GLIDING

& ADVANCED SOARING

By A. C. DOUGLAS

With CONTRIBUTIONS by
P. A. WILLS, C.B.E
and DR. A. E. SLATER

THE rapid advances in the art and science of Gliding and Soaring have been dealt with comprehensively in this up-to-date book. Every branch of the subject is covered, including Training in all its stages, Sailplane Design and Construction, Meteorology and Advanced Soaring, Club operation, and has been especially written for those people who want to take up this fascinating sport. It has been written without abstruse technicalities and is illustrated with explanatory diagrams and photographs. A. C. Douglas has considerable experience in all aspects of Club operation, Flight training and maintenance, having run a club successfully before the war. Dr. Slater was Editor of the official Journal, "The Sailplane and Glider," which had a world-wide circulation as the first magazine entirely devoted to the subject. P. A. Wills is the holder of the British height, distance, and goal flight records.

With a Foreword by
C. ESPIN HARDWICK

Illustrated with
Photographs and Diagrams

16s.
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GLIDING AND ADVANCED SOARING

"The winds and waves are always on the side of the ablest navigators."

EDWARD GIBBON

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A. C. Douglas

Ann Douglas

Ann Welch

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and a FOREWORD by

C. ESPIN HARDWICK

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TO

DAVID BRUNT, F.R.S.

WHO HAS DONE SO

MUCH FOR

BRITISH GLIDING

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FOREWORD

All who have read Mrs. Ann Douglas's *Cloud Reading for Pilots* will especially welcome this further contribution from her pen to knowledgable soaring literature. Broadly speaking, it would appear that only recently has the Science and Art of Soaring Flight been adequately and tastefully dealt with; earlier efforts tended to be too technical or too highly coloured and piecemeal, rather than a straightforward and objective digging-down to the roots and mainsprings of the art.

Although it is some time now since her first book appeared, I still think that it has not received the attention and recognition that it should have done, inasmuch as she was the first to produce a book dealing solely with the air and its structure with special reference to human flight. In other words, to our shame, it may have appeared before its time. In all previous Gliding books the Machine and the Man had been the fundamental basis of the theme.

Then for the first time, Mrs. Douglas directed our attention to the air itself as the fount and mainspring of future study, investigation and discovery; showing how the sub-conscious, if not the conscious mind of the early pioneers had on balance tended that way. I for one believe she was right, and I believe the next ten years' experience will conclusively prove it. The internal combustion engine had blinded our eyes and dulled our hands to the subtle but dynamic forces with which our atmosphere is packed for our good or ill as we choose, and in proportion to our knowledge.

It is obviously necessary to have designed and built the finest aircraft and evolved the finest piloting technique, but when this had been done and well done, the time had arrived for us to become fully air conscious, with the will and knowledge to look for, recognise, use, or avoid, and in the case of thermal "break-aways" over and adjoining aerodromes, etc., *to chart*, the forces which have been continuously liberated in our atmosphere since the beginning of time. In other words, we must "KNOW OUR ELEMENT" in a much more intimate and knowledgable way than it has been generally known or thought necessary to know up to the present, if we are going to complete its conquest and extract that indefinable pleasure which accrues to those who succeed in harnessing natural forces and using them to achieve their objectives.

All Gliding people know that this is no idle dream or theory, but is actually taking place at the present time in a small way by a very few around several aerodromes and soaring grounds, with prospects of extension when high-efficiency soaring craft are available. The fundamental truth which is now apparent is that in each given wind direction, on any and every site, there are definite but limited areas where up-current or down-draughts can be regularly expected whenever conditions are right for thermal activity; and that these areas are *constant in each given wind direction*, and can therefore be charted. It was in this manner that eleven "C" certificates were taken off the flat Walsall Aerodrome in 1945 during two A.T.C courses there. Once these spots are located, all that remains to be done is to find the periodicity of the breakaways each day and the flights timed accordingly, which is now a common practice at the more advanced clubs.

Therefore, this book which traces the evolution of the human desire and aspiration to fly, and which indicates the simplest methods of enabling man to get into the air, and which at the same time indicates the direction in which he is to look for further progress, is particularly welcome at the present time when the individual urge to fly is being cramped and starved through the aftermath of war and general official apathy; many problems with which this book deals are as yet generally unrecognised officially as existing or of any practical importance. It unfortunately appears to be true that only those relatively few who have themselves played the gentle lift of an evening thermal, or fought and held their first big and active day thermal, or again have been seized and whirled upwards by the full force of the storm cloud, or travelled up and down the length of a cloud street, can fully appreciate that there is a problem to solve and many further lessons to be wrenched from nature. Therefore, I think that the greatest contribution that the individual can make at the present time is to quietly continue with his or her soaring at every favourable moment, collecting, recording and charting data which can then be pieced together and used for the general furtherance of the Art and the general safety of air travel.

These conditions, however, presuppose the existence in this Country of suitable machines in sufficient quantities to supply the tools for wrestling with this intricate problem, and here, unfortunately, is the greatest obstacle with which the British Gliding movement is faced. Stripped of its own machines by its own patriotic action during the War, nothing officially has been done so far to replace this precious equipment. Without the freeing of supplies and allotting of factory space, we gliding people can do nothing. It is, therefore, fairly and squarely a Government responsibility to give us the material for the tools so that we can do the job. Never was a movement more deserving of consideration and help than this movement which was born with the hand of every man against it and the finger of derision pointed in its direction. Landowners, vested interests, farmers, physical obstacles of every variety, and weather, transport and finance, all had to be overcome before the brain and hand of man were free to design and build and fly machines of the necessary strength and layout to cope with this intricate and, in the early days, obscure science; alone, unaided until 1937, gliding people did it. Accordingly, they should have earned respect and consideration.

This new book, by pioneers of British Club Gliding, should be generally welcomed both by the old hand and the newcomer, to whom it will be found of equal interest and value, inasmuch as it shows clearly whence and how we have come and to whence we are directing our steps.

C. Espin Hardwick

The authors would like to express their thanks to the Royal Aeronautical Society for permission to include figures 1–7; to D. F. Greig for figures 17 and 76; to C. H. W. Edmonds for figure 90; to F. W. M. Ruck for diagram 39; to the Air Division Gliding Club for figures 6, 9 and 70; and to the editors of *Sailplane* and the *Newcastle Journal* for figures 16, 17, 21 and 19 respectively.

Chapter 1

HISTORY OF SOARING FLIGHT

THE birds, who inspired the human race with the idea of flying, have two ways of keeping up in the air. Either the wings are flapped up and down, or else they are held rigid while the bird sails along without apparent effort. For birds do not invariably glide down to earth when resting on their wings; at times they *soar:* that is, they maintain height or even climb upwards.

It might be thought that, through all the centuries before mechanical power became available, soaring would be the method of choice for any would-be aviator. Then why was it not done until the twentieth century?

The story which follows will show that, before human soaring flight could become an established practice, five conditions had to be fulfilled. It was necessary to discover, first, that there is such a thing as soaring; second, how it is done; third, how to make a soaring apparatus; fourth, how to fly it; fifth—and not least important—to want to soar.

On the first point alone, two famous writers of the past reached opposite conclusions. Leonardo da Vinci, the versatile artist, scientist and engineer, who wrote on the flight of birds from about 1490 to 1515, knew that birds could gain height by sailing round in circles. But Giovanni Borelli, who in 1680 published a classic book on Animal Locomotion, thought that birds could only maintain height in a glide by using up momentum previously acquired by flapping. Unfortunately, da Vinci's writings were lost to the world for three hundred years, leaving Borelli as the standard authority.

Even up to the late nineteenth century many observers refused to accept the soaring of birds as an accomplished fact. Louis Pierre Mouillard, whose book, *L'Empire de l'Air*, published in 1881, inspired the brothers Wright, was exasperated by people who attributed his observations of soaring vultures in Egypt to an optical illusion. Others were so incapable of conceiving how soaring could be possible, that they could scarcely believe their eyes when they saw it done. For instance, H. N. Moseley, of the "Challenger" expedition (1869-73), would watch the albatrosses for hours in the hope of detecting a momentary flicker of the wings; and Professor S. Exner, of Vienna, suggested as late as 1906 that birds with apparently motionless wings were really being pushed along by minute vibrations of the feathers.

The first clear explanation of the mechanics of soaring flight was given by Lord Rayleigh in a letter to *Nature* of April 5, 1883, where he stated that the wind must be either not horizontal or not uniform. The first of these conditions, which means in effect that the air must be moving upwards, is now known to be responsible for most of the soaring of birds and practically all human soaring. Yet even nowadays the great majority of people, educated or otherwise, are so unpractised in thinking in terms of relative motion that they cannot imagine how any object can move upwards relative to the earth while at the same time moving downwards relative to the air in which it is flying.

The earliest recorded attempts to fly, as well as the legendary ones, usually began with an attempt to reproduce a scaled-up bird's wing, often to the extent of putting feathers on it, in the belief that such a structure was inherently able to keep itself up, once it got well aloft.

The idea that the passage of a wing through air causes the air to react by holding it up was held by da Vinci, but later discarded by him when he realized that "a body cannot be pulled by the undulation caused by itself."

The same fallacy is said to have been held by Jean-Marie Le Bris in the mid-nineteenth century. In the course of his travels as a sailor he found that the wing of an albatross, when held up, drew forward into the wind and tended to rise. Having thus, as he thought, discovered the secret of soaring flight, he built a large glider in imitation of the bird and, about 1855, succeeded in getting it off the ground at Trefeuntec, near Dournenez in Finistère (France). It is related that he fitted the machine with controls, and that they worked.

A variant of the reaction idea was held by Dr. E. H. Hankin, who meticulously observed soaring birds in India from 1909 to 1912. He concluded that "soarable air" underwent some unknown physical change beneath a bird's wing, and refused to believe the up-current theory, except in so far as his birds would sometimes soar where the wind was being deflected upwards over an obstacle.

Fig. 1. *Otto Lilienthal flying his monoplane glider (about 1893). Note the slope of the hill, the glider's angle of descent is almost as steep.*

Fig. 2. *Percy Pilcher flying his "Hawk" glider in* 1896.

Human soaring in an up-current of this sort was first performed by Otto Lilienthal, if only for a few seconds at a time. He built a series of gliders from 1891 to 1896, when he was killed in a crash. Lilienthal realised the importance of continuous practice in controlling such a machine, which he did by moving his body about beneath the wing. He would jump off the top of an artificial hill near Berlin, or later from the

Rhinow Hills near Stöllen, and by 1895 was able at times to rise well above his take-off point in the ascending wind over the slope. But apart from this hovering over hills he appeared to have no conception how soaring was done, though some experiments with aerofoils near the ground led him to suspect that the wind was everywhere ascending at an angle of 3 or 4 degrees!

Percy Pilcher, a marine engineer who experimented with gliders similar to Lilienthal's from 1895 to 1899, first near Glasgow and then at Eynsford in Kent, also found himself able to hover momentarily over a slope. But he sought to prolong his flights, not by soaring, but by being towed with a cord, and while doing so he lost his life.

For many years the up-current theory had to contend with its rival, the non-uniform wind theory. Even Rayleigh favoured the latter, and Samuel Pierpoint Langley, in his *Internal Work of the Wind*, published by the Smithsonian Institution of Washington in 1893, actually prophesied that the flying machine of the future would be able to "circumnavigate the globe without alighting" by using wind fluctuations alone, only resorting to motive power in "exceptional moments of calm".

A year later Octave Chanute forecast that the single-seater flying machine of the future would be a "soaring type," and only passenger-carrying aircraft would rely on continuous motive power. But even he could not at that time guess how soaring was done otherwise than in winds deflected up slopes.

Having advised all flying experimenters to concentrate first on soaring, Chanute decided in 1895 that he could not ask others to take risks without doing so himself. So he gathered a small band of helpers, and with them spent altogether eight weeks in the summer of 1896 among the sand dunes on the shore of Lake Michigan, near Chicago. Here they carried out some two thousand glides in winds ranging up to 31 miles an hour in machines with various wing arrangements, mostly designed by Chanute, who took a few hops himself although he was then 64 years old. At first he arranged for the wing-tips to swing back in response to gusts, finding that little balancing movement was then needed; later he fitted controls for the rudder and elevator. The gliders often climbed and hovered for several seconds at a time.

In the autumn one of his assistants, A. M. Herring, who had flown a Lilienthal glider two years earlier, returned to the site and succeeded, by turning somewhat sideways to the wind, in soaring along a ridge for over 300 yards, keeping in the air for 48 seconds. Yet in the same year he had given his opinion, in the *Aeronautical Annual*, that soaring would not be accomplished until "long after the air has been navigated by steam!"

In 1899, Chanute decided finally in favour of the up-current theory, after satisfying himself that air often rises in places at more than four miles per hour. But in using that figure to prove soaring possible, this professional railroad engineer embarked on a complicated calculation involving foot-pounds per second and other entities. He then refrained from publishing this proof for many years on the curious ground that "to ensure safety, it would be necessary that the machine should be equipped with a motor in order to supplement any deficiency of wind force." In 1907, twenty-three years in advance of his time, Chanute described exactly how a glider should be flown when climbing in circles, except that, in advising the pilot to gain height only when facing the wind, he still showed a failure to understand fully the circling of birds.

After Herring, the brothers Orville and Wilbur Wright made the next advances in practical soaring. In 1900 they began experimenting with biplane gliders near Kitty Hawk, on the Atlantic coast of North Carolina, and by the autumn of 1903 they were able to maintain height over a sandhill for more than

Fig. 3. *A full-size replica of the Wright glider of 1902, made by Messrs. Zander and Weyl for the film "Conquest of the Air".*

a minute on several occasions. They went one better than Chanute by adding lateral control.

The primary object of this soaring was to obtain longer practice flights than could be done by mere gliding descents, in preparation for the great day when the brothers could add a motor to the machine. But before their achievement of power-driven flight in December, 1903, turned their attention from the other kind, Wilbur had prophesied in 1901 that the glider pilots of the future would first learn to gain height over a slope and then go off across country to any desired spot by means of the other up-currents used by the birds. He and his brother had only been deterred from trying out this technique by the risk of landing in the marsh to leeward of their hill, and it was over a quarter of a century before anyone else was clear-headed enough to know how to set about it. A year later, in a paper read at Chicago, he used far simpler terms than Chanute when he explained that "the soaring of birds consists in gliding downwards through a rising current of air, which has a rate of ascent equal to the bird's relative rate of descent."

From the fact that birds usually circle in groups, Wilbur Wright deduced that the currents they use are localised. But the first full and correct explanation of circling appears to have been given by Wilhelm Kress in his book *Aviatik*, published in Vienna in 1905. Kress said that the up-currents which rise from warm ground on sunny days are so narrow that birds must fly in circles to keep within them.

Although soaring flight had now been not only performed by man but also satisfactorily explained, the fact aroused too little interest to become generally known, and even in 1908 Sir Hiram Maxim could declare: "We shall never be able to imitate the flight of the soaring birds." Some investigators, such as Gustav Lilienthal (Otto's surviving brother), still held to the "reaction" theory discarded by da Vinci four hundred years earlier. And José Weiss explained the soaring of birds, other than over a slope, by asserting that a perfectly designed wing should glide on a practically horizontal course, the only resistance being that due to skin friction. He built a large number of bird-like models without tails, and then a man-carrying machine in which, in 1909, E. C. Gordon England was launched off Amberley Mount, in Sussex, rising about 100 feet in the wind blowing up the hill.

An opportunity to explore the higher up-currents was missed by Professor John J. Montgomery, who experimented with gliders between 1884 and 1911 in California. In 1905 he had his gliders released from balloons at 4,000 feet, and one of the pilots passed through clouds on the way down without being aware that they might have contained rising air.

A remarkable soaring flight of five minutes' duration in a biplane of Lilienthal type is stated to have been made in September, 1909, by Raymond Hekking, who flew it in a wind of 20 miles an hour at Larcouet, near Havre. The flight was recorded in the *Petit Havrais* of September 7, but otherwise passed quite unnoticed at the time.

Then, in 1911, Orville Wright returned to Kitty Hawk to try out a control device and also do some soaring. The soaring trials reached their climax on October 24 when, out of twenty-five flights in a wind of over 40 miles an hour, he made one of 7¼ minutes and another of 9¾ minutes. Sometimes he hovered, and at other times worked sideways along the hill over a "beat" a quarter of a mile long.

This last flight remained a world's record for a period of ten years during which hardly a single experimenter thought soaring flight worth developing for its own sake, and gliding was regarded merely as a preliminary to power-driven flight. Just as the pleasures of ballooning weakened the urge to invent an aeroplane, so the latter's eventual success delayed the advent of the sailplane, or soaring glider.

So also has the later mastery of the art of up-current soaring turned people's thoughts from the other sort described by Lord Rayleigh in 1883. This kind, known as dynamic soaring, makes use of irregularities in the wind flow, and a full mathematical treatment of it was published by F. W. Lanchester in his book *Aerodonetics* in 1908. One variety, practised by the albatross, is made possible by the increase of wind speed with altitude, and gliders often gain extra height in the same way just after a launch into a strong wind. It is also possible to take energy from gusts, and this is often done momentarily by both gliders and birds.

The first pilot to exceed Orville Wright's record in soaring flight, Friedrich Harth, used a machine in which the angle of incidence of the whole wing could be varied directly by the pilot, instead of by the slower method of using the elevator as a lever. Harth began experimenting in 1914, with Willy Messerschmitt as assistant, and by August, 1916, had succeeded in maintaining height for 3½ minutes above the Heidelstein in the Rhön Mountains, north-east of Frankfurt am Main. Finally, on September 13, 1921, Harth kept up for 21½ minutes in a wind of 25 miles an hour at the same site, landing only 40 feet lower than his starting point. It was claimed that the ground below had an average slope of not more than 6 degrees, and

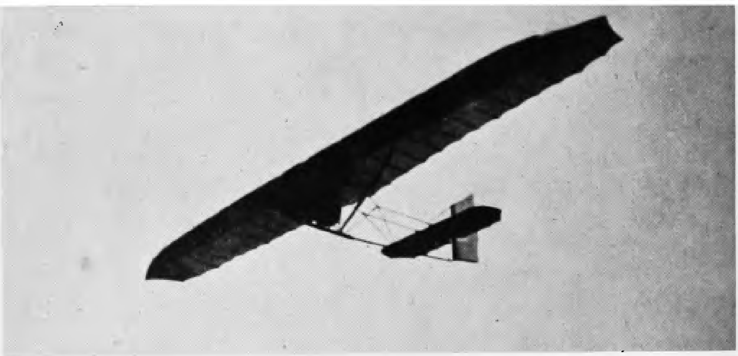

Fig. 4. *The Harth-Messerschmitt glider in which Friedrich Harth put up a world's record of* 21 *minutes, in* 1922. *The longitudinal control was effected by moving the whole wing, thus facilitating the use of gust energy.*

that therefore most of the lift was obtained from gust energy. By using gusts during which the wind would increase momentarily to 40 miles an hour or more, he was able to climb step by step nearly 500 feet above ground level.

Meanwhile, the up-currents were coming into their own again. These same Rhön Mountains had been used for gliding trials by a group of students from Darmstadt between 1912 and 1914. And to the Rhön in 1919 came Oskar Ursinus, editor of the pioneer journal *Flugsport*, taking a holiday, as he relates, after the shock of learning of the treaty restrictions on aviation in Germany. No aeroplanes could be built or imported for a period which was extended to May, 1922; restrictions on the performance of aeroplanes were then imposed, but removed in 1926, after which, however, no public funds might be used to train any but commercial pilots.

Recollecting the gliding that had been done there before, and seeing some buzzards soaring over a spur, Ursinus was inspired with the idea of encouraging grounded pilots to get back into the air without motors, and called a meeting for the purpose which was held on the Wasserkuppe, the highest of the Rhön mountains, from July 15 to September 17, 1920.

Fig. 5. *W. Klemperer flying the Aachen monoplane "Blaue Maus" at the Wasserkuppe, in* 1920.

Although, like most of the earlier pioneers, he had hoped to develop soaring as an aid to the evolution of an efficient light aeroplane, Ursinus set going a series of annual meetings which established soaring flight as an art and science in its own right, and not as a mere stepping-stone to some other end.

The 1920 meeting brought some descending glides and a few short soaring flights of less than a minute. But while it was going on, a tailless glider designed by Wenk soared for more than two minutes over the Feldberg in the Black Forest; the pilot, Peschkes, flew along a beat nearly 1½ miles long in a wind of 20 miles an hour.

At the 1921 meeting on the Wasserkuppe several machines of improved design turned up, and some prolonged glides of up to 15 minutes were made, one of which, by Otto Klemperer, included ten minutes' continuous soaring.

About this time much attention was still being paid to the possibility of using wind fluctuations. Klemperer tried flying across the wind and swaying in response to the accelerations from either side, but gave it up after he had nearly swayed himself into the hill. However, attempts at dynamic soaring were practically given up after the spectacular meeting of 1922 showed what up-currents can do, though a few designers still produced wings intended to take advantage of the "Knoller-Betz effect," by which energy for soaring can theoretically be obtained in a wind which rapidly fluctuates in direction alternately above and below the horizontal.

At this 1922 meeting Arthur Botsch first showed how to soar in a slope up-current. Then, on August 18, Arthur Martens, in the sailplane "Vampyr", soared over the west slope of the Wasserkuppe for 42 minutes and climbed 355 feet in a wind varying between 18 and 8 miles an hour; after this he flew out over the valley and glided down to a landing 6 miles away. He had been in the air altogether an hour and six minutes, of which the first 53 minutes were above the starting level. Next day F. H. Hentzen kept the same machine up for two hours, and on August 24 he raised the record to 3 hours 6 minutes, climbing over a thousand feet in the up-current and landing higher than where he had taken off.

Thus the possibility of prolonged soaring flight by man was established beyond doubt. It had been proved before thousands of witnesses and the news of it travelled round the world.

Having reached the most outstanding event in soaring history, we may pause to ask why such substantial results were not achieved before, since man's urge to perform effortless flight like the soaring birds had existed for thousands of years during which he had all the materials needed to make a sailplane. Probably H. G. Wells gives as good an answer as anyone when he writes that the glider "has had to wait throughout the ages until the fruits of scores of remote explorations and discoveries had filtered down to practical exploitation. It could not have happened earlier than it did, and only as a consequence of that fundamental work".

This explanation may take us down to Lilienthal's time, but further delay in exploiting the new art has been attributed likewise to slowness in the advance of aerodynamic knowledge and structural design. Yet this need not have prevented a lot of soaring, for Lilienthal had already hovered over a hill and his pupil Herring sailed along a ridge. The most that can be claimed is that these technical advances have enabled soaring to be done in lighter winds, so that Martens, for instance, managed to keep going during a critical lull when the wind on the Wasserkuppe dropped below eight miles an hour.

His "Vampyr" came through this ordeal because it was designed for the lowest possible rate of sink through the air. The pilot's body was enclosed in a streamlined fuselage and the hole through which he entered it was covered in with a leather fairing up to his neck. The wing as originally planned had a mean aspect ratio as high as 10 to 1, and a thick wing section had been evolved which needed hardly any strutting and could be stiffened by a single main spar and a plywood leading edge to take torsional stresses. The latter was an innovation in aircraft design and has subsequently been adopted in nearly all sailplanes and many aeroplanes.

While all these improvements were helpful, they were not essential for soaring in strong winds. One novel feature, however, distinguished the efforts which brought such success in 1922. This was that encouragement and help, instead of ridicule or apathy, were at last offered to those restless dreamers who persisted in wanting to soar like the birds in a world caught up in the aeroplane age.

The "Vampyr" was created by co-operative enterprise, not by secretive inventors hoping to avoid detection or fearful of their ideas being purloined. Professor Pröll and Hermann Dorner (who had been inventing flying machines since Lilienthal's day) suggested the design; Dr. G. Madelung sketched it in; Martens, Hentzen and Walter Blume worked out the details, and the Hannoversche Waggonfabrik built it.

Among the 53 entries for the 1922 contest (not all of which turned up) were several other machines of good aerodynamic design which soared for periods of up to an hour and a half.

Some were built by university groups which have continued ever since to play a prominent rôle in the improvement of sailplane design.

Naturally the activities in the Rhön district stimulated attempts to soar elsewhere. But before the year was out the only real success was obtained at a meeting on the South Downs, between Newhaven and Eastbourne, organized by the *Daily Mail* and held from October 16 to 21. The need for turning along the slope immediately after a launch had first to be demonstrated by Antony Fokker, who had already flown his two-seater biplane at the Rhön. Later on, F P. Raynham

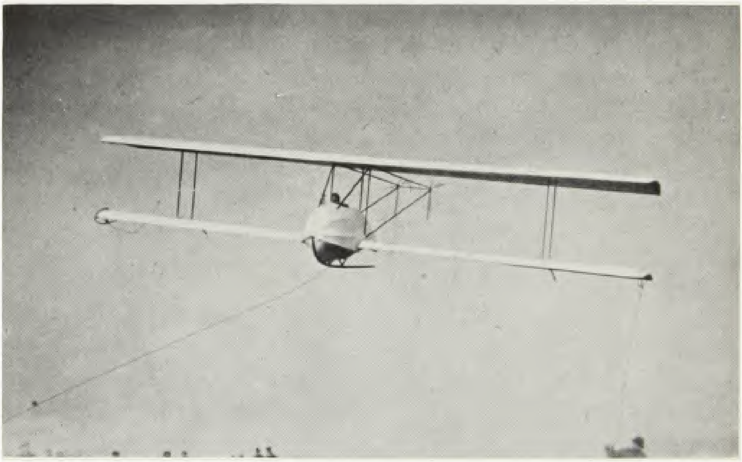

Fig. 6. *The Fokker biplane which put up new records for two-seater soaring both in Germany and England in* 1922.

soared for 1 hour 53 minutes, G. P. Olley with a passenger for 49 minutes (a world's record), and Alec Gray for an hour; finally, Alex. Maneyrol stayed up for 3 hours 21 minutes in a Peyret tandem monoplane, similar in design to Montgomery's balloon-launched glider of 1905.

This record was beaten three times in January, 1923: first at Biskra Oasis, Algeria, by Thoret in a monoplane with motor stopped; then at Vauville, again by Maneyrol, and later by Barbot (8 hours 36 minutes). Later records have been established in East Prussia, the Crimea, Hawaii, Sylt, Auvergne, and finally again in East Prussia, where Ernst Jachtmann soared for 53 hours 52 minutes in September, 1943. The duration record for soaring flight, which began as a thrilling duel between man's intellect and the law of gravity, has now become primarily a test of endurance, although in fact most of the more recent flights have been made in awkward conditions which called for considerable soaring skill.

After the outburst of activity at the beginning of 1923, interest in soaring flight declined among all but the few persistent devotees. There was general doubt whether hovering noiselessly over the same bit of ground brought any satisfaction once the novelty had worn off. During the next five years only a handful of soaring centres remained active.

Vauville, near Cherbourg, was used again in 1925 for a meeting at which Massaux, from Belgium, put up a new duration record; and again in 1928, when a visiting team came from Germany.

Near the bird-ringing station at Rossitten, on the Baltic coast, a useful site was developed by Ferdinand Schulz, a schoolmaster, who set up new duration records there. It is on a long sandy spit with an almost continuous line of giant dunes rising in places to 200 feet, along which Schulz was able to soar 37 miles to Memel in May, 1927.

After a team from Russia had taken part in the Rhön meeting of 1925, the leading German pilots were invited to the Crimea and set up new world's records at Koktebel, near Feodosia. This site, consisting of a line of hills 600 feet high, had been used since 1923 for annual gatherings of Russian glider pilots.

Meanwhile, the Rhön carried on, and the Wasserkuppe remained the centre of pilgrimage for those who still hoped for the future. But all was not well there. The gradual resuscitation of aeroplane flying, coupled with lack of progress in soaring technique, caused both public and official interest to sag, and with it sagged the enthusiasm of many of those who had done the soaring in 1922. In the following year poor winds led to equally poor performances. Then, at the 1924 meeting, some glider-like aircraft with light motors took part; but as the Wright brothers had added a motor to a glider in 1903 (hence the aeroplane), this was merely history repeating itself and no new paths were opened up.

Late in 1924 the first steps were taken to surmount the critical situation that had arisen. A subsidised organization was set going with the dual purpose, firstly, of facilitating the construction and flying of gliders by impecunious aviation enthusiasts all over Germany, and secondly, of promoting technical research into the further possibilities of soaring flight.

In 1925 this body, known as the Rhön-Rossitten Gesellschaft (R.R.G.), took over two gliding schools at the Wasserkuppe and Rossitten which had already been operating on a small scale. Then Alexander Lippisch, a talented aerodynamic expert and designer, produced a series of single-seater training machines of which the most famous are the Zögling, for teaching beginners to handle the controls, and the Prüfling, for elementary soaring. Both types appeared in 1926, and it then became possible for the first time to train beginners right through to the soaring stage, without the need of previous flying experience in aeroplanes such as all successful soaring pilots had hitherto had. Further, these types could be easily built and repaired by amateurs.

For the second object of the newly-formed Company, that of scientific and technical advance, the main inspiration came from Dr. Walter Georgii, ably backed up by Lippisch and the university groups in the matter of sailplane design.

Georgii, a leading meteorologist from Darmstadt, had published a book in 1923 on *Soaring Flight and its Source of Energy in the Atmosphere*. It was a sound book except for the author's assertion that "man will never be able to soar for any length of time with the help of thermal up-currents". He based this opinion on the belief that thermal currents rarely rise faster than 3 feet per second, that contemporary sailplanes sank twice as fast as this, and that they could not be turned in tight circles like the birds. In 1926, Georgii became leader of the R.R.G. and did all he could to encourage meteorological research into up-currents.

That same year saw the development of a new technique of cross-country soaring from hill to hill, climbing as high as possible above one hill and then gliding across the gap to the next. Johannes Nehring, of the Darmstadt group, became its leading exponent. He made a difficult flight from the Wasserkuppe to the Milseburg, 3½ miles distant, and back, in 1926; then in 1927 he increased the distance record to 38 miles, and in 1928 to 43 miles, in each case by using successive mountain slopes as stepping-stones.

But an even more notable event marked the year 1926. On August 12 Max Kegel, of Kassel, was soaring over the Wasserkuppe when a thunderstorm passed over. He was drawn upwards two or three thousand feet within the cloud, and by the time he could extricate his machine and land he had travelled 35 miles. Thus by a happy accident the soaring fraternity were liberated from their dependence on wind deflection over hills and vast new regions of the atmosphere were opened up to them. But not at first, for unfortunately Kegel gave such a harrowing account of his experience that no-one else felt like following his example. So for the next advance history had to wait two years.

In spite of Georgii's disbelief in the efficacy of the thermal currents which go up from heated ground in the daytime, he thought nevertheless that they might be strong enough to lift a sailplane where cumulus clouds formed in their tops, because the condensation of moisture into cloud liberates heat and so gives an extra boost to the up-current. So in the Spring of 1928 he arranged for Nehring to fly a light aeroplane up to the clouds and try to soar underneath them with the motor stopped. The attempt succeeded, and up-currents of 3 to 16 feet per second were found.

This research bore fruit at the same year's Rhön meeting when, on August 6, Robert Kronfeld made connection with the up-current below a passing cumulus cloud, used it to reach the Himmeldankberg 4½ miles away, and returned to the Wasserkuppe against the wind by similarly using a whole line of clouds in succession. Kronfeld had only started gliding the year before, and had never flown an aeroplane.

In the early summer of 1929 further meteorological research was done by the R.R.G., this time into the type of storm used by Kegel in 1926—a "line squall" or travelling line of thunderstorms caused by a "cold front", where warm air is forced up over a body of cold air coming in to replace it. It was found that a wide area of smooth rising current exists in the clear air in front of the storm, so there is no need to go inside the cloud as Kegel did.

Kronfeld, having first provided himself with a parachute in case of trouble, succeeded on July 20, 1929, in connecting with just such an up-current in a flight from the Wasserkuppe and landed 89 miles away. Ten days later he climbed through an enormous cumulus cloud to 8,320 feet above the mountain, nearly half the climb being inside the cloud, and while descending from this record height he found weak lift in the clear air *above* the tops of the smaller cumuli. He finally soared along a mountain chain and landed near Bayreuth after covering 93 miles.

These striking new developments made little or no impression on the general public, but the aeronautical world realised the significance of what was happening, and some talked of reviving an interest in soaring. A few actually tried to get

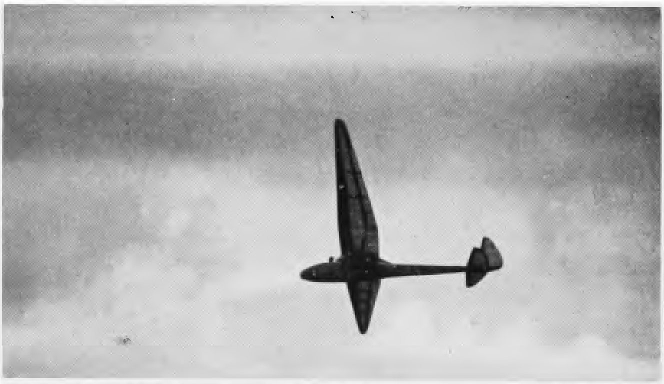

Fig 7. The "Wien" sailplane in which Robert Kronfeld set up spectacular records for cross-country soaring flight in 1929.

some soaring done, though they still had no idea how to do it except by the now old-fashioned method of staying over a slope.

It is at this point that those administrative units, the Sovereign States, break in upon our story, which began as an effort of the human race to achieve by guile what the birds perform by instinct.

First, the Germans discovered that, by promising to get quantities of "youth" into the air without the expense of a motor, they could raise enough public funds to effect qualitative improvements in the technique of soaring. Thus the best pilots could be made instructors and so enabled to live on a soaring site; the skilled designer could exploit his talents for a living; and the meteorologist could carry out expensive research into vertical currents.

About 1927 the Russians began an intensive development of gliding all over the country in connection with their "five-year plan", but practically the only real soaring was done at the annual meetings at Koktebel. At the end of ten years 140,000 glider (not sailplane) pilots were reported to have been trained.

In Poland the first soaring attempts were made in 1923, but success first came in May, 1928, when Szczepan Grzeszczyk kept up for 7 minutes and netted a government subsidy of £120 for his group. Next year a flight of two hours created such a sensation that a large training organisation was set going with government help, and Bezmiechova in the Carpathians, where the flight was made, became the national soaring centre. In addition, in 1932, a technical research institute was set up in Lwow University; it has investigated thermal currents and other phenomena, and produced a "thermal map" of Poland showing the distribution of cumulus cloud.

The visit of two Frenchmen, Auger and Abrial, to the Wasserkuppe for an instruction course in 1927, led to the revival of the Vauville site in 1928 and the setting up of a national organisation, L'Avia, in 1929, on the initiative of Pierre Massenet. A subsidy of a million francs was secured in 1931 and the Banne d'Ordanche, in Auvergne, developed as a national centre.

A British Gliding Association was founded at the end of 1929 and soon began angling for a subsidy, which, however, failed to materialize till five years later. Kronfeld paid a visit and soared 50 miles along the South Downs in June, 1930. A large number of gliding clubs was formed, but many of them petered out, and for the first few years almost the only soaring was done at Dunstable Downs by some members of the London Gliding Club.

So the tale goes on for other European States. Subsidies, if any, would come from a government department, or an Aero club, or a rich industrialist, and people hopped about on primary gliders, but little soaring was done.

In America nobody exceeded Wright's record of 1911 until a small German mission arrived in 1928 and Peter Hesselbach soared for 4 hours 5 minutes at Cape Cod, south of Boston. A gliding school was started there, but soaring flight as such aroused little interest for the next two years. Then W. Hawley Bowlus began designing high-performance sailplanes, and soared one for 9 hours at Point Loma, in California, early in 1930. Professor R. E. Franklin designed a glider, the "Utility", suitable for towed flight and for all stages of instruction, including soaring. And a national centre was founded at Elmira, a hilly district in New York State, where annual contests have been held ever since.

To the first contest came a visitor from Germany, Wolf Hirth, perhaps the best known sailplane pilot in the world, owing to his habit of visiting various countries to persuade and help people to improve the quality of their soaring—a necessary antidote to the national subsidy distributors with their quantitative outlook.

On October 2, 1930, Hirth took off from Elmira into an absolutely cloudless sky and travelled 33 miles across country by using invisible thermal currents. He climbed in them by going round in tight circles, having first found them by watching where another sailplane was getting extra lift, or where birds were circling; or else by the indications of his variometer, or rate-of-climb indicator, an instrument first used by Kronfeld in 1928. This is one of the outstanding flights of soaring history, as it has set pilots free from both hills and clouds. Thermals, as they are now called, can be used either at low levels where clouds do not indicate their distribution, or higher up when no clouds are there to help.

In the Spring of 1931 thermals over flat country around Berlin were explored, the sailplane pilots being towed up behind an aeroplane and then cast loose. This method of launching, soon to come into widespread use, was first demonstrated by Gottlob Espenlaub at Cassel in 1927. Instruction courses in aeroplane-towed flight were instituted at Darmstadt, and Günther Groenhoff used this method of launching to start on a record flight of 169 miles from Munich into Czechoslovakia, using a "cold front" storm.

For three years it was believed that long distances could only be achieved on cold fronts, until in 1934 and 1935 distances of up to 313 miles were flown from the Wasserkuppe by using the continuous belts of up-current associated with long rolls of

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