June 12, 1931. Vol. 1. No. 40

THE SAILPLANE AND GLIDER

Price 3d.

TOWED FLIGHT.



One of Mr. P. Y. Alexander's gliders being towed before the war; the effective lateral control should be noted!

PRACTICAL ASSISTANCE.

As we go to press the glad news is released that *The Daily Mail* has once again offered a substantial prize for the benefit of aviation. This time it is to advance the latest developments of Motorless Flight and the sum of £1,000 is to go to the first man to fly across the Channel and back with an intermediate landing. This is exactly the fillip that is required to focus national attention on The British Gliding Association inter-Club Competitions which are to be held at the end of the summer.

Unlike the Cellon prize of £1,000 which is offered for a single crossing of the Channel, either way, *The Daily Mail* Prize is International as to entrant, pilot and machine. The method of launching is also not limited to the rubber-rope but auto-towing or aeroplane-towing will be permitted to

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allow sufficient height to be reached for contact to be made with the cloud-upwinds.

The British Gliding Association, and especially its Chairman, Mr. Gordon England, are to be congratulated on having been able to secure so generous an award for an achievement which must help on the progress of the Movement. They have discovered a way whereby the very finest machines and pilots in the World can be induced to demonstrate the possibilities of Motorless Flight. Indeed if our own pilots and designers are as wide awake as we have good reason to believe they are, they will assuredly profit by the tactics of the winner, and see the way to winning the Cellon prize with an English pilot in an English machine.

On the other hand, as towing behind an aeroplane is permitted, a flat glide will take a machine across the Channel if sufficient height can be gained by towing. In a flat calm something like 6,000 ft. should be enough for a sailplane to do this, so that actually there is not such a premium on experience and high-efficiency design as at first appears. But the crossing of the Channel by such means, by soaring before a line-squall or using cloud-upwinds, will be all to the general good.

Actually *The Daily Mail* will award £500 to the first pilot who accomplishes a Motorless Flight from France to England. If the same pilot after landing in England makes the return flight on the same day, the prize will be increased to £1,000. The Competition is to be open for four months from June 20 until Oct. 4 unless the prize is won before the latter date in which case the Competition will be considered as closed.

Entrants must hold a current "C" F.A.I. Glider Certificate. Competitors must carry a barograph, the flights must be made in the hours of daylight and if the machine is launched by towing behind a power-plane the sailplane must be released a mile inland.

The organisation of the whole Competition is in the hands of *The British Gliding Association*, and full particulars can be obtained by writing to Mr. Waplington, at 44a, Dover Street, W.1.

THE TWELFTH RHOEN GLIDING COMPETITIONS.

The R.R.G. have now issued the regulations, rules, and instructions regarding The Twelfth Rhoen Gliding Competitions which are to be held at the Wasserkuppe from July 22 to Aug. 5. The competitions are really divided into two main sections, the so-called "Practice" and the "Performance" Competition. Each has its own share of the prize money. The prize money for the first totals M.10,000 (£500) and the second M.12,000 (£600).

Pilots who enter for the first must have obtained their "C" Certificate after Jan. 1, 1930, and not have made a duration flight of more than 5 hrs. or conversely not flown a motorless machine since Jan. 1, 1928. They must never have made a solo flight in a power machine. In each competition there is a prize of M.2,000 (£100) to be awarded at the discretion of the authorities for daily prizes during the course of the Competitions. These prizes are so devised that each day a competition can be set to suit the existing weather conditions and so retain interest throughout the Meeting.

Interesting rules are that all starts must be made with a rubber rope though power-plane towing is allowed for the Hindenberg Trophy, of which more anon, and that all pilots must have "C" Certificates or the equivalent. Foreign pilots must produce proof that they have made five gliding flights within the last three years making a total of thirty minutes' duration without damaging the aircraft and that each time the aircraft has remained over the starting point for at least two minutes.

There are five main divisions of the prize money for the "Practice" Contest. The first for the greatest total duration of flight is M.3,500, and is split into two parts. M.1,500 of this amount will be split among three aircraft in proportion to the total duration of flight. This competition is open only to aircraft piloted by those who have not flown for an hour in one flight prior to entering the Competition. The second part of this prize, M.2,000, will be divided among three aircraft in the proportion of the total duration which must be more than five hours. This is open to the remainder of the pilots in the "Practice" Category.

The next division is for the maximum total height obtained in at least five flights, if more are made the five highest only will count. Only flights above 100 m. (328 ft.) will count. M.1,500 will be divided proportionately among the first three.

The third division is for distance flights. M.1,500 will be divided among the three machines which complete the longest distances in an unbroken flight to be measured in a straight line. Only flights of more than 20 km. (12½ miles) will count.

Fourth is an award for construction. Five awards of M.300 each will be made to the competitors who enter aircraft, the principal parts of which were built by the competitor after Sept. 1, 1930, which shall take part in the competition and reach a minimum height of 100 m. (328 ft.). If more than five aircraft fulfil these conditions the five awards will go to the machines which reach the greatest height.

The fifth prize is of M.2,000 and is for special daily prizes as already explained.

There are also six prizes for "Performance," but there is no award for construction. The first item is a prize of M.1,500 for the Encouragement of Distance Flights and will be divided among the three aircraft which have flown the greatest total distance during the Competitions. Only flights of more than 25 km. (15½ miles) will count and the event is only open to pilots who, previous to the Competitions, have not flown a non-stop distance of more than 20 km. (12½ miles).

The second item is a prize of M.2,000 which will be divided among three aircraft in proportion to the total distance flown. These must have flown a distance of not less than 50 km. (31 miles) in one flight during the Competitions. This event is only open to aircraft the pilots of which took part in the "Performance" Competition for the first time in 1930 and 1931.

In the third event M.3,000 will be awarded to the two aircraft which complete the longest distances in an unbroken flight, not less than 100 km. (62 miles). The prize will be awarded in proportion to the distance flown.

The fourth event is again for long distance and two prizes of each M.1,000 to the first aircraft which fly from the Wasserkuppe to Oechsenberg (b. Vacha), which is some 20 odd miles to the North of the Wasserkuppe, and back without an intermediate landing.

The fifth event is for a prize of M.1,500 and will be awarded to the aircraft which during the Competition reaches a height of at least 2,000 m. (6,560 ft.) over the Wasserkuppe. If several aircraft qualify the prize will be divided in proportion to the height.

The sixth item is the M.2,000 which is reserved for the special daily prizes.

Besides all these there is the Hindenberg Trophy, which, together with M.3,000, will be awarded to the competitor who obtains the best total flying results on gliders between Apr. 1 and Dec. 31, 1931. The Competitors must be German subjects or subjects of German-speaking countries.

BIRTH.

James.—On June 11, at 64, Holland Park, W. 11, to Doris (*née* Allerton), the wife of Thurstan Trewartha James—a daughter.

SLOWLY BUT SURELY the superiority of Auto-Towing for efficiently launching all Motorless Aircraft, and as a means of giving *ab initio* instruction, is being admitted

HERR KRONFELD, when at Balsdean recently, said he would not be satisfied until he had the Gliding Movement efficiently working from level aerodromes.

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THE ELEVENTH RHOEN SAILPLANE COMPETITIONS.

BY WALTER GEORGII, DARMSTADT.

Translated from "Zeitschrift für Flugtechnik und Motorluftschiffahrt," Mar. 14, 1931, by B. S. Shenstone.

(Continued from page 313, Vol. I, No. 39.)

The barogram of this cloud flight is notable. Fig. 1 shows part of the height-time curve while in the cloud. Bedau sailed at first in the hill-upwinds of the Wasserkuppe. In the 214th minute of flight he contacted with the upwind of a cloud which brought the aircraft with moderate climbing speed to an absolute height of 1,600 m. The bottom of the cloud was at 1,300 m. height. After the first climb, the wind dropped, until suddenly in the 226th minute of flight an unusually strong upwind seized the aircraft and lifted it in 3 minutes through a height of over 900 m. (2,953 ft.). The dive followed the rapid climb in which the aircraft reached a falling speed of 25 m. per second (82 ft. per second) and which later developed into a spin in which Bedau came out of the cloud.

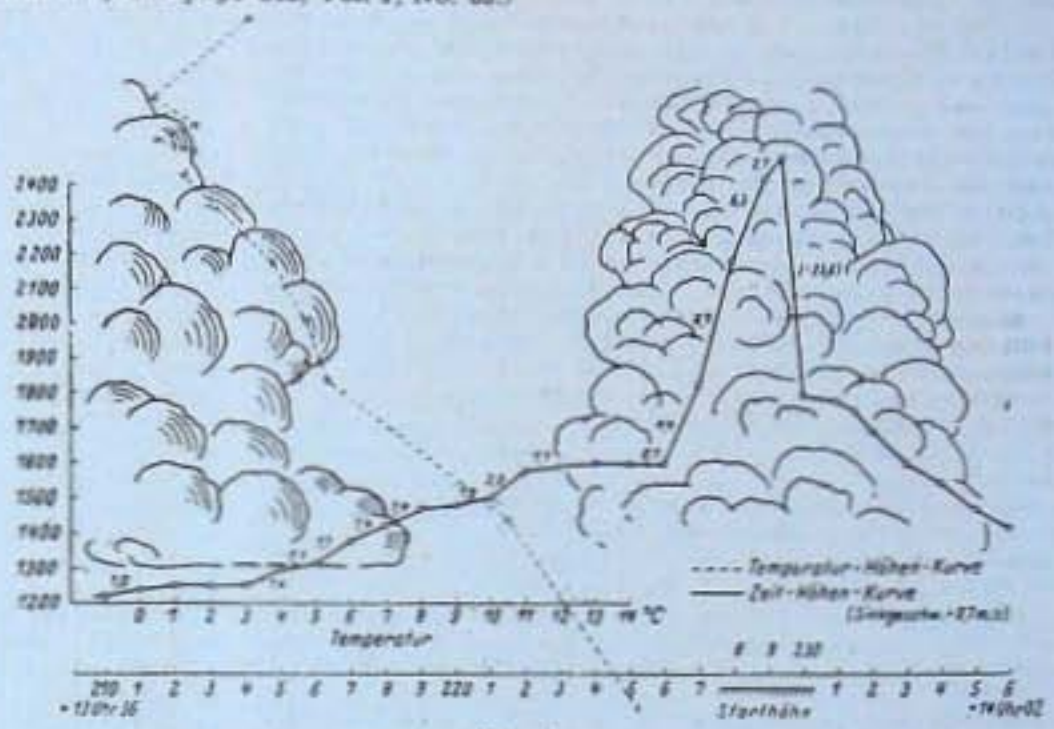


Fig. 1.

Considering the *Luftikus* as having a sinking speed of 0.7 m. per second (2.3 ft./sec.), one has a vertical airspeed in the cloud of 6 to 7 m. (19.7 ft./sec. to 23 ft./sec.) per second. This upwind velocity in a cumulus cloud of the size of 1,200 m. (3,937 ft.) is very high. It exceeds considerably the vertical speeds which have been measured up to now and shows even more clearly that in the harmless-looking cumulus clouds air motions take place which are only to be expected in thunderstorm clouds. The very sudden change from quite low vertical motion to high up-

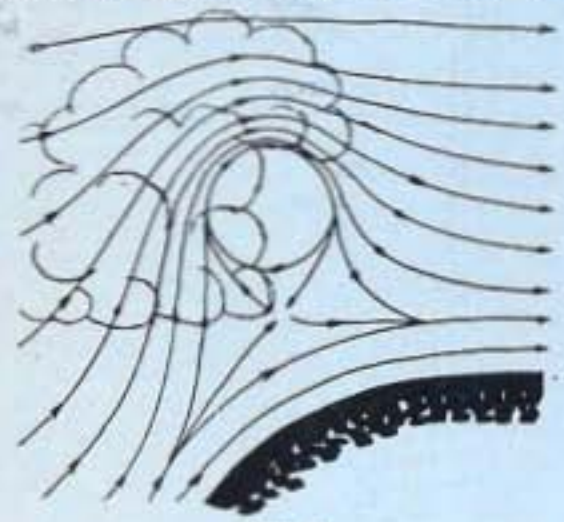


Fig. 2.

wind velocities makes the assumption probable that the upwind in cumulus clouds is caused by an eddy with a horizontal or vertical axis. There are many possibilities for such an eddy arising when the wind comes in contact with an obstacle such as a mountain.

A diagram of the streamline directions, as shown in Fig. 2, reveals how when the wind speed increases rapidly with height, eddies may occur by the rising of the more slowly moving lower layers combined with thermic upwinds. This case concerns an eddy with a horizontal axis, which can be changed into an eddy with vertical axis by being bent downwards in or under the clouds. Observations which have been made on other sailing flights point to similar flow occurrences. On Oct. 10, 1930, von Chlingensperg carried out a flight from the Wasserkuppe to Melrichstadt in a Professor type sailplane (see Fig. 3). While still in the region of the Wasserkuppe, von Chlingensperg climbed to 660 metres (2,165 ft.) above the start by making use of cloud-upwinds. He found himself still 200 m. (656 ft.) under the cumulus cloud base. While under the cloud he discovered that his aircraft showed a tendency to swing to one side in spite of the fact that he had given opposite rudder. This occurrence also speaks for the assumption that there is an eddy motion in the region of cumulus upwinds into which the aircraft tends to turn.

Bedau's flight showed clearly again that valuable results can be obtained for the kinematics of the atmosphere through cloud sailing flights, for all aviation is interested in increasing knowledge of the vertical movements of the air, even more so, as hardly any dependable material has existed up to the present on the up and down movements of the air. The occurrence of such strong vertical currents occurring in quite normal cloud development as was shown by Bedau's flight seem certainly of value to power flight, and also for lighter-than-air craft. The fostering of cloud-soaring flights and flights before line-squalls is necessary if motorless flight is to take advantage of all the possibilities offered here in order that the performance standard be raised. Bedau's flight also clearly showed that the aircraft can be very highly stressed on such occasions. It has been shown this year and at other times (one only needs to remember the storm flights of Hemmer and Muschick) that the high quality sailplanes are able to withstand these stresses, but even so it must be kept in mind that *our high strength standards in sailplane design must be retained at all costs.*

By discussing endurance flights we have at the same time covered all the other events of the Practice Contest, as all the conditions in connection with the other events were fulfilled in connection with endurance flights. The prizes for the greatest total flight duration were won by the

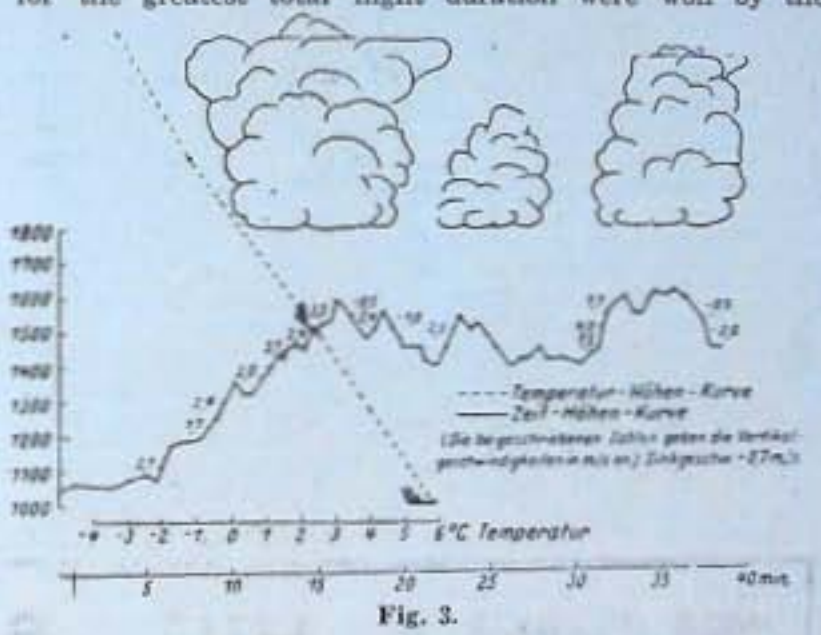


Fig. 3.

In these diagrams the figures against the curve give the vertical speed in m./sec. These are the measured speeds, to get the actual speeds the sinking speed of the sailplane (.7 m./sec.) must be subtracted. The broken line gives the temperature height curve.

aircraft *Darmstadt*, *Luftikus* and *Rheinland*, piloted by Starck, Bedau and Paetz with 27½, 24½ and 16½ flying hours respectively. Bedau and Starck stood first and second respectively in the competition for the greatest total altitude, having average maximum heights in five flights of 734 m. (2,409 ft.) and 520 m. (1,706 ft.) respectively. Hemmer was in third place with 250 m. (820 ft.). After earlier considerations over the technique of endurance flights, it is quite clear that the aircraft which has achieved the greatest endurance will also stand at the head as far as altitude is concerned.

During the endurance flying, the prize for the 5 km.-and-

back (3 miles-and-back) flight, the third main event of the Practice Contest fell to the aircraft *Darmstadt* and *Luftikus* without any trouble. On Aug. 17 there was good cloud upwind for a short time in the afternoon. Starck, who had already been several hours in the air in *Darmstadt*, reached an altitude of 760 m. (2,494 ft.) under a cloud and used this height to fly 5,450 m. (3.4 miles) in the direction of Fulda and to fly back again to the Wasserkuppe. Bedau did the same thing, as he flew right behind the *Darmstadt*, although at the low altitude of 400 m. (1,312 ft.) over start. Bedau's turning point lay 5,150 m. (3.2 miles) from the Wasserkuppe. Both aircraft followed the direction of a cloud chain or "cloud street" which stretched out towards the west from the Wasserkuppe in the direction of Fulda. In the upwind of the cloud street the 5 km.-and-back could be safely and easily flown. After Starck and Bedau, Paetz in *Rheinland*, fulfilled the conditions of the 5 km.-and-back flight on the same afternoon, which shows how unusually favourable the soaring possibilities were this day, even outside the upwind regions of the Wasserkuppe.

In the Performance Contest there was a prize offered for a flight of at least 25 km. (15½ miles) in the direction of Fulda. The idea in this was to have a distance flight carried out only with the help of cloud-upwinds. Thus the direction towards Fulda was decided upon, as in this direction it is hardly possible to make use of hill-upwinds. The prize was not awarded, because, except on Aug. 17, no suitable weather conditions occurred during the whole contest. The aircraft in the Performance Contest could have made use of the same cloud street which Starck and Bedau had used, and could have fulfilled the conditions of this especially attractive and interesting distance research prize. Unfortunately these aircraft had already departed on this day to do other distance performances, and were therefore unable to take advantage of the favourable weather conditions for the distance research prize.

The carrying out of the 5 km.-and-back flight was completed by other methods than those considered at the time of fixing the event. This flight was to have been an instructional flight for pilots of the Practice Contest. Therefore it had been assumed that the flight would have been carried out by flying off suitable slopes. A serious and very notable attempt was made in this direction by Ruch in the *Professor* of the Wuerttemberg Aviation Club on Aug. 12. With very dexterous piloting Ruch was able to reach the required distance of 5 km. from the Wasserkuppe in the direction of the Milseburg. In the second part of his flight he lost more and more height during his return to the Wasserkuppe and had to finally land in the valley before the western slope of the Wasserkuppe.

This year the flights in the Practice Contest were to a greater number exploring flights than those in the Performance Contest. It must not, however, be assumed that this in any way disparages the performances put up by the flights of the Performance Contest. Hurttig's line-squall flight in the Performance Contest considerably broadened and deepened our knowledge of thunderstorm flights in scientific aspects. The distance flights of Kronfeld and Groenhoff had also scientific importance, although they were primarily flying successes. It is characteristic for this year's great distance flights that they were carried out mainly in hill-upwinds in contrast to last year, when the unusually favourable weather conditions made it possible to fly great distances easily with the help of cloud upwinds.

The flights of the Eleventh Rhoen International Gliding Contest are quite in contrast to the above distance flights. The comparatively low heights which were reached on the individual flights show clearly enough that cloud-upwinds helped towards the success of these flights only a very little, and that the flight distance was only attained by flying from slope to slope and from hill to hill. As under these circumstances it was possible to exceed the maximum distance flights of last year, the perfection of tactics and flying ability and the unusual alertness of the pilots for the upwind conditions over various terrains is all the more to be appreciated. Thus is the success of this year's Contest to be judged as higher than is shown by the flight performances as expressed in figures.

This year's Performance Contest showed clearly how extraordinarily difficult it is for an unexperienced pilot to make a distance flight. Even the decision to leave the dependable upwind region of the Wasserkuppe is very difficult for the inexperienced. A necessity for every distance flight which is not carried out at a great height in cloud-upwinds but quite dependent on the slope-upwinds appeared very clearly in this contest. This was the fact that it is necessary, if success is wished, that every flight must be carefully prepared beforehand. Every pilot must have decided on his route depending on the wind conditions, before he starts his flight. He must know exactly which hill he must fly to, he must always be on the watch during a flight in order to keep the correct course with respect to the wind. Flights which have been only incompletely carried out on paper before taking off in the hope that during the flight it would be possible to use whatever conditions one meets are almost certainly doomed to an early end.

It cannot be too often repeated that participation in the Performance Contest in the Rhoen, which is the real upper school of soaring, makes it absolutely necessary to go exhaustively into the details of a planned flight even before the Contest commences. It is necessary that the pilot, with the help of maps and assumed wind conditions, works out routes and knows them so well that in all suitable weather during the contest, he knows exactly which direction to take and to which hill he must fly in order to have the most favourable upwind conditions. In no case is it enough to make just a general preparation of a route, but one must go into all details for a flight with given wind-direction in advance. With the exception of Nehring and Kronfeld hardly any pilot has come so completely prepared to any contest. But this planning and working-out is the most important basis for success. To this Nehring owed his mastery of distance flight and it is none the less the secret of Kronfeld's success.

Kronfeld is really not a "pathologically gifted" pilot, but an extraordinarily "rational" flyer who carries out his flights with his mind before carrying them out with clever flying. In looking back on this year's contest, experience shows us that the "non-flying" part of distance flights is absolutely necessary. By neglecting this, even the most skilled pilot is doomed to failure. In the combination of brain-work and flying skill lies the greatest attraction of distance flight, which when perfected in these directions, shows all the beauty of motorless flight.

As mentioned above, the pilots in this year's Performance Contest had an extremely difficult task, as the heights reached during flight were rather low due to the unfavourable weather conditions, and thus made the overcoming of dangerous downwind areas during flight very difficult indeed. But how well even the pilots who were inexperienced in distance flights learned overland flying is shown by Mayer, who, after a few short beginners' flights, was able to carry out a very excellent flight of 46 km. (28½ miles) to Marisfeld, near Meiningen. Especially worth mention are the distance flights of Hurttig of the Niederhessischen Aviation Club. Although a junior pilot in the Performance Contest, Hurttig carried out three flights of more than 40 km. (25 miles), of which two were hill-upwind flights and one flight of 51 km. (31 5-8 miles) was a masterpiece of line-squall flying. Hurttig carried out the flights of 39.3 km. (24 5-8 miles) and 40.2 km. (25 miles) to Kieselbach and Leimbach by the well-proven "Nehring Route." Nehring chose this route for his first great flights of 51 km. (31 5-8 miles) in 1927 and 71.2 km. (44½ miles) in 1928 because it lies along the High Rhoen, follows the direction of the Ulster Valley and over the Ochsenberg, near Vacha, and has an almost unbroken upwind field. Kronfeld also chose this route this year for one flight and after covering 51.5

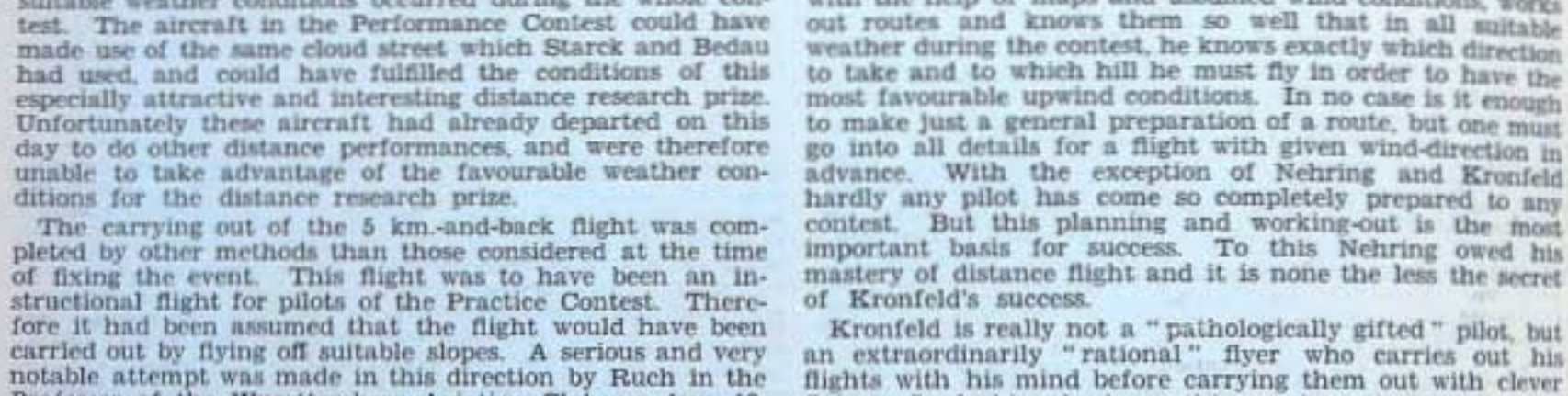


Fig. 4.—Hurttig's thunderstorm flight to Lengfeld on Aug. 13, 1930. The streamlines show the motion of the warm air before the passing of the storm in extremely simplified form. The terrain is not to scale, but drawn in dependence on the flying time.

km. (31 7-8 miles) landed at almost the same place as Nehring in 1927.

Hurttig's line-squall flight had many similarities with Kronfeld's thunderstorm flight in 1929, although it was not so successful as far as distance covered is concerned. On Aug. 12, several squalls passed over the Wasserkuppe. Kronfeld used the first which reached the Wasserkuppe at 2.30 for starting on his flight to Rehau. The squall had a rather low intensity and the upwind was therefore not strongly marked. The second squall reached the Wasserkuppe at 4 o'clock. This squall was very well developed and showed a clear "cloud cylinder" on the leading edge. The thunderstorm ascended so rapidly that it was not possible for aircraft to make contact with it. At 5.30 the last and third squall came from the west. Hurttig was early at the start with his aircraft *Elida*. After he had been once more told to keep in front of the squall, no matter what happened, and instructed in the usual technique, he took off and flew towards the west to meet the approaching squall.

It was a disadvantage that the squall hung very low, so that the higher Rhoen hills were enveloped by it. A few minutes after starting Hurttig was able to connect with the upwind region of the storm. In front of the "cloud cylinder" he rapidly reached a height of 320 m. (1,050 ft.) above the take-off. He remained before the line-squall until it disintegrated in the Ulster valley on the High Rhoen and remained behind the aircraft. On the east side of the High Rhoen Hurttig came into the strong down-wind region there, and lost considerable height. But very soon he was able to make contact, between the High Rhoen and Geba, with a new squall which was forming on that side of the High Rhoen. Once more Hurttig climbed to 380 m. (1,246 ft.) above take-off and carried out the rest of the flight at this height. This part of the flight, which was flown a few hundred yards in front of the following line-squall, was similar to Kronfeld's thunderstorm flight last year.

Exactly as Kronfeld was able to keep at constant altitude without noticeable fluctuations, Hurttig remained at constant height for 15 minutes without hill influences. The course of the barograph reveals this unusual evenness of the upwind before the squall, which was shown last year in the case of Kronfeld to an even greater extent. Hurttig left the line-squall the other side of Meiningen and landed near Schleusingen, in Thueringer, after a long glide. Fig. 4 shows this very interesting flight diagrammatically. The streamlines shown are not supposed to be a continuous "stream field," but only show diagrammatically the upwind region before the actual thunderstorm, by which the respective positions of the squall and the aircraft at various time are shown. It was extremely pleasing that this year a pilot, who up to this time had so little experience in distance flights, could have mastered the line-squall flight. By always staying in front of the squall, Hurttig was able to fly without any danger. Hurttig again brought to our attention, that by suitable care, flight before a line-squall is no particular acrobatic feat, but a well-done performance, which in its careful carrying out makes it possible to master and use the somewhat dangerous energies of the line-squall for soaring flight.

Distance flights in which one flies to a goal some kilometers from the Wasserkuppe and returns to the point of take-off have been regular events in the Performance Contests in the Rhoen since 1926. This is because being forced to carry out a distance flight in a given direction and to return to the starting point demands well-thought-out flying tactics and great flying skill and usually also great tenacity and endurance. For these very reasons, these distant goal flights have been very valuable in teaching the many-sided tactics of long distance flights and have considerably helped in the advances made in past years. In the 1930 Rhoen Contest, the conditions to fulfil in order to win this distance prize were much more difficult than ever before, not only because the goal, the Kreuzberg, lay 15 km. (9¼ miles) from the Wasserkuppe, the necessary distance to be covered being increased by 10 km. (6¼ miles) over last year, but because the terrain was very difficult.

Between the Wasserkuppe and the Kreuzberg lie the ridges of the Himmeldankberg, the Simmelsberg and the Dammersfeld, which must be flown over. These ridges also cause critical downwinds on their lee sides, towards the Kreuzberg in case of west winds, which makes the Kreuzberg flight extraordinarily difficult. It is thus pleasing to be able to say that this flight was carried out by two aircraft, first by the *Wien* with Kronfeld, and a few days later by the *Fafnir* with Groenhoff as pilot. In this flight Kronfeld again showed his typical tactics, which, apart from good flying, consist in having a definite goal for each flight.

On Aug. 12, the day of Kronfeld's Kreuzberg flight, the morning weather reports stated that a line-squall was expected in the afternoon. The approach of the squall in the early afternoon was a sign for all pilots of the Performance Contest to prepare for flight. Groenhoff took off first in *Fafnir*. After him came Mayer of Aachen and then came Kronfeld and finally Kegel in his *Kassel*. Mayer left first in front of the dark squall, to make distance. He accomplished a flight of 20.2 km. (12½ miles) to Gerdhausen, east of the High Rhoen. Kegel flew only 15 km. (9¼ miles) to Tann. The squall did not bring the expected upwind strength. This was especially notable in Kronfeld's flight which was along the front of the squall towards the Milseburg. He often disappeared in the clouds and lost considerable height at the Milseburg. Now Kronfeld's classical tactics were shown.

On recognising that a flight before the squall would be of little value, he took no account of the possibility of there being better conditions as the flight progressed, but immediately decided on a new goal, the flight to the Kreuzberg. Although Kronfeld found himself near the Milseburg, from where the flight to the Kreuzberg is much more difficult than from the Wasserkuppe, he immediately bent all his energies into reaching the new goal. From the Milseberg Kronfeld first returned to the Wasserkuppe, but did not land, and then tacked over the Gersfeld valley and reached the opposite hills at the Simmelsberg. Kronfeld remained over the Simmelsberg for some time, gaining and losing height alternately until he finally dared to make for the Kreuzberg. After rounding the Kreuzberg, he returned to the Simmelsberg, where he had another long flight with the changing upwind strength until he reached sufficient altitude to enable him to return to the Wasserkuppe via the Rotes Moor.

The last part of the flight brought him considerable altitude so that he had his maximum height shortly before landing, which enabled him to land quite near the point of take-off. Fig. 5 shows the course of Kronfeld's Kreuzberg flight and show best how the success was achieved by skilled use of whatever upwind regions were to be found. The diagrams of the course were drawn by the "Measurements Group" led by W. Harth (Engineering Undergraduate) as were also the other figures. This group did a good job of collecting and quickly calculating out all measured data in the Practice and Performance Contests and are to be congratulated. The intelligent completion of this work did much to help the frictionless course of the contest and made possible, above all things, a complete technical analysis of the flights.

On the same day that he made his Kreuzberg flight, Kronfeld gave another example of his unusual enthusiasm, his endurance and tenacity. He started for the Kreuzberg at 2.00 and returned to the Wasserkuppe at 4.15. Just ten minutes later he was again in the air in order to carry out his original plan, viz., a long-distance flight. On this day Kronfeld made his first attempt to reach the Thueringer Forest by pure hill-soaring across the Rhoen in an easterly direction. On this flight he reached the borders of the Thueringer Forest. He landed after flying 41 km. (25 5-8 miles) near Fambach, only a few kilometers from the first slopes of the Thueringer Forest. Two such performances by *one* pilot in *one* afternoon are unique in the annals of motorless flight.

Groenhoff's Kreuzberg flight was flown in a similar manner to that of Kronfeld, although the first part of the flight was made easy for him. After several hours' endurance flight on the west slopes of the Wasserkuppe, Groenhoff reached 790 m. (2,592 ft.) height by cloud upwind. This height was sufficient to fly from the Wasserkuppe to the Kreuzberg in a flat glide. The return to the Wasserkuppe was, however, considerably more difficult. Groenhoff lost so much height in the critical downwind region between Armsberg and Himmeldankberg (Fig. 5) that he was not able to fly over the ridge of the Himmeldankberg. Therefore he turned back to the Armsberg and acquired more altitude by working back and forth over the

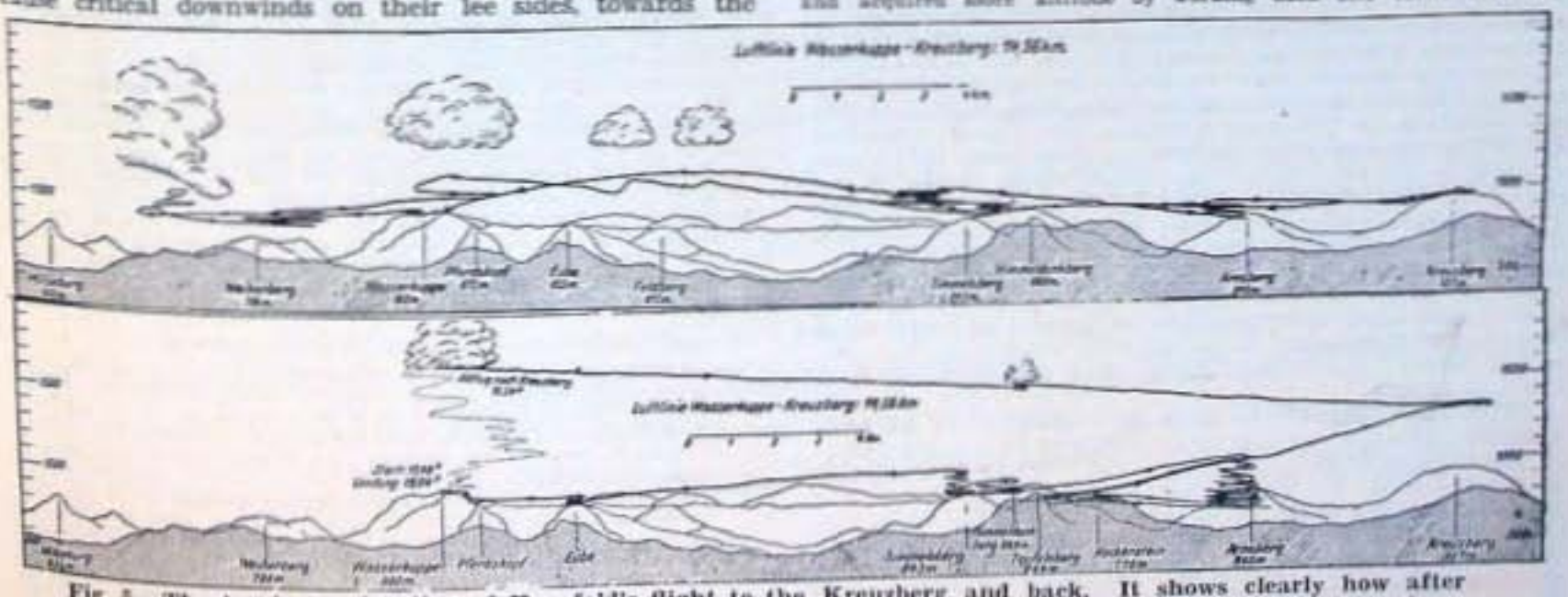


Fig. 5.—The top is an elevation of Kronfeld's flight to the Kreuzberg and back. It shows clearly how after nearly reaching the Milseburg, Kronfeld turned back to make the out-and-return flight to the Kreuzberg. The lower picture shows Groenhoff's route to and from the same point.

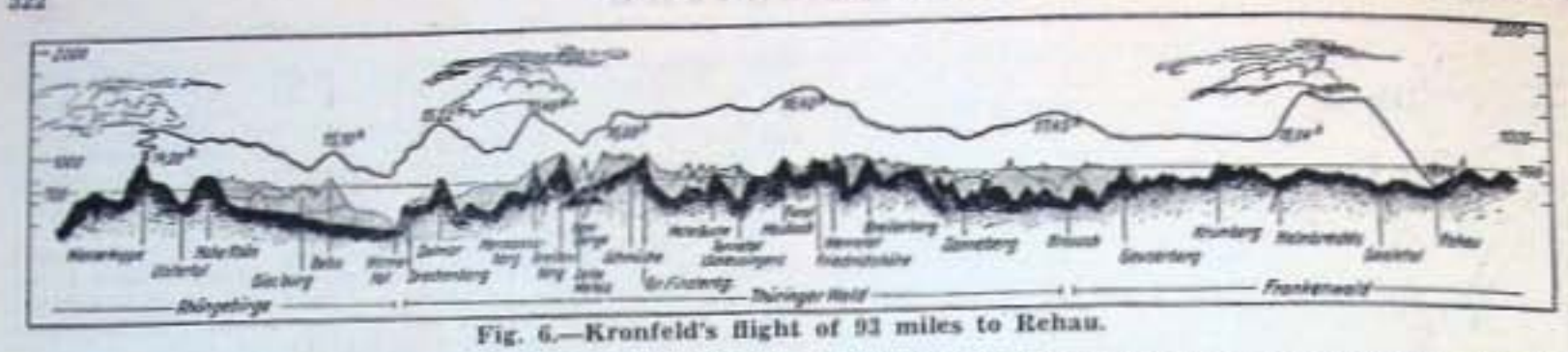


Fig. 6.—Kronfeld's flight of 93 miles to Rehau.

jutting slope for a long time. Again Groenhoff made for the Himmeldankberg, but again in vain. Again he could not get over the ridge and into the saving upwinds of the Himmeldankberg.

Only by exercising great care was Groenhoff able to return to the Arnsberg for the second time to try to attain the requisite altitude for continuing the flight. The upwind on the Arnsberg brought Groenhoff from 200 m. (656 ft.) below take-off height up to take-off height. With this still rather small reserve, Groenhoff tried the difficult crossing of the Himmeldankberg for the third time, and with success. He was just able to skim over the tops of the trees on the crest of the Himmeldankberg and fly into the upwind area. Groenhoff had to lark back and forth on the Himmeldankberg and Simmelsberg for some time before he could finally dare to cross the Gersfeld valley and return to the Wasserkuppe. On the Wasserkuppe no one reckoned on Groenhoff returning.

Everybody was astonished when a sailplane was seen along the Ehbe slope late in the afternoon, and Groenhoff's machine recognised. Groenhoff took-off from the Wasserkuppe at 1.45 and landed at 7.00 before the Wasserkuppe. This flight of Groenhoff's belongs to that group of flights, which because of the way in which they were flown, can be called masterpieces of flying and are typical in showing the thought and tenacity necessary for success in distance soaring flights.

For years the most important part of the Rhoen Contests has been distance flights. On these the pilot should show how he can use his experience in endurance flights, goal flights, cloud flying and line-squall flying in covering great distances. The various possibilities which are placed to-day at the disposal of soaring have brought us a great variety in soaring technique. The typical distance flights by Nehring in 1927, 1928 and 1929 were hill-flights. Kronfeld's first 100 km. (62 miles) flight over the Teutoberger Forest was also flown only by the use of hill-upwinds. The Rhoen Contest of 1929 brought us distance flights of quite another nature. The great flights by Kronfeld to Thueringer and Oberfranken last year were flown by use of a line squall and cloud upwinds and with no attention paid to the terrain. To make use of all these soaring possibilities in one flight, i.e., cloud-upwinds, seeking a line-squall or hill group, whichever might help to lengthen the flight, is the great art of distance soaring flight. Unfortunately Nature shows herself seldom so gracious that she gives all the various upwinds at one time.

There was practically no cloud-upwind during the Eleventh Rhoen Contest, and the line-squalls which appeared were of too low intensity for flights such as that by Kronfeld last year to Gera in Thueringer. Long distance flights only using hill-upwinds are only possible from the Wasserkuppe when, after crossing the Rhoen Hills, contact can be made with another range which is so laid out that good upwinds are present with prevailing winds. From the Wasserkuppe flights of 50 to 60 km. (31-37 miles) can be flown within the boundaries of the Rhoen Hills. Through the great number of long distance flights of all kinds which have taken place since 1926 in Rhoen Contests, the Rhoen has been pretty thoroughly sailed in all directions, so that there are only a few routes which have not as yet been flown.

The effort to collect more and more experience and flying possibilities in every Contest, and attempts to increase performance without help from cloud and line-squall flying led very soon to the search for routes so that one could fly from the Rhoen to other ranges. The most obvious of the possibilities is the Thueringer Forest. This region, stretched out from south-east to south-west, makes an admirable obstacle to the wind and very good upwinds are to be expected. The continuation of the Thueringer Forest through the Frankenwald and the Fichtel Hills and further, through the Bohemian and Bavarian Forests in the same direction, makes it possible to reach the Danube from the Wasserkuppe by using only hill-upwinds. There is hardly another route in Germany of equal value in the size of the upwind regions and favourable direction with respect to the prevailing winds, and which holds such prospects for long distance flights.

Considering these facts, it is no wonder that as soon as it had been learned how to do flights of 50 km. (31 miles) or more in sailplanes, attempts were made immediately to contact with the Thueringer Forest. Nehring was the first who recognised the great possibilities of this route and already in 1927 he made attempts to reach the Thueringer Forest via the eastern part of the Rhoen. His flight at that time showed how great the difficulties were that must be overcome. Most important of all is the strong downwind which occurs with west winds in the lee of the High Rhoen, and which, for instance, were very noticeable in the course of Hurttig's thunderstorm flight (Fig. 4) and which were a great danger to the successful completion of the flight. The region between the High Rhoen near Frankenhain and the Geba (the eastern Rhoen foothills) is through these downwinds so critical that most aircraft which have dared to attempt the flight to the Thueringer Forest have been forced to land.

So Nehring had to land at the foot of the Geba on his first flight in this direction in 1927. Mayer, Krebs and Groenhoff, who all took the route via the Geba, the Werra Valley, the Dolmar (the first part of the Thueringer Forest) had all to land near the Geba during the 1930 Contest. Even from the Geba to the Dolmar flying is very difficult, as the heights on either side of the Werra Valley are hardly 500 m. (1,640 ft.) above sea level. Hirth on his fine flight to Metzels in 1929 from the Wasserkuppe had to land only a few kilometers before the Dolmar. The distance between the most eastern hill of the Rhoen, the Geba, and the first of the Thueringer Forest, the Dolmar is 17 km. (10 5-8 miles) on the route Wasserkuppe-Geba-Dolmar. Further north, between the Plessberg near Salzingen and the Altenstein near Bad Libenstein (Thuer.), the distance between the Rhoen and the Thueringer Forest is only 14 km. (8¾ miles). The orographic conditions for reaching the Thueringer Forest along the High Rhoen via the Baier and Pless Hills are more favourable, and it would seem relatively easy to cover the 14 km. to the Thueringer Forest by this northern route.

There have been only four flights which have successfully reached the Thueringer Forest. One of these, that by Kronfeld last year, which led to Lienlas in Bavaria, was mainly a cloud flight. Also Groenhoff's flight in October, 1930, when the Dolmar was reached, was aided considerably during the first part by cloud upwinds. Fig. 7 gives the height-time

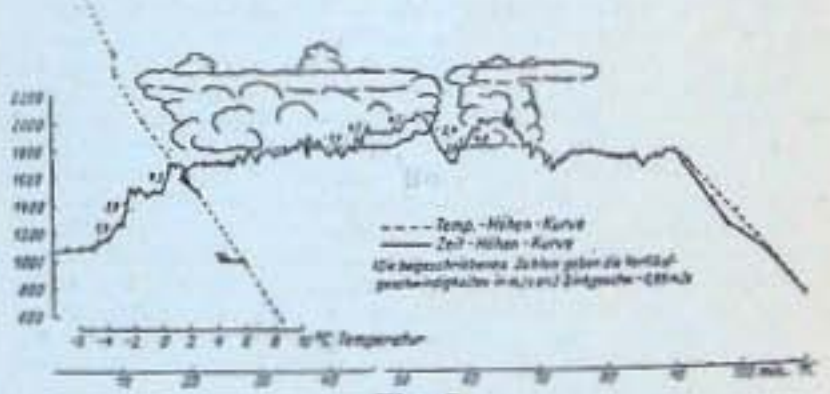


Fig. 7.

curve of this flight. The finest flights on the Thueringer Forest route are the two by Kronfeld in this year's Contest, which ended in Rehau, near Hof, and in Marktredwitz, in the Fichtel Hills.

On these flights the very difficult crossing from the Rhoen to the Thueringer Forest via the Geba and the Dolmar was achieved only by hill soaring with practically no help from cloud upwinds or line-squalls, and after reaching the Thueringer Forest full use was made of the soaring possibilities along the hills. Last year Kronfeld showed how one could fly more than 100 km. (62 miles) with very little effort before a line-squall or by means of cloud-soaring, quite independently of hills and valleys. In his flights this year to Rehau and Marktredwitz he showed that it is possible to fly the same long distances without help from thunderstorms and clouds, by means of patiently carried out hill-flying in which the success of the flight depends at all times on the accurate judgment of the upwind conditions.

The diagram of his flight of 150.3 km. (93 miles) to Rehau (Fig. 6) shows most clearly the difficult and masterful performance, which quite apart from covering a long distance, is also as far as actual flying is concerned of a higher order than those of last year. At the moment that Kronfeld started on his great distance flight to Rehau off the western slope of the Wasserkuppe, a weakly developed squall front appeared. Kronfeld flew along its right side in order to reach the actual front. The squall brought Kronfeld quickly up to 300 m. (984 ft.) altitude. But even so, the squall was too weak for one to follow overland. In the lee of the High Rhoen Kronfeld lost considerable altitude so that he found himself already 200 m. (656 ft.) below the level of the Wasserkuppe when he reached the Geba and was able to acquire more height. The flight from the Geba to the Dolmar cost more height, which he was able to recover at the Dolmar and even improve upon. At the Dolmar he began the long flight

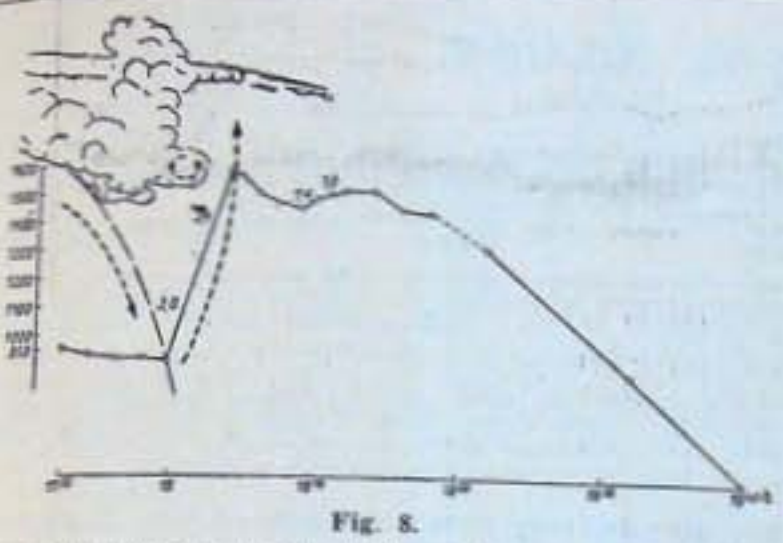


Fig. 8.

along the Thueringer Forest which could be carried out without dangerous loss of height.

After reaching the lower hills of the Frankenwald, the *Wien* lost considerable height again. During the whole flight over the Theuringer Forest Kronfeld was followed by a line-squall, which reached him at four o'clock between the Dolmar and Hermannsberg, but which remained behind the aircraft. Nearing Muenchberg, where the southern foothills of the Frankenwald meet the Fichtel Hills, and where the wind direction at the time was unfavourable for the continuation of the flight, Kronfeld waited for the following squall so that he could continue the flight with its help. The upwind before the squall brought the *Wien* to the remarkable height of 1,650 m. (5,413 ft.) above sea level, the greatest height reached during the flight. Kronfeld was able to hold this height for the next 20 minutes by flying before the squall (Fig. 8).

Unfortunately as the weather became steadily worse with fog shrouding the hills, combined with the approach of evening, Kronfeld was soon forced to discontinue the squall flying and land. This occurred only a few kilometers from the Czecho-Slovakian border near Behau after covering 150.2 km. On Aug. 24 Kronfeld tried the same route again, but he got even less help from squall and cloud upwinds than on the first flight, on Aug 13. Finally the Rhoen, the Thueringer Forest, the Frankenwald and the Fichtel Hills were flown over, the last being a departure from the first route. The flight ended near Marktredwitz with a distance covered of 164.8 km. (102 miles).

These two long distance flights are certainly the high spots of the Eleventh Rhoen Sailplane Contest. They are of extraordinary value for the development of motorless flight for they show how one can cover great distances simply by the use of hill-upwinds without help from cloud and squall upwinds, by suitable choice of route. The unusually favourable weather conditions for cloud and line-squall flying in the 1929 Contest and the (for sailplanes) tremendous heights which were reached and which permitted long distance flights with little trouble, doubtless lowered long distance hill-flying in the estimation of all.

This year's contest brought hill-flying again up to the same level as cloud and squall flying. Further, the 1930 contest pointed very clearly to the great task of the coming Rhoen Competitions, which for the Performance Contest will have the Danube as a goal to be reached from the Wasserkuppe. The great long distance flights from the Rhoen over the Thueringer Forest to the south-east must be in future the main goal for the aircraft of the Performance Contest. The flying possibilities which this route offers certainly allow one to expect a further improvement in the performances of the future Rhoen Sailplane Competitions.

AUTO-TOWING.

Mr. Lowe-Wylde continues to pit his enormous store of energy against the inertia of things as they are. Last week he made a tour of Scotland in a Moth and made arrangements for demonstrations at Selkirk, Edinburgh and Berwick, though unfortunately bad weather interfered with his movements. However, this did not debar him from giving demonstrations at two aerodromes at once on Saturday last, when he was joy-riding with two-seater machines at Hanworth and Brooklands alternately until a machine took-off with the towing cable hitched to its tail-skid with disastrous results to the telegraph wires at Croydon.

When the tangled yards of cable had been collected and straightened out from the resultant disorder, which took a good many hours, B.A.C. Ltd. went off to Totternhoe, where some thirty flights were made in spite of the fact that a start was not made until 3 p.m.

The B.A.C School of Auto-towing has been operating in an experimental way for three weeks. During this time much information has been gained and out of a total of about 14 hours of operation some 82 flights have been given. Only two items of damage have occurred, neither serious, and both to the undercarriages. The first pupil to make his "A" Test was Mr. A. C. T. Isaac, a member of the Rugby Club, who made a beautiful flight of 32 secs. after receiving only 18 flight lessons.

The Border Gliding Club are the first British Gliding Club to adopt auto-towing equipment from the very start and a B.A.C. V with trailer is now on order for them.

Sheila, as the original B.A.C. VII is called, has now carried over 200 passengers, with a total flying time of approximately 15 hrs. The second machine of this class, which is only two weeks' old, has already carried eighty passengers. The latest additions to the list of distinguished passengers are the Hon. Mrs. Forbes Sempill, Mlle. Susi Lippens and Herr Kronfeld.

Demonstrations of auto-towing, together with the usual joy-riding facilities, have already been arranged for the following dates:—

June 13-14.—Border Gliding Club at Selkirk.
June 26.—Wiltshire Club at Swindon.
June 27-28.—Herts and Essex Club at Bishops Stortford.
July 4-5.—Harrogate.
July 11-12.—Wolseley Club at Birmingham.
July 18.—Northampton Aero Club at Northampton.
July 25-26.—North Cotswold Club at Evesham.

FOR THE SEA-SIDE.

Most of us have already thought what fun it would to glide over the sea, especially during the summer when the sea is blue and the sun really hot. In fact some of us have got so far as visualising some kind of auto-towing with a speed-boat instead of a motor-car. Then we have thought that perhaps one might be able to cast off and soar in the up-currents which Captain Entwistle has mentioned as forming along our Southern coasts in summer.

But as usual the initiative has been left to others. Fortunately for the Movement Mr. Lowe-Wylde has already seen the possibilities of such towed flight and the two-seater B.A.C. Bat-Boat is practically complete and should be tested next week. This machine uses the standard wings and tail unit as are interchangeable with the B.A.C. IV, B.A.C. VI, and B.A.C. VII types. The single-step hull seats two side-by-side with the tail unit supported on a duralumin boom which springs from the after-end of the boat.

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NOTTINGHAM GLIDING CLUB
JUNE 27th and 28th, 1931, MONSTER DEMONSTRATION OF SOARING,
ILAM HALL, DOVEDALE
This Terrain is the proposed Headquarters of the MIDLAND SOARING SCHOOL.
Every Gliding Club in England is invited to attend, and bring all their machines. A WEEK-END spent on this Site will be equal to MONTHS of EFFORT on Clubs' own slopes.
MECHANICAL RETRIEVING DEVICES. MINIMUM LABOUR, MAXIMUM GLIDING & SOARING POSSIBILITIES
It is hoped that the following Clubs will take part in the Competitions:—Bradford, Askern, Birmingham, Barnsley, Bolton, Ilkley, Leeds, London, Leicester, Midland, North Lindsey, North Staffs, Oxford and County, Preston, Rugby, Sheffield, South Down Skysailing, Wiltshire, Harrogate, Matlock, Manchester, North Cotswold.
Will all Clubs who have not received an invitation direct, and those Clubs who have not yet replied, please get in touch with—
All Gliding Clubs are invited to attend a MEETING which is to be held after the Demonstration on Saturday, June 27th, in the Ballroom of Ilam Hall, to discuss the formation of the MIDLAND SOARING SCHOOL.
L. BURBIDGE, Hon. Sec. Nottingham Gliding Club,
BLACK BOY HOTEL,
NOTTINGHAM.

NEWS FROM THE CLUBS.

THE CHANNEL GLIDING CLUB.

On June 3 a good muster of members turned up at Etching Hill and a most enjoyable and successful time was spent. After the more advanced members had made flights, the greater part of the afternoon was devoted to the instruction of the beginners. Each of these made three or four hops in succession. In this way the experience gained on one flight was immediately turned to advantage and a marked improvement in the handling of the machine was noticeable.

On June 6 Mr. C. M. C. Turner brought out his B.A.C. IV and we proceeded to our soaring ground near *The Valiant Sailor* on the Dover Hill. The machine was quickly rigged and Mr. Turner took off, making a flight of 9 mins. 56 secs. He was again launched and this time clocked 12 mins. 45 secs. On landing Mr. Turner humorously remarked that he thought he had now made every possible mistake and had flown over every inch of the ground where he should not fly and promised us better results in the future. The wind, by this time, had fallen considerably, but it was decided that he should make one more flight. This was a splendid effort and but for the lack of wind he would have fulfilled his promise. The conditions, however, compelled him to land after flying for 5 mins. 30 secs.

The flights that Mr. Turner has made from various points on this site have taught him much regarding the currents set up by the contour of the line of hills and this knowledge will now stand him in good stead.

The weather conditions on Sunday were such that made gliding out of the question. In the words of the popular song of a few months ago, "Drizzle. Drizzle. The party's a fizzle."—L. H. H.

THE GLASGOW GLIDING CLUB.

On Saturday and Sunday, May 30 and 31, the Glasgow Gliding Club and the Lyons' Tea People held the first Scottish display of gliding and sailplaning at Campsie Fells. This site has been pronounced as being of a most excellent character both by Herr Krause and Mr. Geoffrey Woolf, but the unfortunate weather conditions prevailing detracted greatly from an otherwise successful meet in that no soaring by Herr Kraüse was possible.

The *Falke* was not launched at all on Saturday, but on Sunday afternoon in order to lessen the disappointment of the spectators Herr Kraüse made one glide, which, though short of duration, nevertheless clearly demonstrated the high efficiency of the sailplane. It is to be hoped that Herr Krause will be afforded another opportunity on this site in more favourable conditions, when, we are certain, some splendid duration figures could be obtained.

We are greatly heartened by the success of the inter-Club competitions which were held in conjunction with Herr Krause's display. It is indicative of the progress here that both Edinburgh and Kilmarnock brought their gliders and that representatives of Stirling, Falkirk, Dumfries and the new Border Club from Selkirk were present. It is estimated that over two thousand spectators attended on Saturday, and on Sunday, in considerably worse weather conditions, about three thousand turned out.

On Saturday afternoon teams of three were put up by the competing Clubs, but it was decided that the best individual flight would be declared winner. Competitors must be *ab initios*. Edinburgh and Glasgow tied, but Glasgow eventually won with 14½ sec. flight. Wind was light and coming from an unsuitable quarter.

On Sunday the competition was for the Alan Boyle Challenge Cup—teams of three—but power pilot members could compete. Glasgow also won this event through Mr. A. Dunlop's fine flight of 27 secs. Again conditions were adverse and the results were more satisfying than appears on paper.

Mr. Sinclair of the Kilmarnock Club made the first Scottish *ab initio* attempt for the "A" certificate. He was taken well up the hillside and achieved a fine straight glide of 33 secs.' duration.

Various display glides were made by Lord Douglas Hamilton, Mr. A. Dunlop, Mr. Sinclair, Mr. G. Cameron and Mr. Houston Anderson.

It is hoped that the exhibition of our gliders at the Scottish Flying Club's Air Pageant may further stimulate interest in the motorless side of Scottish aviation. The Club wish to thank all those who have aided us in these efforts to develop gliding and soaring in the North.

THE LEEDS GLIDING CLUB.

Leeds, like a good many other Clubs, has had very great difficulty in finding a suitable site. We have pretty well scoured the immediate vicinity of Leeds, and have come to the conclusion that a really good ground does not exist. All this site hunting and changing has had a very disorganising effect on the Club, and attendances have not been as satisfactory as we should like. However, we have about a dozen really enthusiastic people, who do a tremendous amount of work, grouse a lot, but who will surmount any difficulties in order to satisfy their instinct to fly.

On May 17, at the very kind invitation of the Ilkley Club, we took our Reynard up to their new site at Malham. This must be almost an ideal site, a sort of plateau surrounded by hills reaching to heights of 200 to 400 ft., where flying can take place in any wind direction; its only drawback is the presence of a few small outcrops of limestone which, at any rate, teach one to choose one's landing. They have a perfect little hill there for taking "A's" and three members, although they had not previously been off a hill more than half the height, were successful in obtaining their certificates—(R. F. Stedman 30 secs., C. W. Richardson 40 secs., J. W. Smith 34 secs.).

On Whit-Monday, May 25, our machine was taken to Woofa Bank to support the Ilkley Club and the Lyons' Tea Demonstration. This was rather an unfortunate day, and after seeing the *Westpreussen* and two other machines damaged, Stedman made a good flight down the hill, and then we packed up while still whole.

May 31 was spent at the N.F.S. Pageant at Sherburn—a very good show.

Last Sunday, June 7, we were again at Malham, and on arrival had the pleasure of meeting the enthusiastic Mr. Waplington, who was inspecting the site. Ilkley were not flying, but two of their members stayed the day with us, and worked like niggers. Most of the time was spent in giving two members intensive training, and excellent progress was made. Our "A" pilots repeated their certificate flights, and we finished up in a deluge of rain. A call at the "Buck Inn" at Malham, and a toast to "Happy Landings," put us in good form for the 40-mile journey back to Leeds.—C. W. R.

THE PRESTON AND DISTRICT GLIDER CLUB.

Enthusiasm was rife among six of our members, and the call of the air was strong in their blood, so emulating the gentleman of advertisement fame they leapt from their beds on Sunday morning at 7 *o'clock* and arrived at our site to find Beacon Fell shrouded in a mantle of low-hanging cloud.

Assured by our landlord, Mr. Butler, that the mist would dispel within the hour we set to work to unload our R.F.D. machine and rig same. Mr. Catterall, our constructional engineer, had made some modifications to the fuselage during the previous week consequent upon the breaking of another king-post, and during the period of training that ensued the efficacy of the bracing employed was fully proved.

Our modification is quite simple for we have carried two bracing wires from each side of the bottom of the skid over two wooden posts to a point just below the wing-root fittings and in line with the centre of the king-post. The wooden posts are screwed and glued in position, having a half-section of 3/16 copper tube recessed into the tops to carry the wires. The wires are stretched by means of L. and R. hand turnbuckles.

On three occasions at least the machine was landed with so much drift that the king-post must have inevitably broken without the bracing, but all that happened was the jumping of the bracing wires from the tops of the posts due to the flexing of the king-post under the strain. It was a matter of seconds to replace the wires and tighten up again. We had a full day of training, but unfortunately the attendance was small, as a number of members were unable to come. Considerable time was devoted to launching members many times who had previously crashed and it was found that by progressing in easy stages their confidence slowly returned.

The advanced class commenced instruction in making turns, and were launched higher up the slope, slightly cross-wind, had to make a gentle turn and land on a given point. At first no great success was registered, a marked disinclination to apply bank being noticeable. This was due to the fact that a few degrees of bank seems a colossal amount to the *ab initio* when he deliberately applies it 20 or 30 feet "off the deck." The tendency was to apply bank and rudder for the turn, but neutralise so quickly that the controls had no time to take effect. This fault will doubtless be corrected very soon when the pilot accustoms himself to the feel of the machine banking over.

We shall be very grateful if any reader can give us information dealing with successful launching by means of a motor-car. (Not auto-towing.) We have seen references to mechanical launching with the shock-cord, but no details were obtainable. If anyone has tried out the car idea we shall be glad to know the exact method employed and the degree of success attained.—L. E. F.

[*The Dorset Club described in* THE SAILPLANE *for June 5 fairly completely their method of using a car to stretch the rubber-cord. The North Kent people use the same method without the pulley, the car in that case pulls straight ahead. The B.G.A. have also issued some very excellent regulations,—a copy of which can be obtained by writing to Mr. Waplington.*—ED.]

THE SOUTHDOWN SKYSAILING CLUB.

Weather conditions on Sunday made flying impossible, but several members met at the Club workshops and carried out valuable work on our new machine which is rapidly nearing completion. The machine is now ready for fitting the fabric and doping. We hope to be able to test it in the air within the next two weeks. As this machine has been designed and built entirely by members of the Club we are anxiously awaiting the results of the tests.

On Friday last we were honoured to have with us Mlle. Lippens (one of our Charter Members), complete with *Professor*. Early in the morning the wind was northerly and ideal for an endurance flight, but unfortunately before getting ready to take-off it had veered to nearly due East. This is one of the worst wind directions for the Ditchling site, but in spite of this handicap Mlle. Lippens made a very fine flight of over 20 minutes and was forced to land owing to the wind temporarily dropping to almost a complete calm. In view of the existing conditions we consider the performance decidedly good. The flight was carried out on a portion of our ground not previously used for gliding or soaring. We succeeded in getting the machine dismantled and removed before the "Deluge."

It is proposed to carry out flying on Wednesday evenings in future as well as on Sundays. Members please note.

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