magnesium covers; the state of the surface finish was perfect. With a small wing (6.9 sqm area), the machine weighed 775 kg. Of all the speed record Aircraft, from 1918 to the present day, it was the lightest and had the least equivalent drag area (CDxS): 0.126 sqm (Note: the least equivalent drag area of all the aircraft to win the Schneider Cup was that of the Supermarine S5: 0.32 sqm). Its stalling-speed with flaps was 122.5 km/hr.

By taking the world speed record to 505.848 km/hr, at Istres on December 25th, 1935, with an engine limited to 370 HP, Delmotte was demonstrating the most elaborate racing Aircraft: Riffard was showing the way ahead.

It was natural that Riffard had thought to fit one of his marvellous speed aircraft with a more powerful engine. He did not convince Renault to design a new prototype until a year later, when Howard Hughes had recaptured the speed record.

The new engine was an inverse V12 Renault (19 litres) running at 3200 rpm and giving 750 HP with benzol fuel. An Aircraft - the 712R - of the same style as the C460, was designed around this engine. It had nearly the same dimensions as the C460, but weighed 1200 kg; its wing loading was 173 kg/sqm and its stalling speed was 145 km/hr, practically the same as all its successors (photo 20).

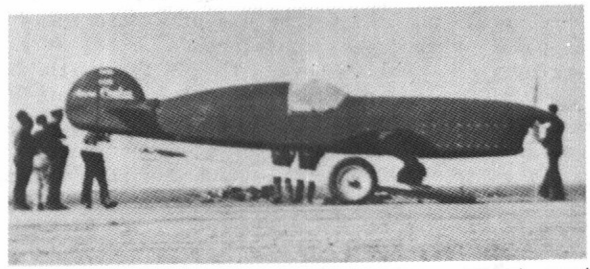

Photo 20 - Caudron 712 de Delmotte ; tentative de record, Avril 1937

On October 9th, 1937 at Istres, Delmotte made an attempt for the record; after taking-off in less than 20 seconds, he set his speed before attacking the run; he was then at 620 km/hr, as seen on the airspeed indicator, and not yet at full speed; at this moment, Delmotte felt that he was losing control; he pulled-up and succeeded in bailing out: a pebble had been thrown into the tailplane during take-off, and, during flight, the stabilizer was damaged, tearing the tip of the elevator...

In 1939, Riffard had redesigned a new Aircraft, which was to be fitted with a new 1000 HP Renault prototype; but the engine could not be developed in time; the war was approaching and there were other things to do in the immediate future. The airframe of this Aircraft, which never flew, is preserved at the Air Museum at Le Bourget, where one can admire its well streamlined shape.

The last American record before 1939.

The famous american manufacturer and pilot, Howard Hughes, decided in 1934 to build a racing Aircraft, with the help of the engineer Dick Palmer, but with his own ideas and under his name.

By July 1934, aerodynamic tests were achieved with a formula conceived around the Pratt and Whitney, 14 cylinder, Twin Wasp Junior engine (700 HP at 2500 rpm, boosted to 900 HP, thanks to a special 100 octane fuel). The propeller was a constant-speed Hamilton Standard. The fuselage was monoshell in aluminium alloy, with an open cockpit. The wing was in one piece, in wood, with two spars and a plywood skin thickly glued and painted in such a way as to ensure the exact shape of the wing section and an excellent surface finish. The wing section was a thick biconvex shape based on the NACA 2418 section at the wing root, transformed at the outer section by a NACA 2409. A large Karman flushed the wing to the fuselage. One cannot refrain from finding in this thick wooden wing a similarity with Bernard-Ferbois rather than with those of the seaplanes;

the flaps used in the Hughes allowed the choice of a small aspect - ratio: 4.54 instead of 7.2. The wing - loading came to 156 kg/sqm giving a stalling speed of 141 km/hr. This machine, well designed and well manufactured, had a total drag coefficient CD a little better than that of the Delmotte C460, despite its thick wing and probably thanks to a lower cooling drag. Bur its greater size was to give it a greater equivalent drag area: CDxS= 0.224 instead of 0.126 sqm.

The Aircraft, built in great secret in 16 months, was ready in August 1935. After four test flights, totalling 2 hrs 20 mns, and several incidents necessitating the change of the propeller regulator and the hydraulic pump, Howard Hughes launched his assault on the record and, on September 13th, reached 567.115 km/hr (photo 21).

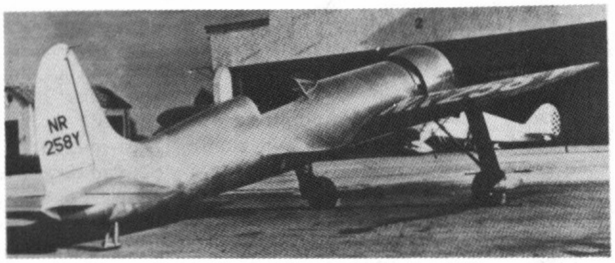

Photo 21 - Hugues H-1 de Howard Hugues, Septembre 1935 (567 km/h)

But to be sure to have reached the fastest speed, Hughes, having completed the two requested runs in each direction, was going to continue to try a second series; unfortunately, he had unsufficient fuel and, on the seventh pass, the engine stopped. He succeeded in belly - landing his Aircraft in a beet field. The FAI, considering that the pilot had controlled his Aircraft to the end and that, strictly speaking, there was no crash or accident, confirmed the record.

Only minor damages were caused to the Aircraft and Hughes modified it by giving it a greater wing area and aspect ratio, fitting a NACA 23012, allowing a greater fuel capacity to be carried. The engine was changed from the standard to a more recent model which would improve his endurance; this engine delivered 850/900 HP in continuous cruise regime and 1000 HP for short periods.

On January 19th, 1937, H.Hughes established a new record for the US west - east crossing - his great dream - in 7 hrs 28 mns 25 secs, from the Burbank airfield to that in Newark with an average speed of 526 km/hr. This record was only beaten after the war, by Paul Mantz with a P51 Mustang.

The Germans arrive on the scene.

It was already clear that the speed records were so high that in order to break them it would be necessary to design a new prototype using the very last technique and the most powerful engine; only very rich men, like Renault and Hughes, could still compete in this adventure without any guarantee of future commercial success, because such racer was far from military project configuration.

Unless a government, for reasons of prestige, set out to conquer the record: this is precisely what happened in Germany.

As early as November 11th, 1937, Wurster, in a special Aircraft introduced as the BF 113R, derived from a Messerschmitt fighter prototype,

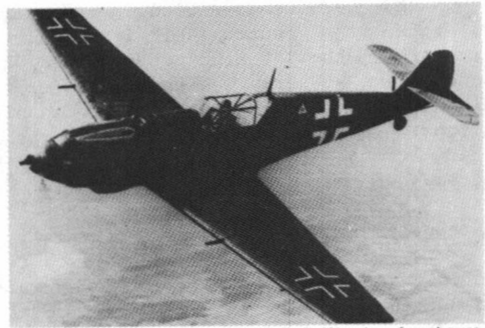

Photo 22 - Messerschmitt Bf 109 E de Wurster, Augsbourg, Novembre 1937 (611 km/h)

powered by a Daimler Benz 600 of 950 HP (the brilliant winner of the Zurich meeting), reached 610.960 km/hr (photo 22).

Few details were given by the official German authorities at that time; today we know that it was a Messerschmitt BF109 - V13, very similar to a Messerschmitt 109E. One may suggest, without much fear of contradiction, that the published power of the engine was a nominal power; it was probable that, as the knowledge was available to the whole aeronautical community, the engine could be pushed to at least 1400/1500 HP; Mr Riffard, interviewed at that time, stated that, in 1937, it was possible to almost double the nominal power for a short time, for a record.

We had more informations, but only after the war, about the two others speed records established within a month in 1939 by Dieterle on a Heinkel 100, and by Wendel on a Messerschmitt 209-V1; they were presented to the press under the designations He 112V and Me 109R to suggest that they were direct derivatives of in-service fighter Aircraft. The only authorized photographs then did not allow any characteristic details to be identified. As for the files set to the FAI, they do not say much.

The Heinkel (photo 23) was equipped with a DB601-E giving 1175 HP, like the Messerschmitt; one suspects that the effective power would have been closer to 2000 HP.

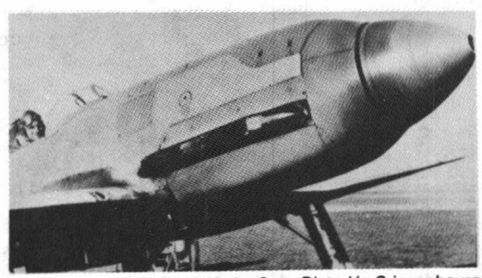

Photo 23 - Heinkel 112-U du Cap, Dieterlé, Crianenbourg, Mars 1939 (746 km/h)

But the increase in power between the 610 km/hr of Wurster and the 746.660 of Dieterle or the 755.11 of Wendel - about 5 to 600 HP - is not sufficient to explain the enormous increase in speed. In fact, it was necessary to have a very refined airframe, with good high-lift devices to increase the wing loading to 175-180 kg/sqm; the Aircraft was reduced in size as much as possible; 14.5 sqm for the Heinkel and 13.2 for the Messerschmitt, the smaller of the two; their take-off weight were respectively 2600 and 2300 kg.

Then, the war would follow, preventing the record race from continuing. It is during this conflict that the jet aircraft appeared, which, at the end of the war, was to fly faster than the Wendel Aircraft thanks, above all, to an effective power that left piston engines far behind: on November 7th, 1945, a Gloster Meteor, with 975.675 km/hr, smashed the German record.

Then another race for the speed record started: it is reported in the second part of this paper.

However, in the US, some enthusiasts felt that they could not leave the propeller Aircraft speed record unbroken.

Sporting achievements after the war.

Of course, to beat the 1939 German speed record in the 60's and 70's was a very difficult proposition without support of a patron or a government: only some determined and competent men could attempt it for national pride or for the love of sport.

One can only admire the test pilot Darryl Greenmayer (*) and his team, all volunteers, for having succeeded in the exploit, but not without problems: it is only after a four years effort that, on August 16th,1967, they were succesfull in taking the propeller Aircraft record to 777.35 km/hr.

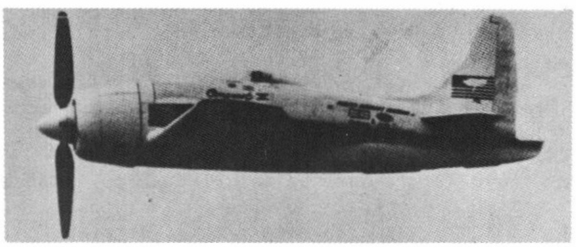

Photo 24 - Grumman F8-F "Bearcat" de Greenmayer, Base d'Edwards, août 1969 (776 km/h)

Using only limited funding, their personal resources and some private assistance, the Greenmayer team selected as a basic Aircraft the F8F2 Bearcat, in service with the Navy at the end of the war; they carried out considerable modifications to it with a view to reducing its drag and weight (photo 24). The wing surface was reduced by shortening the wing span from 10.85 to 8.71 m. A Hoerner wing tip was fitted to compensate for the enormous torque of the propeller with the shorter wing. To save weight, the split-flaps were locked, and all their control system suppressed; all the military equipment was discarded and the electrical system simplified. The canopy was replaced with a smaller version; the air-intakes on the leading-edge, feeding the internal oil radiator were closed and the necessary cooling was obtained by a water evaporation heat-exchange system. The tail and rudder were reduced and a tail-cone installed. A propeller spinner, coming from the P51 was fixed in front. Careful filling and smoothing of gaps, a requirement that was well understood, was then completed.

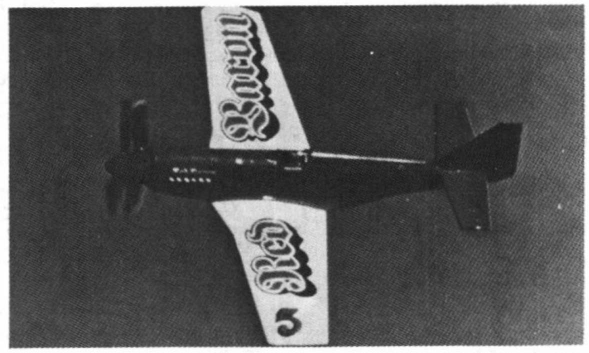

Photo 25 - P-51 "Mustang" de Steve Hinton, Tonopah, Août 1979 (803 km/h)

The original Pratt and Whitney T2800-34W engine with high-altitude compressor was modified thanks to parts from other series of the same type of engine: a lighter compressor adapted for low altitude, a reduction-gear reducing propeller rpm, water injection, a 4.11 m, 4 bladed Skyraider propeller, so big that it forced the pilot to take-off with tail-down. Finally an exotic fuel, including a little nitromethane, allowed the engine to give 3300 HP.

It was in these rather stunty conditions that this team improved the maximum speed of the basic Aircraft by more than 100 km/hr, with a stalling speed of 146.4 km/hr, a little less than that of the Me 209-V1, thanks to a total weight reduced to 3515 kg for a wing area of 20.6 sqm.

But this extraordinary record would next be broken by another american team, that of Steve Hinton, who has chosen a P51 Mustang whose original engine was replaced by a Rolls-Royce Griffon, driving two contrarotative propellers. The power of this engine was boosted to 3800 HP and the gain obtained from the double propellers, equal to nearly an extra 10% power, combined with the excellent lift-to-drag ratio of the basic Aircraft, made it unnecessary to modify it profoundly, as the Bearcat: a wing area reduction and a good surface finish were sufficient!

The speed record was put to 803.069 km/hr on August 14th 1979 (photo 25).

It is difficult to imagine going much further with propeller driven aircraft. But if one realizes that the last two aircraft presented were characterized by 3600 kg, 21 sqm and 3500 HP whereas the two previous Germans were around 2450 kg, 14 sqm and 2000 HP level, for a difference of 50 km/hr, one can imagine that it is still possible to fly the same speed with much less power than 3000 HP thanks to a better aerodynamic design (both for the airframe and for the propeller).

(*) The same Darryl Greenmayer, in 1977, has established the low-altitude record for jet-aircraft at the astonishing speed of 1590 km/hr on a F104.

2 - JET AIRCRAFT.

General remarks.

The end of the second World War coincided with the start of the jet-aircraft era. This offered the prospect of considerable gains in speed, far greater than anyone imagined in 1945.

But the new method of propulsion had its own characteristics, its advantages and its limitations. In order to adapt to these new conditions, it was necessary for the FAI rules to evolve; it was also necessary to use appropriate flight procedures.

These two approaches were established thanks to the considerable progress in measuring instruments. This, however had a drawback for continuing the speed race: because Aircraft performance could be measured with precision, traced in detail in manuals, networks of graphs, charts and in a computer mathematical model, the record was no longer necessary to "prove" actual performances to the potential customer. Commercial interest in the records was growing thin, leaving in its place the motivation of prestige, often at a national level.

One sometimes have the feeling, when examining the time table of events, that some intermediary records could have been obtained... if rewarding!

Moreover, Aircraft performance reached such complexity, as a function of the configuration, test conditions, the state of the atmosphere... etc, that the "direct" description of the record often appeared inadequate to an expert.

This explains certainly why the last 40 years have not seen the development of specific record Aircraft. Records have been broken, rarely by special versions of existing aircraft (the Lockheed P80R, the Hawker Hunter Mark 3), but more often by standard Aircraft a little "cleaned" (removing of aerials, filling in some openings, smoothing the surfaces with filler, polishing etc) and authorised to exceed their usual flight limits... and frequently by standard operational Aircraft.

Therefore, at the same time the speeds attained nearly quadrupled (from about 900 km/hr to about 3500 km/hr), the interest in the records vanished and some basic questions arrive today.

The types of records are too numerous to be all studied. We shall limit this presentation to three typical cases:

- the 3 km record at low altitude,
- the 15 to 25 km, at any height,
- the 1000 km closed circuit record.

Table III gives the essential conditions for these records as determined by the FAI and the chronological changes of rules.

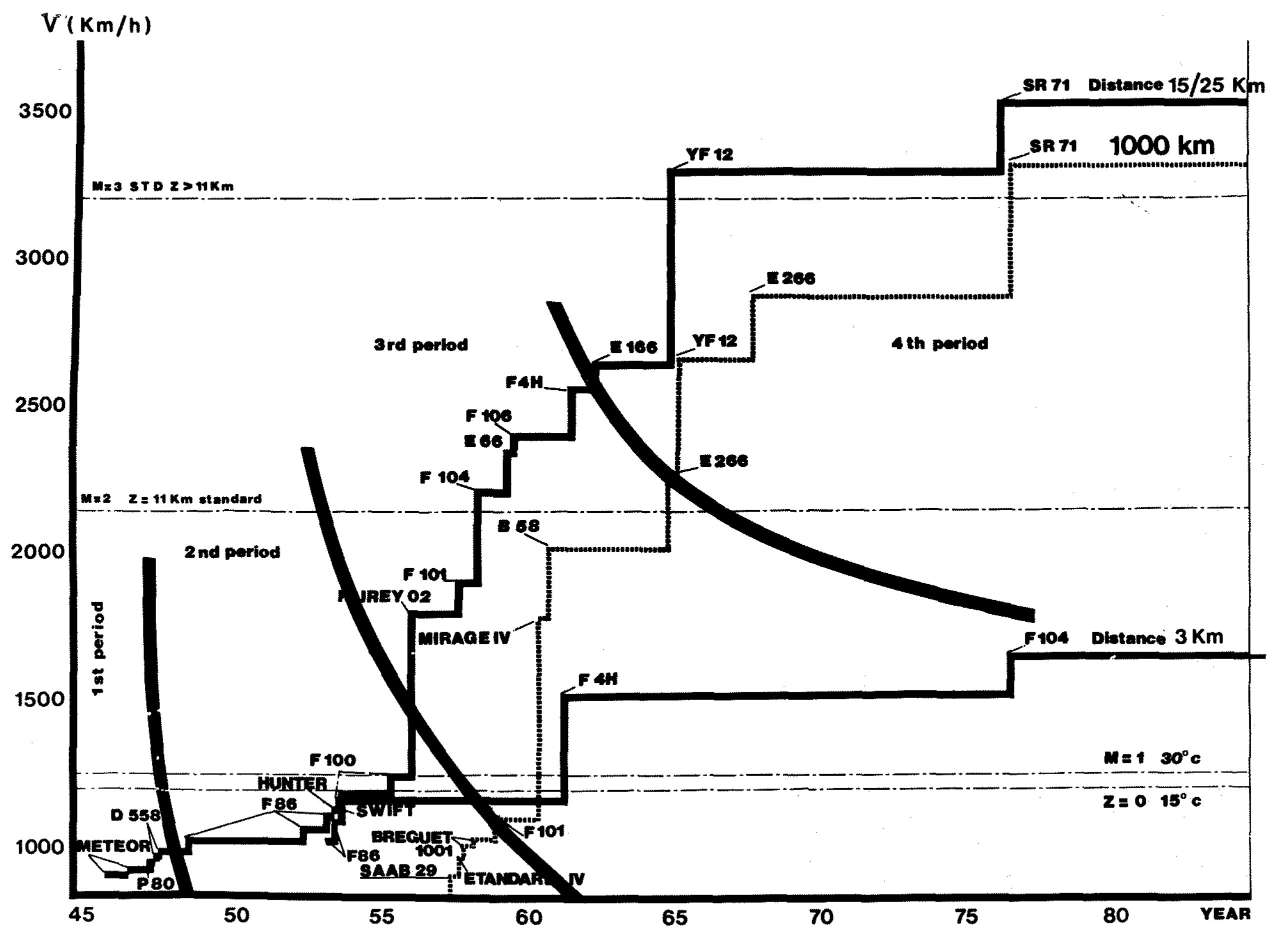

FIG. 3 - F.A.I. WORLD SPEED RECORDS, JET AIRCRAFT FROM 1945 TO PRESENT DAY

This second part will attempt to analyse the simultaneous evolution of these three records and the associated main technological stages, conveniently split into four typical periods. Figure 3 gives a synthetic representation of all these records. Their list is given in Table II.

Photo 26 - Gloster "Meteor" IV du Cap, Wilson, Novembre 1945 (975 km/h)

First period: early attempts (1945 - 1947).

Only the 3km run was recognised during this period corresponding to the discovery of the new possibilities of jet aircraft. Those are the first generation: fighters of the immediate post-war (Meteor IV - photo 26), or derived from them (P80R - photo 27 - a specially modified version of the Shooting - Star), or finally an experimental Aircraft: the Douglas Skystreak (photo 28); all have straight wings (aspect - ratios of 4 to 5), without power - assisted controls (booster on the P80 ailerons).

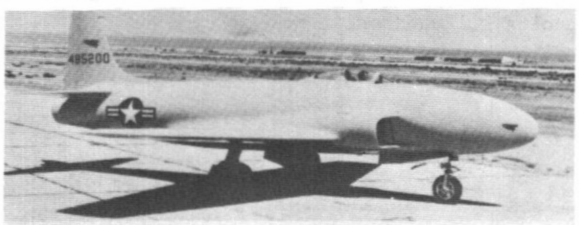

Photo 27 - Lockheed P-80 R du Col. Boyd, Muroc, Juin 1947 (1004 km/h)

While being cautious about the flutter problems (presence of tabs on the "free" control surfaces), these Aircraft hit against compressibility, phenomena arising before Mach 0.8, or a little more (0.83) for the D558.

In those conditions, after the two records obtained by the Meteor IV (975 and 991 km/hr) in the climate of a British autumn (November 7th, 1945 and September 7th,1946), the three American ones were flown in California over "Muroc lake", the last two by the same D558, at the same Mach (0.828), the temperature having the happy idea of climbing from 25°C to 34°C over a five day period (1079 km/hr on August 25th, 1947).

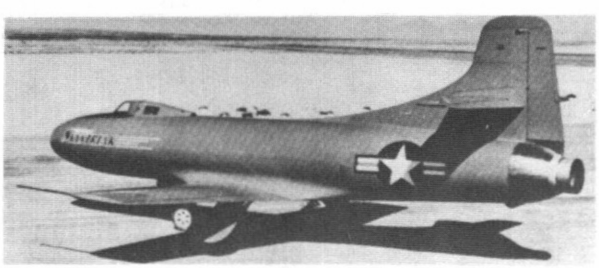

Photo 28 - Douglas 558 "Skystreak" du Maj. Carl, Muroc, Août 1947 (1080 km/h)

Second period: maturity for a breakthrough.

It extends from 1948 to 1955, except for the 1000 km record, up to 1958.

It is a breakthrough to the extent where it corresponds to the "sound barrier" crossing, mostly during a dive and, for the last Aircraft involved, during a full-power level flight at very low supersonic speed.

It is also maturity to the extent where the main characteristics of these jet - Aircraft are quite similar.

What are these common characteristics?

At first, they have a swept-back wing: from 25° sweep (Saab 29) to 45° (F100, Etendard IV, Bréguet 1001); the relative thickness is simultaneously reduced from about 12% to about 6%. Flight controls considerably evolved, with the general use of irreversible servo - controls and, then, of all moving horizontal tail.

Photo 29 - F-86-D "Sabre" du Lt-Col. Barns, Salton, Juillet 1953 (1152 km/h)

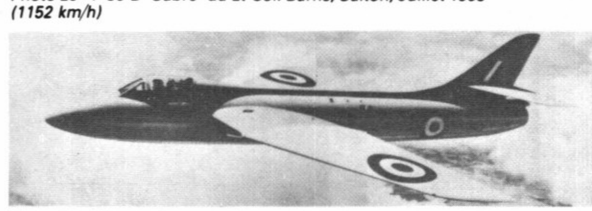

Photo 30 - Hawker "Hunter" MK3 de Sq. Ld. Duke, Septembre 1953 (1171 km/h)

All these improvements were made possible thanks to progress in Aerodynamics and in manufacturing methods (firstly the integral tooling), which is favourable to flutter prevention (even if some static aeroelasticity problems are still remaining). Thus a better control effectiveness gives to these Aircraft a Mach capability above 0.9 without afterburning, and generally above 1 in level flight with afterburning.

Notice the existence of two "cuckoos" in the nest: the Douglas XF4D Skyray, holder of the 3 km record in 1953, was a Delta Aircraft and the Tupolev 104 (photo 36), which broke the 1000 km record in 1957, is the only civilian transport Aircraft appearing in the table.

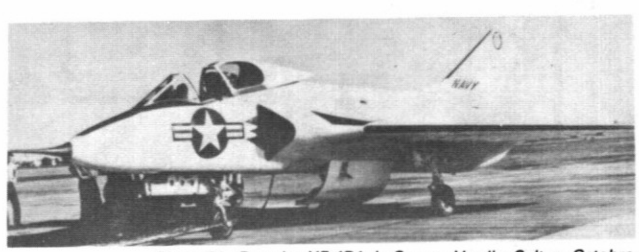

Photo 31 - Douglas XF-4D1 du Comm. Verdin, Salton, Octobre 1953 (1212 km/h)

As far as the 3 km record is concerned, in the cases where those Aircraft are still limited by the transonic drag, hot or even below sea-level terrain were favoured: Lybia for the Supermarine Swift (photo 32), Salton Sea in California (at minus 72 m) for the American records (photo 29).

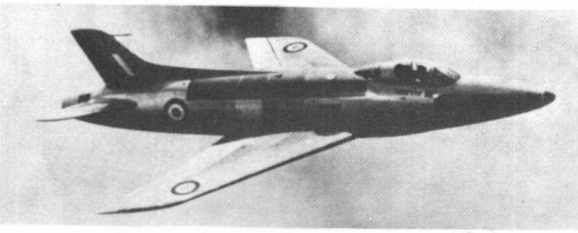

Photo 32 - Supermarine "Swift" de Lithgow, Libye, Septembre 1953 (1184 km/h)

For the 15/25 km run, apart for the 1953 record performed at low level altitude above Salton Sea, the other two, by a canadian Sabre (photo 34) and by a F100 (photo 33) in 1955, were flown around the tropopause, the second being the first supersonic record (1323 km/hr).

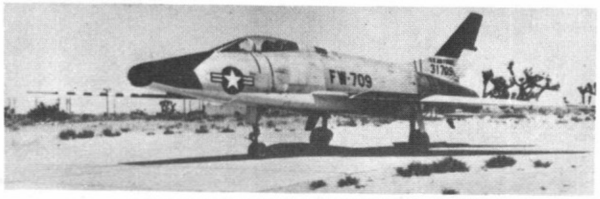

Photo 33 - North-American YF-100 du Col. Everest, Salton, Octobre 1953 (1215km/h)

From 1955 to 1958, the 1000 km records reappeared: after those obtained by the Saab 29 (photo 35) and the Tu 104, they are held by French Aircraft in 1958 (Etendard IV - photo 37, Bréguet 1001 - photo 38): candidates in the NATO contest for a tactical support Aircraft, they are relatively light and they have enough internal fuel to fly at more than Mach 0.9 for one hour.

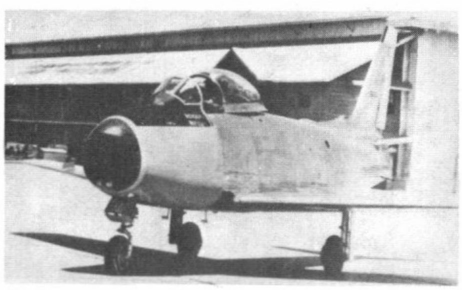

Photo 34 - Canadair F-86 "Sabre" de Jacqueline Cochrane, Muroc, Juin1953 (1087 km/h)

Photo 35 - SAAB-J29 de A.H. Ney, Nyköping, Mars 1955 (901 km/h)

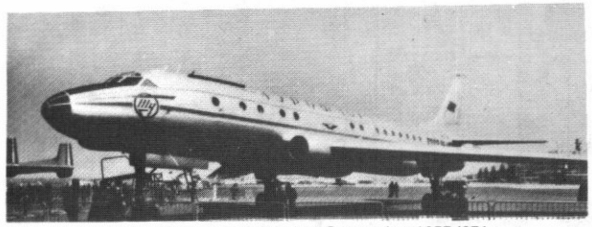

Photo 36 - Tupolev 104 A de V. Kovalev, Septembre 1957 (971 km/h)

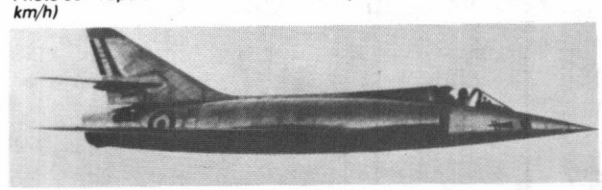

Photo 37 - Dassault "Etendard" IV (prototype) de P. Galland, Istres, Janvier 1958 (1025 km/h)

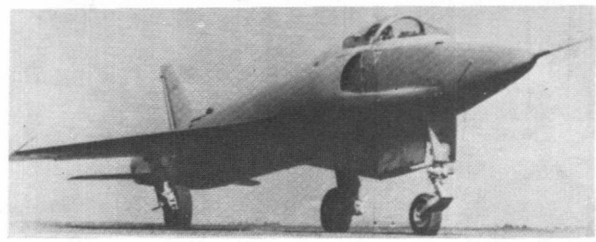

Photo 38 - Bréguet 1001 "Taon" de B. Witt, Istres, Juillet 1958 (1075 km/h)

Figures 4 and 5 illustrate the increase in Aircraft performance for the first and second periods: the first represents in a plane [altitude versus airspeed] the shape of flight envelope in relation to iso - Mach; also shown are the iso "w/V" curves (V is the airspeed and w the total climbing speed): w/V is a measure of the excess thrust minus drag, i.e. the available acceleration. For a given altitude, figure 5 gives the acceleration as a function of Mach number.

It is clear that these Aircraft hit on compressibility phenomena: the acceleration is good until maximum speed, a deceleration during a turn is quickly compensated by a reacceleration, the Mach number stabilises in straight and level flight and varies very little over a range of altitudes. Consequently, the 1000 km records were generally performed in two oposite directions, with only one turning point.

From 1956, the Aircraft characteristics are very different and allow a true supersonic flight.

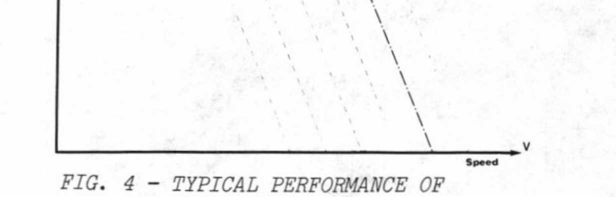

FIG. 4 - TYPICAL PERFORMANCE OF THE 2nd PERIOD AIRCRAFT (1948-55)

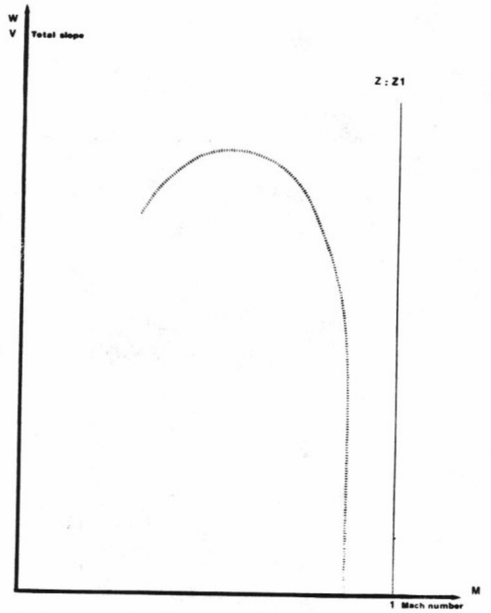

FIG. 5 - 2nd PERIOD AIRCRAFT ACCELERATION IN LEVEL FLIGHT

Third period.

What are "truly supersonic Aircraft? Thanks to a lower wave drag, to the continuous use of an afterburner and, above all, to the improvement of air-intakes (variable geometry), the potential Mach number increases from a little above 1 to about 2.

Excluding the particular case of the unswept wing shape of the F104 (photo 39), the record Aircraft are combat Aircraft (fighter or bomber) which come from two different aerodynamic families.

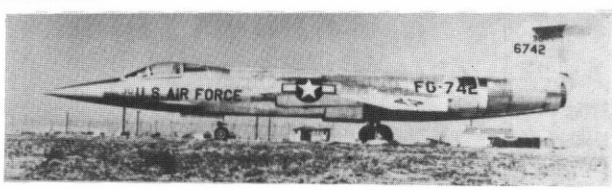

Photo 39 - Lockheed F-104 A de D.G. Greenmayer, Tonopah, Octobre 1977 (1590 km/h)

Most are 60° Delta Aircraft with a relative thickness close to 3% (Fairey Delta 2, E66, F106, Mirage IV, B58 - photo 40 to 44): the Fairey Delta 2 was the first, in an official record, "to beat the sun". The others (F101, F4H - photos 45 and 46) have swept wings more or less accentuated (35 to 45°) with a relative thickness of 5 to 6%.

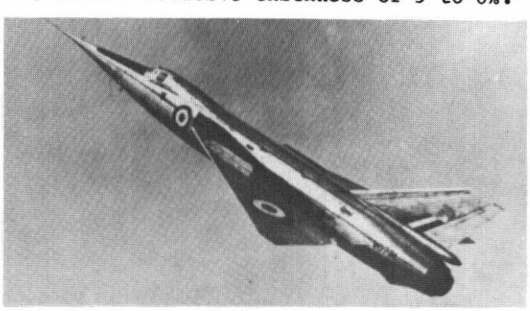

Photo 40 - Fairey "Delta" 2 de L.P. Twiss, Chichester, Mars 1956 (1822 km/h)

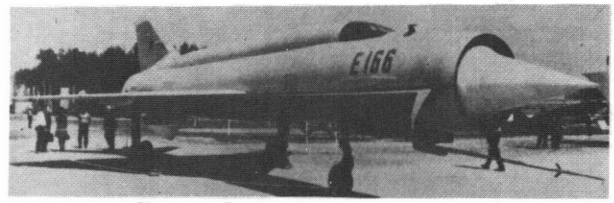

Photo 41 - E-166 de G. Mossolov, Juillet 1962 (2681 km/h)

Photo 42 - Convair F-106 A de J.W. Rogers, Edwards AFB, Décembre 1959 (2456 km/h)

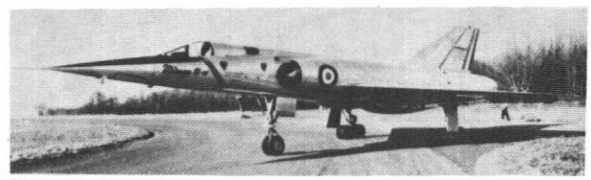

Photo 43 - Dassault "Mirage" IV-01 de R. Bigand, Septembre 1960 (1822 km/h)

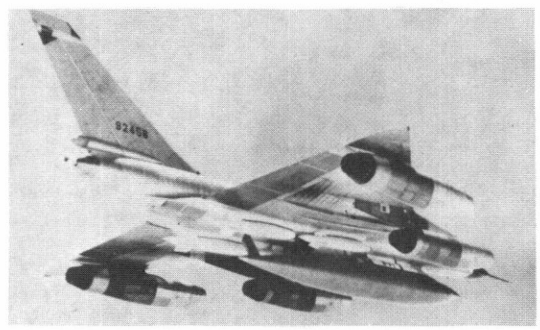

Photo 44 - Convair B-58 de H. Confer, Edwards AFB, Janvier 1961 (2067,6 km/h)

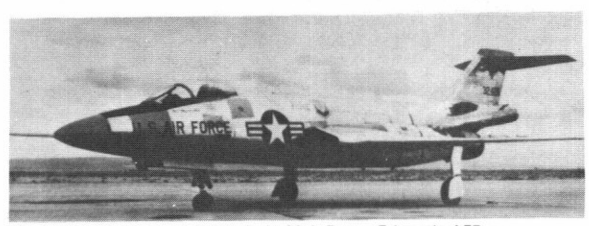

Photo 45 - Mc Donnell F-101 A du Maj. Drew, Edwards AFB, Janvier 1957 (1943 km/h)

Photo 46 - Mc Donnell F4H du Lt-Col. Robinson, Edwards AFB, Novembre 1961 (2585 km/h)

It is close to the tropopause level that these Aircraft have their maximum performance: they were particularly well adapted for the 15/25 km record at altitude. The bombers only (Mirage IV, B58), using afterburner and getting maximum performance without external tanks, were able to attempt the 1000 km record.

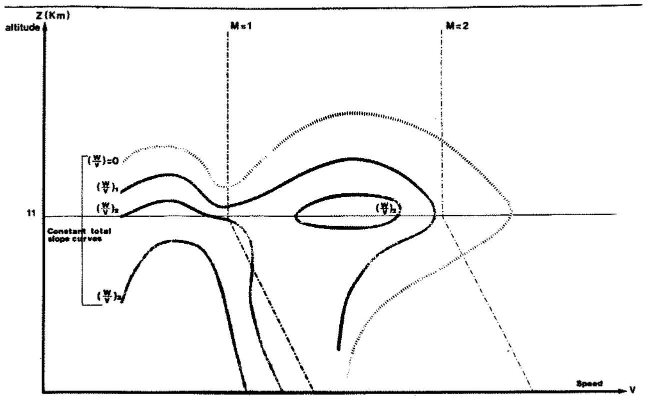

FIG. 6 - TYPICAL PERFORMANCE OF THE 3rd PERIOD AIRCRAFT (1956-61)

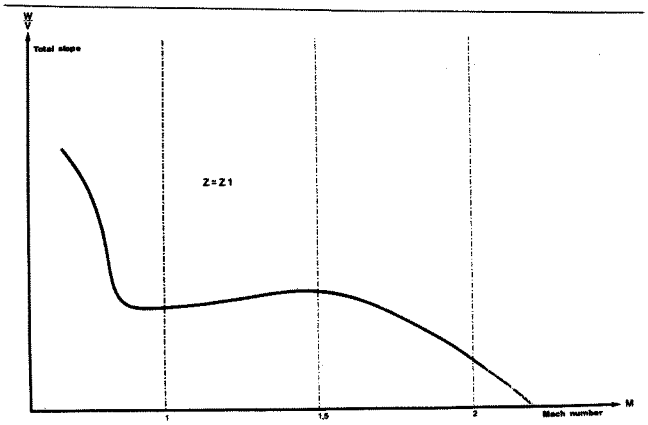

FIG. 7 - 3rd PERIOD AIRCRAFT ACCELERATION IN LEVEL FLIGHT

This is illustrated by figures 6 and 7 similar to figures 4 and 5, which show the typical performance characteristics of an Aircraft capable of Mach 2+: their maximum speed is reached at the tropopause, the available excess power, transferable into acceleration, is relatively modest: acceleration time is relatively long. The supersonic induced drag is large during turns, and the deceleration becomes noticeable as soon as the load factor increases. The turning radius is becoming important as illustrated on the following table giving the turning radius in the stratosphere as a function of Mach number:

Bank angle	Load factor	TURNING RADIUS (km) at M=1	at M=2	at M+3
37°	1.25	13.3	53.3	120
48°	1.50	8.9	35.8	80.5
60°	2.00	5.8	23.1	52

Consequently, at the time of these records, the only way to avoid large deceleration during the turn was a moderate load factor, and hence a large turning radius; in the opposite case, it would be necessary "to pay" for the deceleration with a reacceleration which takes time and costs extra consumption.

Precise optimisation depends upon the individual characteristics of each Aircraft. Nevertheless, it is obvious that, for the closed circuit 1000 km record, it is appropriate to select a large number of turning points so that a continuous turn under a moderate load factor is performed during the major part of the course.

For structural reasons (on airframe, as on engine), the performance of these Aircraft at low level are limited. This explains the large gap between the last 3 km record by the F4D and the subsequent two records obtained with the F4H and the F104. When thinking to the flight conditions for this record (about 7 seconds duration at less than 100 m altitude), it is clearly a severe test for the machines but, above all, for the nerve of the pilot! The time between each of the last records in this category (1953, 1961, 1977) is explained by the dangerous nature of the course; thus the 3 km record became meaningless for the trisonic aircraft of the fourth period.

Fourth and last period.

There is a certain grey area between the boundaries of the third and fourth period. In effect, there isn't any discontinuity in flight behaviour between M=2 and M=3. It is the flight duration above a certain Mach number which is going to become a design parameter: firstly the material behavior at high temperature (on airframe, engines and pieces of equipment) and then the air-conditioning system for the crew. The same technical solutions are not applicable if the excursion into very high speeds lasts for one minute as opposed to half an hour.

On the other hand, operational requirements don't require extreme performance at low or medium altitudes, the technical optimisation leads to reduce aerodynamic loads and, consequently the mass, by flying at the higher altitudes, in excess of 20000 m.

The above mentioned turning problem is even more evident when the speed exceeds 3000 km/hr: a good example is given on figure 8, which illustrates the trajectory flown by the SR71 (photo 47) when the most recent 1000 km record was broken on July 27th, 1976.

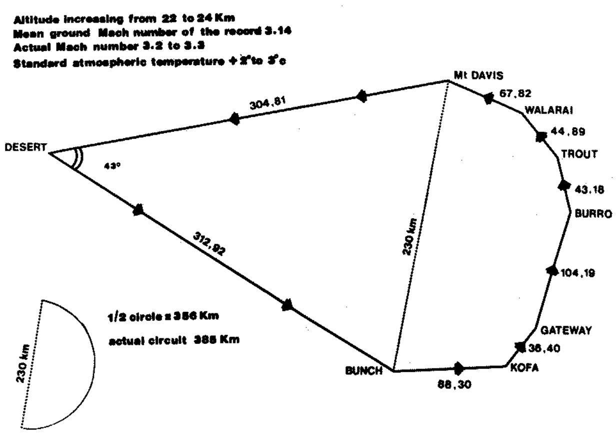

FIG. 8 - SPEED RECORD TRAJECTORY OVER A 1000 KM CIRCUIT BY THE SR-71 (3367 km/h, on July 1975)

The number of Aircraft of this fourth period are too few (2 types: Y12/SR71 and E266) and too little known to be able to comment on their design parameters; equally important are the engine characteristics. It is therefore necessary to leave the subject for a next ICAS Congress...

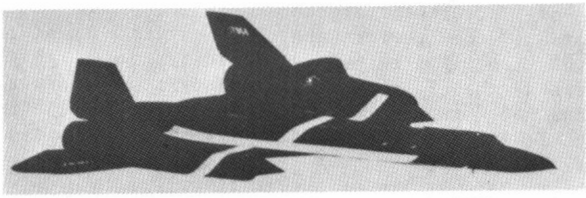

Photo 47 - Lockheed SR-71 de A.H. Bledsoe, Beale AFB (3367 km/h)

The future of Aircraft speed records.

The last records were broken in 1976/1977. Moreover the attempts have become less numerous since 1963.

The 3 km record is becoming more and more of a delicate operation; that of the 1000 km closed circuit is resembling more and more to a continuous circle.

Clearly, it is out of question for developing costly and complex machines such as a MIG25 or a SR71 with the sporting aim of breaking record. If such Aircrafy have to be sold for export, the potential customers will evaluate their operational capabilities and their missions by testing and data analysis.

CONCLUSION.

We have just looked through the history of Aircraft speed records from the beginning of aviation to the present day.

We have been able to appreciate the stumblings of the pioneers who did not yet take advantage of an aerodynamic theory still in infancy; nevertheless some gifty pioneers like Nieuport and Bechereau, had some inspired intuitions during this first era.

After the 1914 - 1916 war, racing Aircraft were easily derived from military equipment; we have a tendancy to smile at more empirical than scientific methods by aeronautical engineers at that time.

But progress in the design of airframes, engines, propellers and radiators was already apparent from succesful solutions and some outstanding Aircraft, amongst which one can identify the Nieuport Sesquiplane, the Curtiss R6 and R2C1 and the Bernard-Ferbois which will remain unbeaten for nearly eight years.

However, because of the poor state of the airfields, the take-off speeds had to be limited and that allowed the seaplane to take the initiative. Curiously, the progress due to the Schneider Cup was mainly reflected in the development of liquid cooled engine, finally beneficial to Great Britain and, more precisely Rolls-Royce.

France did not have a powerful engine program and, despite some weak efforts, will not participate to the Schneider Cup; from 1926, the USA had left practically the liquid cooled engine in order to concentrate on air cooled engine which were used for recapturing the speed record; in order to follow the american example, Italy will not advance its experience in liquid motors until 1935.

Germany, which never participated in the speed record nor the Schneider Cup has, however, followed the general development and, in 1934, launched a very good liquid inverse V engine - a very advantageous solution for a good integration into the aerodynamic design of the Aircraft.

In 1934, the Riffard's Caudron 460 opens a new way, that of aerodynamic refinement; but the lack of a powerful engine had restricted the result.

In 1935, Howard Hughes had produced an excellent racer.

But it was the Germans who, taking the lessons from the races history, and thanks to a unlimited financial support, have produced the archetype of propeller Aircraft racers: succesful aerodynamic design, compact and powerful engine.

Only missing was the coaxial propeller already used by Agelo; this ultimate step was accomplished by the private initiative of Steve Hinton, reaching 803 km/hr, a speed record difficult to improve!

The jet Aircraft, which very soon after the second world war flies-off to conquer the record, at first followed the way of its predecessors. But it appeared that the development cost of a new specialised prototype was obviouly so high that the production of such racers was stopped. It is only on the occasion of military programmes - and, exceptionnally, civilian programmes - that a specific Aircraft was able to break a record; it was chosen in the production line and specially prepared for that purpose: it becomes a by-product of a study conducted for another objective. Under these conditions, it is natural to find again, in the history of speed records, the various periods corresponding to the state of the art at the successive stages of evolution.

The "by-product" record appears more and more as a mark of national prestige to demonstrate the best performance of the most developed product in a country.

Now, the main objectives are more and more economy, operational equipment , complete weapon system; all these aspects can be judged with modern technical approaches without the need of a speed record.

Although it was fascinating to follow this speed adventure from the beginning up today, it was shown that no speed records were announced since 1976 and 1979 for jet and propeller Aircraft respectively: it is allowed to wonder if there is still much future for the world speed record...

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TABLE III : EVOLUTION OF THE FAI SPORTING CODE.

- Before 1920: 1 km base at low altitude.
- From 6-1-1920: 1km run, twice in each direction. (with the requirement to exceed the previous record by at least 4 km/hr)
- June 1920: first record over a 1000 km circuit.
- 1-4-1923: Distance increased to 3 km.
- 4-6-1950: Founding of a 15/25km record at altitude
- Since 3-10-1979:
  a) 3 km distance extended at each end by corridors of at least 1 km, flown twice in each direction. Maximum height on the base and along the corridors: 100 m. Maximum height during the flight: 500 m.

-....

b) 15 to 25 km distance extended at each end by 5 km corridors flown once in each direction. Unlimited altitude, but cannot vary on the base or in the corridors by more than 100m. Maximum altitude during the flight: 200 m above the altitude chosen for the base.
c) 1000 km closed-circuit: obtained in one or several circuits. Level flight for at least 1 km before the starting line (100 m tolerance). Final height greater than or equal to departing height.

TABLE II : LIST OF SPEED RECORDS, JET-AIRCRAFT

1- Distance 3 km at low altitude

DATE	LOCATION	SPEED (Km/h)	AIRCRAFT	PILOT
07.11.45.	Herne Bay (GB)	975,675	Gloster Meteor IV	Gr.Cn.H.J. WILSON
07.09.46.	Little Hampton (GB)	991	Gloster Meteor IV	Gr.Cn.E. MORTLOCK DONALDSON
19.06.47.	Muroc (E.U.)	1003,811	Lockheed P80R	Col. BOYD
20.08.47.	Muroc (E.U.)	1031,78	Douglas D558	Comm. TF. CALDWELL
25.08.47.	Muroc (E.U.)	1047,356	Douglas D558	Major M.E. CARL
15.09.48.	Muroc (E.U.)	1079,841	F 86 A	Major R.L. JOHNSON
19.11.52.	Salton Sea (E.U.)	1124,137	F 86 D	Cn. J.S. NASH
16.7.53.	Salton Sea (E.U.)	1151,883	F 86 D	Lt.Col. W.F. BARNS
07.09.53.	Little Hampton (GB)	1171	Hunter Mk 3	Sq.Lr.N.F. DUKE
25.09.53.	*Castel Idris (Libye)*	*1184*	*Supermarine Swift*	*M.J. LITHGOW*
03.10.53.	Salton Sea (E.U.)	1211,746	Douglas XF 4D	Lt.Com. J.B. VERDIN
28.08.61.	Holloman AFB (E.U.)	1452,777	Mc Donnell F4H	Lt. H. HARDISTY
24.10.77.	Tonopah (E.U.)	1590,45	Lockheed F 104	D.G. GREENMAYER

3 - 1 000 km close circuit

DATE	LOCATION	SPEED (Km/h)	AIRCRAFT	PILOT
23.03.55.	Nyköping (Suède)	900,660	SAAB 29C	Cn. A.H.M. NEY
24.09.57.	U.R.S.S.	970,821	TU 104 A	V. KOVALEV
18.01.58	Istres (France)	1025,315	Etendard IV	P. GALLAND
25.04.58.	Istres (France)	1050,636	Breguet 1001	B. WITT
23.07.58.	Istres (France)	1075,347	Breguet 1001	B. WITT
08.04.59.	Edwards AFB (E.U.)	1126,619	RF 101 C	Col. E.H. TAYLOR
19.09.60.	France	1822	Mirage IV	Cdt R. BIGAND
14.01.61.	Edwards AFB (E.U.)	2067,58	B 58	Mr. H.E. CONFER
16.03.65.	Podmoskovnoe (U.R.S.S.)	2319,2	E 266	A.V. FEDOTOV
01.05.65.	Edwards AFB (E.U.)	2718,006	Y 12 A	Mr. W.F. DANIEL
27.10.67.	Podmoskovnoe (U.R.S.S.)	2920,67	E 266	P. OSTAPENKO
27.07.76.	Beale AFB (E.U.)	3367,22	SR 71	A.H. BLEDSOE Jr.

2 - Distance 15 to 25 km

DATE	LOCATION	SPEED (km/h)	AIRCRAFT	PILOT
03.06.53.	Muroc (E.U.)	1087,068	Sabre Canadien M K 3	Jacqueline COCHRAN
01.09.53.	*Vandalia (E.U.)*	1139,219	*F 86D*	*Cn. H.E. COLLINS*
29.10.53.	Salton Sea (E.U.)	1215,298	Y F 100	Lt. Col. F.K. EVEREST Jr.
20.08.55.	Palmdale (E.U.)	1323,312	F 100 C	Col. H.A. HANES
10.03.56.	Chichester (G.B.)	1822	Fairey Delta 2	L.P. TWISS
12.1.57.	Edwards AFB (E.U.)	1943,5	F 101 A	Mr A.E. DREW
10.05.58.	Edwards AFB (E.U.)	2259,538	F 104 A	Cn. W. W. IRWIN
31.10.59.	Petrovskoe (U.R.S.S.)	2399	E 66	G. MOSSOLOV
15.12.59.	Edwards AFB (E.U.)	2455,736	F 106 A	Mr. J. W. ROGERS
22.11.61.	Edwards AFB (E.U.)	2585,425	F 4 H	Lt. Col. R.B. ROBINSON
07.07.62.	Podmoskovnoe (U.R.S.S.)	2681	E 166	G. MOSSOLOV
01.05.65.	Edwards AFB (E.U.)	3331,507	Y F 12 A	Col. R.L. STEPHENS
28.07.76.	Beale AFB (E.U.)	3529,560	SR 71	Cn. E.W. JOERSZ

TABLE I :

LIST OF SPEED RECORDS, PROPELLER-AIRCRAFT

DATE	LOCATION	SPEED	AIRCRAFT	PILOT
12.11.1906.	*Bagatelle (Fr)*	*41.292*	*Santos-Dumont XIV Bis*	Alberto SANTOS DUMONT (Br)
26.10.1907.	Issy-les-Mx (Fr)	52.700	Voisin-Farman	Henry Farman (Fr)
20.05.1909.	Pau (Fr)	54.810	Wright	Paul TISSANDIER (Fr)
23.08.1909.	Reims (Fr)	*69.821*	*Herring Curtiss*	Glenn CURTISS (E.U.)
24.08.1909.	Reims (Fr)	74.318	Blériot XII	Louis BLERIOT (Fr)
28.08.1909.	Reims (Fr)	76.995	Blériot XII	Louis BLERIOT (Fr)
23.04.1910.	*Nice (Fr)*	77.579	*Antoinette Levavasseur*	Hubert LATHAM (Fr)
10.07.1910.	Reims (Fr)	106.508	Blériot XI	Léon MORANE (Fr)
29.10.1910.	New-York (E.U.)	109.756	Blériot XI	Alfred LEBLANC (Fr)
12.04.1911.	*Pau (Fr)*	*111.801*	*Blériot XI*	Alfred LEBLANC (Fr)
11.05.1911.	Châlons (Fr)	119.760	Nieuport	Edouard Nieuport (Fr)
12.06.1911.	Etampes (Fr)	125.000	Blériot XI	Alfred LEBLANC (Fr
16.06.1911.	*Châlons (Fr)*	130.057	*Nieuport*	Edouard Nieuport (Fr)
21.06.1911.	Châlons (Fr)	133.136	Nieuport	Edouard Nieuport (Fr)
13.01.1912.	Pau (Fr)	145.161	Deperdussin	Jules VEDRINES (Fr)
22.02.1912.	*Pau (Fr)*	161.290	Deperdussin	Jules VEDRINES (Fr)
29.02.1912.	Pau (Fr)	162.454	Deperdussin	Jules VEDRINES (Fr)
01.03.1912.	Pau (Fr)	166.821	Deperdussin	Jules VEDRINES (Fr)
02.03.1912.	*Pau (Fr)*	167.910	Deperdussin	Jules VEDRINES (Fr)
13.07.1912.	Reims (Fr)	170.777	Deperdussin	Jules VEDRINES (Fr)
09.09.1912.	Chicago (E.U.)	174.100	Deperdussin	Jules VEDRINES (Fr)
17.06.1913.	Reims (Fr)	179.820	Deperdussin	Maurice PREVOST (Fr)
27.09.1913.	Reims (Fr)	191.897	Deperdussin	Maurice PREVOST (Fr)
29.09.1913.	Reims (Fr)	203.850	Deperdussin	Maurice PREVOST (Fr)
07.02.1920.	Villacoublay (Fr)	275.862	Nieuport-Delage 29 V	SADI-LECOINTE (Fr)
28.02.1920.	Villacoublay (Fr)	283.464	Spad-Herbemont 20 bis	Jean CASALE (Fr)
09.10.1920	Buc (Fr)	292.682	Spad-Herbemont 20 bis	Bernard de ROMANET (Fr
10.10.1920.	Buc (Fr)	296.694	Nieuport-Delage	SADI-LECOINTE (Fr)
20.10.1920.	Villacoublay (Fr)	302.529	Nieuport-Delage 29 V	SADI-LECOINTE (Fr)
04.11.1920.	Buc (Fr)	309.012	Spad-Herbemont 20 bis	Bernard de ROMANET (Fr)
12.12.1920.	Villacoublay (Fr)	313.043	Nieuport-Delage 29 bis	SADI-LECOINTE (Fr)
26.09.1921.	Etampes (Fr)	330.275	Nieuport-Delage Sesquiplan	SADI-LECOINTE (Fr)
21.09.1922.	Etampes (Fr)	341.233	Nieuport Delage Sesquiplan	SADI-LECOINTE (Fr)
13.10.1922.	Detroit (E.U.)	358.836	Curtiss P-6	Brigadier Général MITCHELL (E.U.)
15.02.1923.	Istres (Fr)	375.000	Nieuport-Delage Sesquiplan	SADI-LECOINTE (Fr)
29.03.1923.	Dayton (E.U.)	380.751	Curtiss R6	Lt.R.Russell MAUGHAN (E.U.)
02.11.1923.	New-York (E.U.)	417.078	Curtiss R2 C1	Lt. Harold J. BROW (E.U.)
04.11.1923.	New-York (E.U.)	429.025	Curtiss R2 C1	Lt.A.J.WILLIAMS (E.U.)
11.12.1924.	Istres (Fr)	448.171	Bernard-Ferbois (SIMB)V2	Adj.Chef Florentin BONNET (Fr)
03.09.1932	Cleveland (E.U.)	473.820	Monoplan Gee-Bee	Major James H. DOOLITTLE (E.U.)
04.09.1933.	Chicago (E.U.)	490.800	Monoplan Wedell WILLIAMS	James R.Wedell (E.U.)
25.12.1934.	Istres (Fr)	505.848	Caudron Renault 460	Raymond DELMOTTE (Fr)
13.09.1935.	Santa-Anna Californie (E.U.)	567.115	Monoplan Hughes Spécial	Howard HUGHES (E.U.)
.11.11.1937	Augsbourg (All)	610.950	Monoplan BF 113 R (BF 109 V13)	Hermann WURSTER (All)
30.03.1939.	Oranienburg (All)	746.604	Heinkel He 112 U (He 100)	Flugkapitan Hans Dieterle (All)
26.04.1939.	Augsbourg (All)	755.138	Messerschmitt BF109 R (He 209V1)	Flugkapitan Fritz WENDEL (All)
16.08.1969.	Edwards AFB Californie (E.U.)	776.449	Grumman F8F-2 Bearcat modifié	Darryl GREENMAYER (E.U.)
14.08.1979.	Tonopah Nevada (E.U.)	803.138	North-American P-51.D Mustang modifié	Steve HINTON (E.U.)