WOLF HIRTH

The Art of Soaring Flight

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Emil T. Czerkas

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The Art of Soaring Flight

by

WOLF HIRTH

Translated from the German

by

Naomi Heron-Maxwell

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Translation of the work „Die Hohe Schule des Segelfluges" by Wolf Hirth.

Dedicated to the memory of:

Eric Collins

and

Warren Eaton

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Preface

In many countries, there are today a number of sailplane pilots, who fly well and have good machines and yet are not sufficiently knowledgable and experienced to make full use of all the soaring possibilities at their disposal. Here and there much valuable information has, it is true, appeared in various publications; but it is difficult for the beginner to pick and choose. That is why this little book has been written. It is a guide to those who are anxious to be initiated into the secrets of soaring: the sublime, silent flight of the birds, the finest sport of all.

I have purposely refrained from dwelling at length on the mechanics and meteorology of flight, but have striven to give the student of soaring flight a clear explanation of all that must necessarily be of interest to him or her. However, in order fully to understand this book, readers will find it advantageous to possess a little rudimentary knowledge, and suggested reading matter is appended.

Wolf Hirth

Translator's Note

During the past few years soaring flight in Great Britain and America has made rapid strides; but many enthusiasts have, I think, like myself, been severely hampered by the lack of available literature. For a long time I could only gain a limited theoretical knowledge by means of verbal discussions, and when at last I had the good fortune to meet Wolf Hirth personally and read "The Art of Soaring Flight" in the original, a new world was opened up to me.

Wolf Hirth needs no introduction as one of the pioneers of soaring flight, and in this work he has given to the world the result of his accumulated experience. When, therefore, he asked me to translate it into English, I was only too delighted to do so and thus give others the opportunity of learning from one who had already taught me so much. No student of soaring flight can ever hope to achieve success without an understanding of certain meteorological phenomena, which are clearly explained in this book, and I feel that the reader will find every page both instructive and stimulating.

Soon after the original was published, it was translated into Polish, and it may be truly asserted that this was a considerable factor in placing Poland second only to Germany in the realm of motorless flight: at any rate, its immediate result was the acquisition of 19 Polish "Silver C's" within the year of its publication.

In conclusion, I would like to thank all those who have so kindly assisted me in my work as translator, in particular the following: — Dr. A. E. Slater, the well-known Editor of the *"Sailplane and Glider"*, and Mr. P. A. Wills for their important contributions; Mr. J. S. Fox and Herr K. Schlichting for their useful assistance in certain chapters; Mr. L. B. Barringer for his initial work in the translation; and finally Mr. F. C. H. Allen for his untiring patience and invaluable help in the preparation of the whole book: without his aid it is doubtful whether I would ever have been able to complete my task.

Naomi Heron-Maxwell.

Introduction

The very earliest pioneers visualised in soaring, as we know it today, the solution of the problem of flight. There was Leonardo da Vinci the renowned artist and scientist 500 years ago, Berblinger the tailor from Ulm 100 years ago, and Lilienthal the engineer 50 years ago.

The strength of the human body had proved inadequate to maintain flight, and light engines did not then exist. Yet, as some birds apparently had no difficulty in flying long distances at high altitudes, it was thought that the secret of their flight must lie in the air itself. All these first soaring theorists believed in the truth of this, and among them was Lilienthal, who became not only the first actually to fly, but also the first to succeed in soaring, by allowing himself to be borne aloft by a breeze blowing up a hill.

Then came the internal combustion engine and its subsequent adaptation to aeroplanes; but the idea of motorless flight remained. Here and there new and more accurate soaring theories were evolved. Meteorologists had already discovered the existence of air-currents, which might be utilised, and their real value was soon to become actually demonstrable under the influence of the rapidly growing knowledge in both aerodynamics and the technique of flying.

In the year 1920, hill-soaring was revived on the Rhön on more or less the same lines as Lilienthal's early efforts, but this time with wider aims in view. The Rhön Mountains form a mighty barrier over which Westerly winds must always climb, as they cannot flow round them. Over the West slope, therefore, there lies a belt of air rising right up over the ridge, many million times greater in volume than the region of slope-currents over Lilienthal's historic site. But in 1920 even this belt of rising air proved insufficient to keep sailplanes aloft.

At that time, great hopes were centred round the possibility of dynamic flight, for which the gustiness of the air might be used to enable these "dynamic" sailplanes to fly as far as desired: but people soon realised that this idea was impracticable.

However, it was not long before pilots were not only to be practising a new art called "hill-soaring" but also to be flying from one hill to another by utilising various soaring sites, which branched out in all directions from the Rhön for a distance of 15—20 miles.

the topography of which had been carefully mapped by the scientific leaders of the soaring movement.

When, one day, a sailplane pilot was actually carried 30 miles away from these hills by a thunderstorm, it was seen that a new avenue was opened up to the enthusiasts and soon several pilots were making regular use of this form of cross-country flying.

Before long still further soaring possibilities were discovered. With the help of meteorological information, by observing soaring birds and by using instruments, sailplane pilots began to find and make use of upcurrents in all kinds of weather conditions and over the most varied tracts of country.

Nowadays, the art of hill-soaring is generally understood, but the technique of thermal and cloud-soaring offers many difficulties to the embryo sailplane pilot. The object of this book, therefore, is to explain the technique of these new methods of soaring, which was once a secret known only to a select band of experts.

Sailplane „Musterle" slope-soaring, while waiting for a thermal.

1. A few Remarks on Flying

Most of my readers will, I feel sure, be sufficiently knowledgable to understand and appreciate the following points; but my several years' experience as a flying instructor have taught me that many sailplane pilots, though long in possession of the "C" Certificate, are still apt to confuse such terms as "sinking-speed" and "gliding-ratio".

The "gliding-ratio" is the relation between the distance covered (measured horizontally) and the height lost. Thus, a sailplane, which from a height of 100 ft. glides a distance of 2,000 ft. has a gliding-ratio of 1:20. Incidentally, this is quite a good ratio for a sailplane.

The expression "gliding-angle" can be dispensed with altogether.

The "sinking-speed" gives us the amount of height lost in a certain time.

An average sailplane has a sinking-speed of approximately 2½ ft./sec., i. e. with every second of gliding it loses 2½ ft. of height in relation to the surrounding air. If the air itself is ascending at the rate of 4 ft./sec., then the sailplane rises 1½ ft. sec.: in other words, the sailplane is in "soaring-flight".

This can be exemplified by comparing the rising air to a lift. We will presume that we are climbing down a ladder rung by rung, at an even speed, inside the lift; our descent will then correspond to the glide of a sailplane. Now, if the lift, i. e. the air surrounding us, is itself moving upwards, then, even though we are climbing down the ladder, we will soon find ourselves at a higher level: we shall have risen. In the same way, an engine-less plane always glides downwards even when soaring.

We must not forget that when flying correctly, the air always flows past the machine at an even rate. In relation to the surrounding air we should therefore always have approximately the same speed.

Turns: in gliding there is only one kind of turn, the "true turn" at an even speed, with no "slipping in" or "skidding out". Either of these two faults may seem apparent to a ground observer in a strong wind; whereas in reality it is a deception caused by the wind force affecting the flight-path. To summarise: turns should always be made at a constant speed with the pilot's body pressing straight down on to the seat.

Steep Turns

By Ludwig Hofmann

Steep turns are turns with a bank of more than 45^0, and their mastery is absolutely essential for successful thermal flights.

During every turn, the inertia of the plane produces a centrifugal force, which tends to force it out of the turn. The smaller the radius of the turn, the stronger this force becomes. The banking position must be such that the combined pull of gravity and centrifugal force is directed vertically to the wings and the plane holds the turn. At a certain position and at a certain speed of the plane, it is necessary to make such a narrow curve that the centrifugal force together with the pull of gravity results in a vertical pressure on the wings.

Flat turns are therefore those that have a large radius, while steep turns are tight; and only when the correct amount of bank is chosen for the corresponding radius, or the correct radius for the corresponding bank, is the turn correct, clean and free from danger.

If one were to hold up a model of a plane in a banked position, the elevator and rudder would then both lie on a slant; if held in a very steep turn with almost 90^0 of bank, it is easy to see that the *effect* of rudder and elevator becomes completely reversed. Banking to this degree therefore requires a change of technique; for the elevator now has the effect of a rudder and "vice versa". This change of control begins to be noticeable in banks of as little as 30^0. If the model is held in a steeply banked turn to the left, one can then see that right rudder raises the nose, as if it were an elevator; while pulling the stick back only has the effect of tightening the radius of the circle, like a rudder. Fundamentally, of course, nothing alters. The plane, when banked vertically, is only in a different position in relation to the ground. The functions of the controls always remain the same, even though their effect is reversed. The pilot ought to visualise and appreciate this point.

The student should not attempt steep turns until he has had considerable experience and feels thoroughly at home in his plane. At first, he should circle with a bank of not more than 30^0, when he will already notice the effect of the controls becoming reversed; and then, as soon as he can make clean circles with a 30^0 bank, he may gradually tighten them until he eventually finds no difficulty in doing the steepest circles without any "slipping in" or "skidding out".

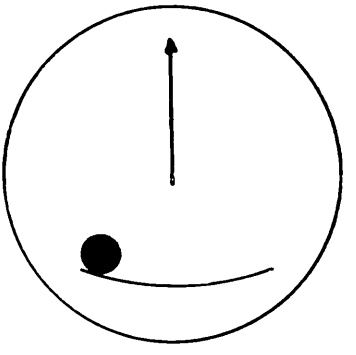
The beginner should not swing suddenly into a turn with much movement of the controls, as this is likely to be dangerous. He should always begin by turning gently, letting his turns gradually get steeper, and not reaching the full amount of bank until two full circles have been completed.

Speed spells safety! If a machine has a normal flying-speed of 30 m. p. h., turns may safely be practised at 35 m. p. h.

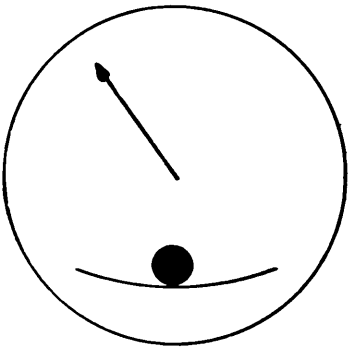
There are two main faults usually made when practising steep turns:—

a) The beginner cannot find the correct amount of bank corresponding to the speed and radius of the turn. If the bank is too steep, much height is lost, for the plane slips inwards. This is due to the fact that the centrifugal force is not as strong as the pull of gravity. If, on the other hand, the bank is too shallow, the plane lies too flat and is forced out of the turn by the proportionately stronger centrifugal force and begins to skid outwards. In extreme cases, this may cause it to fall out of control and spin.

Some pilots are inclined to over-bank their turns. Our sense of "feel" then is not dependable unless we have had a great deal of practice. This sense can best be developed with the help of a turn-and-bank indicator, which is very simply constructed: a small ball rolls to and fro in a glass tube curved upwards at both ends. To reduce movement this tube is filled with a liquid. As long as the ball is in the middle, the plane will be in a correct flying position, but if it moves from the centre, the plane will be incorrectly banked. (See Diagrams.) For example, if in a left turn the ball rolls to the left, it is an indication that the plane is too steeply banked and "slipping in". We must then reduce the bank with right aileron until the ball is in the middle again. If we over-correct, the plane will



Left wing low in straight flight.

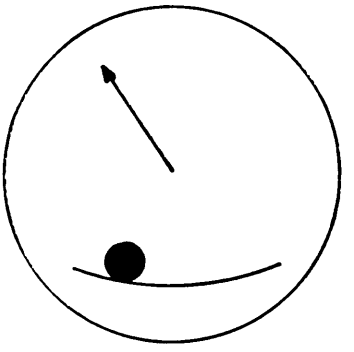


Left turn correctly flown.

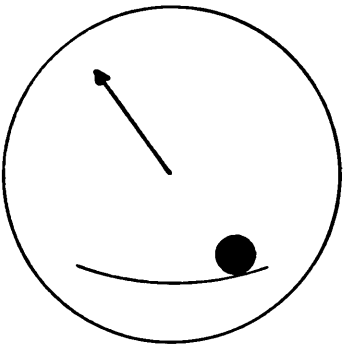
skid out and the ball will roll to the right. Therefore, when practising turns, the plane must always be banked in such a way that the ball stays in the middle.

b) The beginner cannot maintain the correct flying speed. Usually it is a question of too much speed, seldom too little. The excess speed is due to the plane nose-diving. This is because although the pupil introduces the turn correctly with rudder and aileron, and even eases the stick back the correct amount when the controls first, in effect, become reversed, he forgets all about his feet and persistently keeps on rudder, which has now assumed the functions of an elevator. To be correct he should have taken off rudder at the same time as he pulled back the control column. Next, he often makes a second mistake in trying to reduce his excess speed by pulling the stick even further back, as he would do if he were in level flight. He forgets, for the second time, that the controls are, in effect, reversed and that pulling the stick will only tighten the turn and never slow up the machine. The fact that he has kept on rudder will throw the plane still further on to its nose, while the aileron, which he has probably also forgotten to centralise, will continue to increase his bank. In a vain attempt to extricate himself from this distressing and seemingly dangerous situation, he then tries to get the plane out of the steep bank by giving opposite aileron. Finally, the earth starts revolving up at him, and he finds himself in a spin. And no wonder! He could not have done it better if he had tried. The nose of the plane dropped owing to the action of the rudder while the stick was held back. In other words, he had made all the correct movements for starting a spin at high speed. This shows that it is not always necessary to reduce the speed or to stall in order to start a spin.

The rudder is therefore a very important control, and like the



Left turn incorrectly flown, machine "slipping in".



Left turn incorrectly flown, machine "skidding out".

stick it is essential to learn how to use it correctly right from the beginning. Even in steep turns the wind must come directly from the front.

Flying-speed can be regulated by means of the horizon, air-speed indicator (though this is often slow in registering), "feel" on the controls, howling in the venturi, whistling sounds round the plane, and the wind in one's face if in an open cockpit.

If the nose drops, owing to rudder being left on, and the plane gathers speed, it is difficult (and sometimes dangerous) to right the plane by giving opposite rudder. The distortion effected by the movement of the rudder together with the stick being pulled is a severe strain on the fuselage. The tail-unit and the rear of the fuselage may begin to flutter, especially in old planes, and this might easily lead to a structural failure. If, therefore, the steady rudder pressure causes the plane to nose-dive, one should not try to reduce the speed by giving opposite rudder, but should at once take the plane out of the turn, fly straight on at a normal speed, and then begin the turn all over again.

If the speed should fall in the turn, it can safely be increased by a small movement of the rudder in the direction of the turn. It is easier to increase the speed in this way than it is to decrease it with opposite rudder once the plane has started going into a dive.

If, when making steep turns, the plane seems about to stall, one need only push the nose well down for her to regain flying-speed in a nearly verticel bank, and one can then almost at once pull her round into a turn again. This method is constantly employed in thermal soaring, because, owing to the turbulence of the air in thermal conditions, the plane is very apt to stall.

In order to bring the plane out of a correctly flown steep turn, the rudder must be held in a normal position and only aileron used; while the control column should be pushed forward. The beginner usually does not push the stick far enough, but only centralises it and has the feeling that he has pushed it too far, because the pressure on his seat relaxes. In reality, he has not pushed the stick forward at all, because the elevator does not drop until the stick is pushed to beyond the neutral position. The movement of the control is therefore a greater one than that to which the beginner is accustomed. If he forgets to push the control column forward, the aileron used to right the plane brakes so strongly that by the time it has reached a normal position, the plane has almost lost flying-speed and begins to stall and drop.

If the plane seems about to stall or go into a spin, one should give rudder and aileron on the same side as that on which it is going

over, and at the same time push the stick hard forward. The plane will then tip over 180°, start diving and gather speed; as soon as this happens both rudder and aileron should be centralised and the plane slowly and gently pulled out of the dive.

Should one fail to notice that the plane is stalling and move the controls as described, the plane will go over into a pure spin, standing more or less vertically on her nose and revolving round an axis outside the centre of gravity. A spin is often the most dangerous of all flying positions. It can be stopped by pushing the stick hard forward and holding rudder and aileron neutral. The whirling motion will then cease either immediately or after another half or even whole revolution, depending on the type of plane; it will then again be in a straight dive from which it must be righted by gently easing back the stick.

2. Sailplanes and their Instruments

A. Instruments.

No instruments are required when flying within sight of the ground; neither do we need any even without visibility if we have a plane, which, like a well-trimmed model, flies by itself. However, directly we wish to do any serious flying, instruments are indispensable. For blind-flying in a straight line we need a compass, an altimeter, a turn-and-bank indicator, and a variometer, the latter enabling us to note every little rise and fall. Pilots have, it is true been known to carry out long blind flights without instruments, but experience has proved that only a tremendous amount of practice can ever replace instruments—and then only partly, never completely.

The following instruments are today used in sailplanes:—

1. *Air-speed indicator,* for ascertaining flying-speed, though an experienced pilot can judge his speed fairly well by means of his sense of hearing and the pressure on his face. The beginner should gain this experience by practising slope-soaring without an A. S. I., as it very often becomes useless owing to water and ice, particularly when cloud-flying. This, of course, does not mean that one should never have an A. S. I. It is only important that there should be no feeling of uncertainty should this instrument go wrong.

2. *Altimeter*, also not absolutely necessary, but greatly simplifies flights across-country, and is indispensable for cloud-flying and in competitions. A very sensitive altimeter can, moreover, take the place of a variometer.

3. *Variometer*, almost indispensable for all kinds of advanced soaring, especially thermal soaring.

4. *Compass*, important for cross-country flights and essential for cloud-flying.

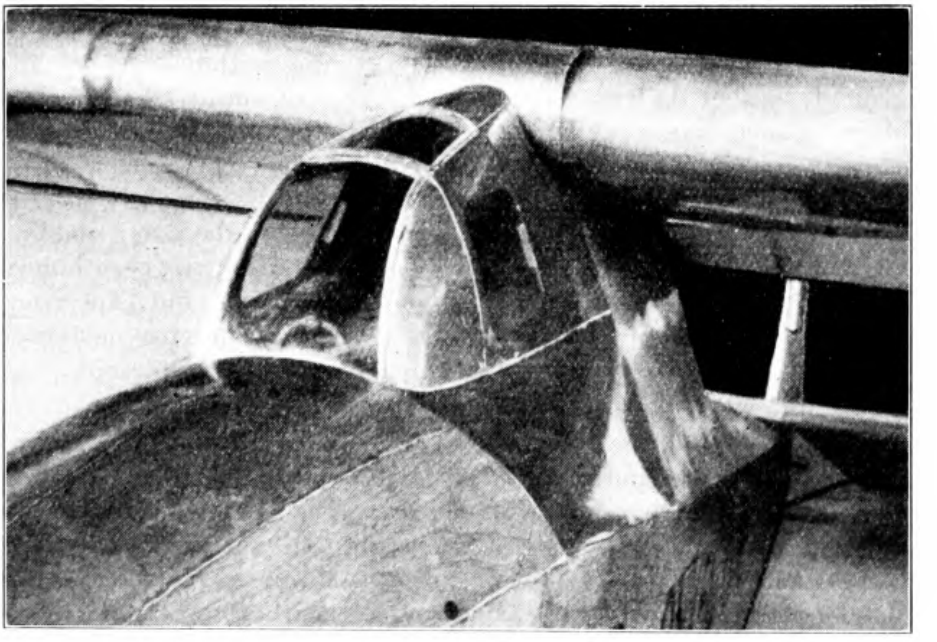
5. *Watch:* it is advisable to take two watches, one set at zero at the start of the flight to show actual flying-time and the other to tell the time of day. A stop-watch can be used for timing.

6. *Turn-and-Bank Indicator*, absolutely essential for systematic cloud-soaring. Past experience has also proved that it cannot be replaced by the artificial horizon.

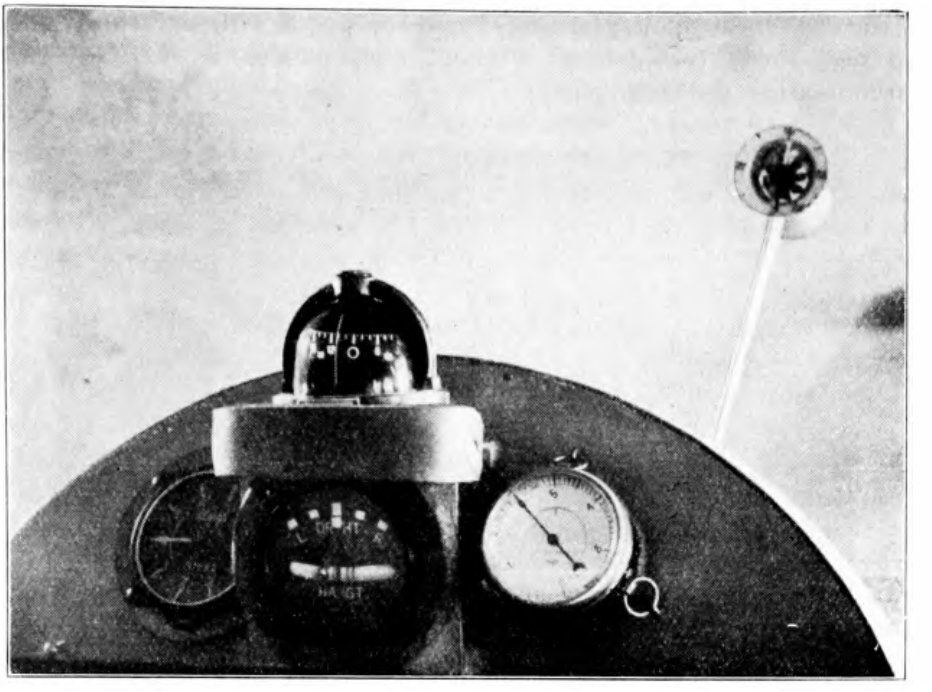
7. *Sensitive thermometer*, to call attention to warm and cold air and enable an experienced pilot to make use of the resultant up and downcurrents.

8. *Barograph*, for recording test flights and required in competitions and for official recognition of records. If hung in the cockpit, it can be used in place of the altimeter.

9. *Wireless Set,* will play an important role in enabling pilots to



Cockpit cover (Grunau Baby II)

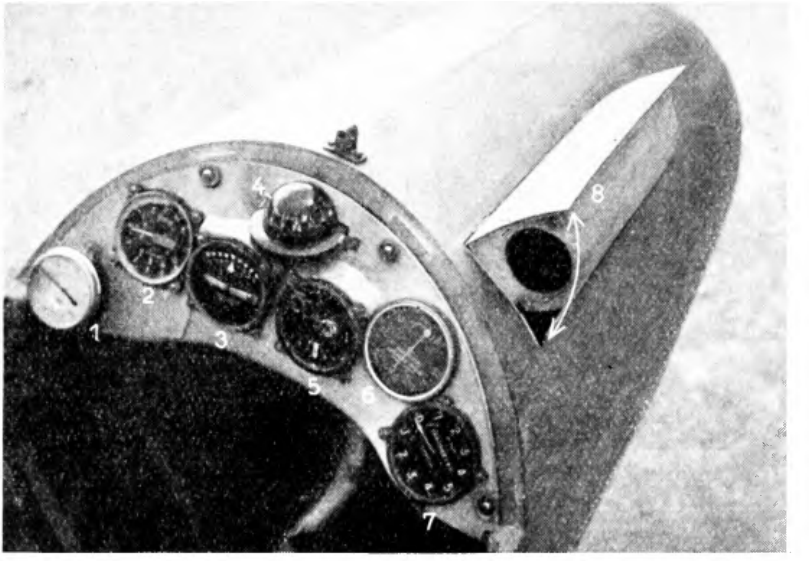


Plain dashboard.
Right: A.S.I. Above: Compass. Below: variometer, turn-and-bank indicator, altimeter.

find their bearings, as soon as a reliable light-weight receiver with a 2/300 mile range is put on the market. With such an apparatus it would be possible to attempt a thunderstorm flight by night. In this way, Grönhoff and I might have been able to tune into the Berlin transmitter during our thunderstorm flight from the Wasserkuppe, and thus reach Tempelhof Aerodrome at Berlin. Although, in the Autumn of 1932, I made some successful experiments at finding my bearings and later still further tests were carried out, sufficient progress has not yet been made to justify any talk of a regular use of radio. It could, of course, be used for soaring in many different ways, as, for example, for receiving weather reports on long-distance or duration flights, and perhaps also for minimising a danger of the future, namely that of a collision in mid-air between two sailplanes flying in the same cloud.

10. *Lighting:* as in cross-country flying there is always the risk of landing at dusk or by night, one should always carry a fairly

powerful flash-light. The use of a verey-pistol with parachute flare is also worth considering. A small pocket-torch is sufficient for illuminating the dashboard.



Dashboard of a modern sailplane

1. Altimeter. 2. Variometer.
3. Turn-and-bank indicator.
4. Compass.
5. Electric turn-and-bank indicator.
6. A.S.J.
7. Variometer.
8. Retractable tube for turn-and-bank indicator.

B. Sailplanes.

The principal aim of sailplane designers used to be to build sailplanes with a low sinking-speed and a good gliding-ratio. For duration flights alone in slope-winds planes with a bad gliding-ratio and a moderate sinking-speed were quite good enough. But during the last few years, we have recognised that especially for thermal flights manœuvrability is also of the utmost importance, though stability must not be sacrificed in order to gain it. Moreover, structural strength has been increased without adding weight or jeopardising the essential qualities of a good sailplane.

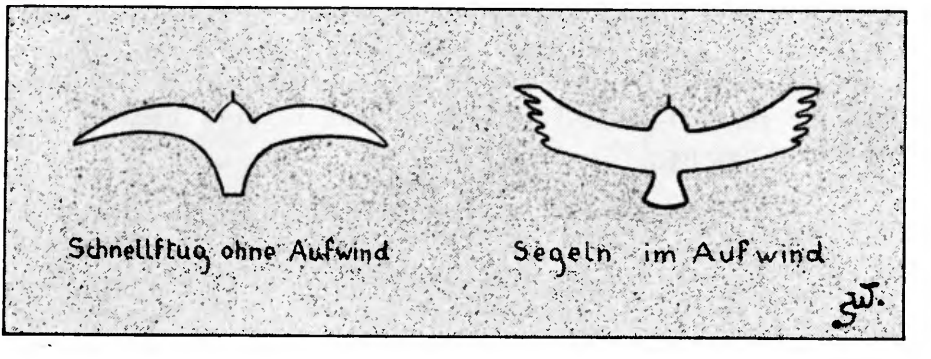
As first class trailers are now on the market for transporting a plane (which was formerly not by any means the case!) more and more sailplanes are being built with large wings made in two parts. In smaller types, the wing can be constructed of one single piece, whereby weight can be saved and manœuvrability improved.

In the same way as there can never be a question of power-flying versus soaring, so there can never be a dispute concerning small or large wing spans: both have the right to recognition and both solve special problems.

Small planes have already performed complete circles of ten seconds duration without much increase of sinking-speed, while their low cost has greatly contributed to the development of soaring as a sport. Large sailplanes, however, have a better chance in competitions owing to their low sinking-speed and better gliding-ratio.

A high flying-speed is of the utmost importance in cross-countries: i. e. the faster a plane can be flown without deterioration of sinking-speed or gliding-ratio, the better. Birds are much better off in this respect than we humans, for they can not only change their wing-area (which is at present almost impossible in sailplane contruction without additional weight*) but they can also vary lift and drag, as desired, by opening and shutting their pinions (slots). (See below.) Here again the sailplane designer has not remained idle. Already in 1932 and earlier, experiments were carried out with the same object in view.

The basic idea of this construction is to enable the pilot to fly as slowly as possible in upcurrents in order to make full use of them, and as quickly as possible in downcurrents in order to remain in them a minimum amount of time. It is to be hoped that new



How the birds do it.
High speed flying without upcurrents. Soaring in upcurrents.

designs will hold many a pleasant surprise in store for us in this respect.

The fact that thermal conditions exist in the best season for a period of only 6—8 hours a day has made it necessary to increase the speed of sailplanes in order to be able to cover as great a distance as possible in that given time. The designer has several means of achieving this. The simplest way is wing-loading, i. e. to increase the weight of the plane for a given wing-area*; this, of course, has the disadvantage of increasing the sinking-speed. By means of a proper selection of wing-section, however, and further aerodynamic improvements, as, for example, the building together of wings and fuselage (São Paulo, Rhönsperber, Minimoa) this disadvantage can be almost eliminated, so that in spite of increased speed owing to additional weight, the sinking-speed only imperceptibly deteriorates.

With my sailplane the "Moazagotl", which was built during the Winter of 1932/33, I had already attempted to compensate for the different thermal conditions during the day by incorporating a water-tank in the fuselage. For cross-country flying in strong thermals, I increased the speed of the plane with a 100 lb. waterballast; and towards evening, when the thermals weakened, let out the water, so that with the lower sinking-speed the plane could remain aloft for a much longer time. Like many other sailplanes, the "Moazagotl" is also fitted with adjustable ailerons of large dimension, which, with stick central, can be pulled either up for high-speed flying or down when it is desired to lower the sinking-speed. This arrangement has proved highly satisfactory in the course of some of my flights. For example, on a day when there was a very slight slope-wind and every inch of height became a struggle, I carried out the difficult Oechsenberg flight with my "Moazagotl" without water-ballast; while on a good soaring day with an abundance of thermals I made my record cross-country flight of 220 miles from the Wasserkuppe to Görlitz in Silesia with a 100 lb. water-ballast, which I dropped when the thermals abated towards evening between Freiberg and Dresden in Saxony.

* All the same, such machines have been built and flown.

3. Storm-Riding

Though not many thunderstorm flights have as yet been made, it is important that this method of cross-country flying should be thoroughly understood. The scientific explanation of the lift in front of storms has been somewhat altered or rather enlarged upon during the last few years. However, the following still holds good and will be found to explain adequately all that is necessary for soaring purposes.

If the "front" is still in its early stages, strongly developed and compact, it is a comparatively simple matter to allow oneself to be drawn along with it. It is far more difficult if the front splits and branches out in all directions. In every case, once having made contact with the storm, the main thing is to keep a clear idea of how it is progressing.

Special difficulties arise when trying to reach a front from the slope, as it is difficult to do this without having to fly through the "rolls" of cloud at its leading edge.

We know three ways of "making contact" with an approaching storm:—

1. By gliding straight into the lift (e. g. my flight with Lore in the 1929 Competitions).
2. By hill-soaring (usually on a slope situated at right-angles to the oncoming front) until the lift of the front reaches us. In many cases, of course, hill-soaring is impossible owing to lack of wind just before a thunderstorm.
3. By waiting for the first wind squalls, hill-soaring with them and then flying towards the thunderhead (e. g. Grönhoff's flight and mine in the 1931 Rhön Competitions). Using this method it makes a big difference how high the thunderhead extends above one's starting-point.

A much simpler way is to let oneself be towed up to the front by an aeroplane. This, of course, is the ideal method, as nothing is left to chance.

A few examples will show the best method of carrying out a thunderstorm flight. During my only partially successful flight of 20th July 1929, I was launched off the South slope of the Wasserkuppe long before I had had time to make myself thoroughly familiar with the weather conditions prevailing. Though I was lucky enough

to find the necessary lift in a projecting corner of the front and to rise rapidly to a height of 3.000 ft. above the Kuppe, I failed, owing to lack of experience, to get a clear idea of the course the storm was taking and consequently flew after the dying portion of the front and very soon had to land again. Kronfeld, on the other hand, who happened to take-off 10 minutes after I did, carried out the first systematic thunderstorm flight ever to be made and was the first to reach a distance of over sixty miles from the Wasserkuppe. But we will let him tell his own story:

My first Thunderstorm Flight

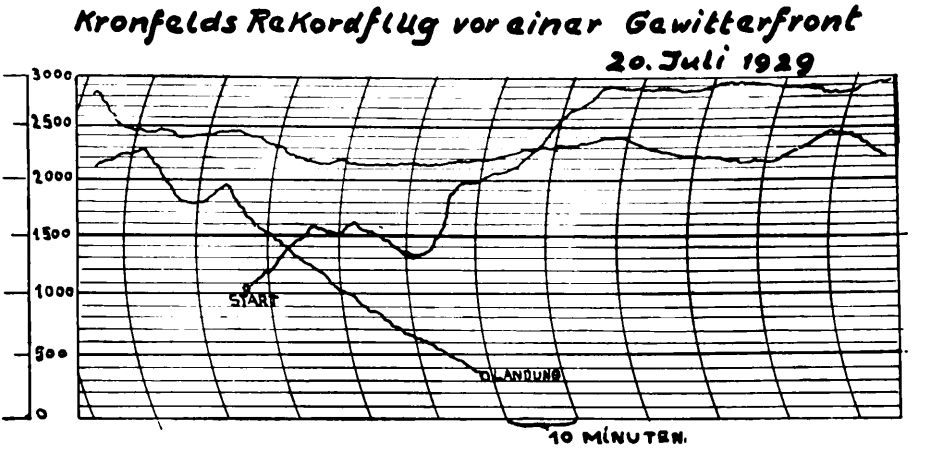
By Robert Kronfeld

No flights of any significance had been made on the morning of the third day of the Rhön Soaring Olympics of 1929. We had all taken off in spite of the unfavourable South-East Wind in the hope of winning the altitude prize which was the chief competition of the day and had fought hard along the South-East slope of the "Eube". Now and again we would find ourselves rising, but the next moment a down-squall from the Feldberg would come and fling us about wildly. It was really no fun, and I myself, finding it extremely unpleasant, came in to land after a comparatively short flight.

Shortly before noon, I was ready to take-off again, and was actually sitting in the cockpit waiting, when amid general cries of horror Grönhoff spun into the ground before our eyes in the Eube Forest. In order to avoid another plane, he had made a steep turn, and a gust of wind had thrown him into a vertical bank, from which he had been unable to extricate himself before striking the ground.

That kind of thing is nerve-racking. For the next three hours I stayed with my friend, who was fortunately unhurt; but what with the combined effect of the weather and this accident, I was in no mood for another flight that day.

However, shortly after 3 o'clock, I came out of Grönhooff's room to see what was happening, and on catching sight of me, the other competitors started running towards me full of excitement to tell me that Hirth was already 3.000 ft. above us in the face of a magnificent thunder-front. It will be too late for me, I said to myself, but nevertheless wandered on to the summit thinking that I might just



Kronfeld's record flight in the van of a cold front, 20th July, 1929.

have time, before the rain came, to try for the second prize of the day: a goal-flight to the nearby Ehrenberg.

The wind had dropped dead, and as I fastened on my parachute, I could not help thinking how ridiculous I must look in the eyes of the spectators for using one in such calm weather. However, I squeezed myself into my gallant "Wien", in which, owing to the fact that I was taking a parachute with me, there was even less room than usual.

So there I sat ready to take-off while the wind-speed indicator pointed with consistent malice to zero! As we waited, the storm drew ever nearer. Surely the wind must get up now! But no, not a breath! Suddenly the first big drops of rain fell, and the spectators fled in all directions. Still the wind-speed indicator refused to move! At last! 5–15–5–20 m. p. h., where upon I gave the word of command, and in a steadily increasing wind-speed of 25 to 30 m. p. h. made straight for the Ehrenberg.

The altimeter showed me that I was climbing steadily, so that it seemed unnecessary to tack over the slope. Up and up I soared, till by the time I reached the Ehrenberg I was almost on the same level as Hirth. Then I looked back. Behind me lay the whole "front", for its progress had been temporarily checked by the Kuppe, while ahead was the "Hohe Rhön". Flashes of lightning lit up the sky and the whole scene was incomparable in its grandeur. For a while I lingered, and as the storm rapidly overtook me, I wondered whether I should be able to maintain my position before it. At first it seemed that I should succeed in doing so.

The mass of the Rhön Mountains hindered the development of a regular front, and in the valley between the Wasserkuppe and Milseburg a few torn clouds would suddenly shoot forward, so that every moment I expected to find myself in the grip of the storm itself. Meanwhile the sailplane continued to rise, thus indicating the solution of my problem, for if I could rise above the storm, I ought also to be able to fly ahead of it a long way across-country.

It was not exactly pleasant, as the air was extremely turbulent and my plane was being flung about all over the place. The air-speed indicator had ceased functioning correctly at the first heavy downpour, and my goggles were so wet and misty that I had to discard them as useless. I was shivering from cold, as I was already at a high altitude; and I couldn't help thinking longingly of my coat which, owing to the closeness of the weather, I had omitted to put on over my shirt. However, all this did not worry me greatly at this stage of the flight, as there was so much to do and consider.

I had at once realised that today there was no question of slope-soaring. My "slope" this time was the thunder-front, which was assuming with ever-increasing rapidity the form of a mighty air-roller.

This first stage of the flight was really a race with the storm. The altimeter rose to 6,500 ft. and more, and as I drew near to Geisa, I gradually obtained a bird's-eye view of the whole front, which stretched from West to East and was moving rapidly Northwards. Below me tiny white clouds appeared like clusters of grapes — a "tell-tale" region of upcurrents. Obliquely behind me lay the white air-roller, but I was still rising. To the North the land lay bathed in sunshine, and down below through the dark grey-blue of rain in the rear of the storm, I could pick out scattered villages. In less than an hour I was high above Berka.

Hitherto I had flown a little in advance of the storm, and I now waited for it to catch me up. But it failed to do so, and somewhat uneasy I turned and flew North-West along the cloud-wall. This was the direction in which, as I later learned, Hirth had also flown. Soon I found myself above a curiously rounded cloud-peak, and on closer inspection noticed that it was motionless. Again I turned and realised to my dismay that some distance away the storm had split. One half, which was dying down, was moving Westwards, i. e. in the direction in which I had hitherto been flying, while the other was moving Easterly towards Eisenach and was already hardly visible in the dusk. Over Berka the weather had already cleared.

"If only I can manage to cross this gap", I thought, "I can keep going."

Once again I flew over Berka, but this time encountered unmistakable downcurrents. I pushed the stick forward slightly to gain speed: it seemed that I might still manage to reach that half of the storm which was moving away Eastwards. Owing to the division that had taken place, the front was partly scattered. Before me hung several huge black clouds, which I strove to avoid. Suddenly it grew curiously misty all around me, and I was reminded forcibly of my experiences of fog on the Kuppe, which on occasion would envelope the whole locality in a matter of seconds.

Visibility diminished rapidly, and soon I found myself in an impenetrable whiteness. Then began the most agonising blind-flying. The air-speed indicator was full of water and the whole plane dripped with moisture. At first I tried to hold a compass course, and for a time was quite successful. Then from a few mild oscillations the compass-needle suddenly began to spin madly. From time to time a heavy squall would shake the water out of the air-speed indicator's tube and the needle would cheerfully begin functioning again. Suddenly it jumped to 40, 45 m. p. h. I pulled the stick, but without effect; I pulled harder, only to find my speed was still increasing. The wind howled round about my "Wien", which groaned in all its joints under the strain. I was pressed firmly into the back of the cockpit, and even pulling the stick right back into my stomach failed to reduce the speed. At this moment, I felt really thankful to have my parachute with me, for I had never before known such a strain on my plane. Now, of course, I know that I was spinning; but in those days I was not a power-pilot, and acrobatics in a sailplane were unfortunately unknown.

All of a sudden the needle of my air-speed indicator dropped back to zero. I pushed the stick forward, and it seemed ages before I once more regained flying-speed. Then from out of the whiteness around me, I saw, like a dream-picture, fields and villages far below slowly revolving round the nose of the fuselage. Almost immediately the curtain closed again, and I flew onward for a seeming eternity. At last, however, it cleared and I once more found myself in level flight close under the base of a cloud. Beneath me lay Eisenach.

I had again approached the front which, as far as I could see, stretched away Eastward. Far below I saw the last spurs of the Thüringian Mountains, around which I knew that I had to fly.

Soon I found myself over a large town which I felt certain must be Gotha. I knew that part of the map by heart, because I had studied it for cross-country flights. By now I had learnt how far in advance of the storm I could fly without losing height and without

exposing myself to over-violent squalls. So, for a whole hour, I flew on always East to South-East.

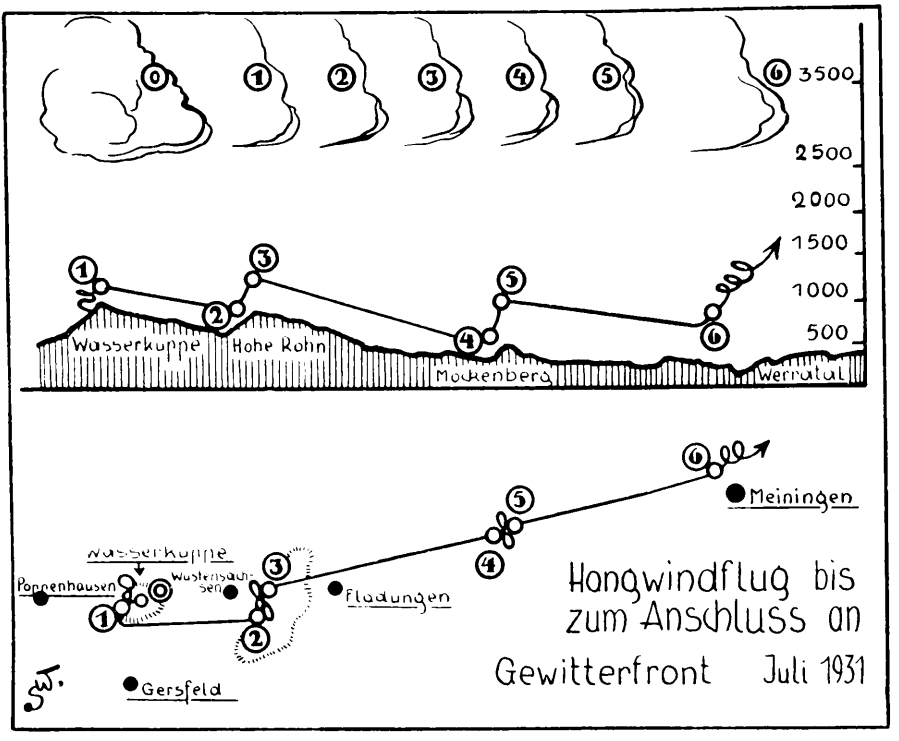
The water which had drenched my hair and run down my neck, was now making me feel very uncomfortable. My teeth were chattering and I began to wonder how long the flight was going to last. It went on uninterruptedly. Minor troubles like this, I thought, as I stuck grimly to my course, must often occur to pilots who fly long distances across-country in power-machines.

Sometimes huge clouds would form in front of the storm itself. I flew clear of these whenever possible; but though I was sometimes compelled to push through them, I found that I was now more competent at blind-flying than at first.

As far as I could make out, the town over which I flew must have been Erfurt or Weimar; but I was not sure which. The front now bent sharply to the South. It was already very late. Visibility was bad and growing steadily worse. Night was falling and I began to think it was time to make an end of the flight. Broad, partly wooded plains stretched before me: I was over unfamiliar country. I knew that the storm behind would soon reach me, so looked about for a building in which I might possibly be able to house my machine after landing. Then I noticed a town with a good landing-field nearby and large factory-sheds close at hand. I glided down and once more carefully inspected the whole place. The fluttering flags of a gymnastic display, which was being held there, showed me the direction of the wind and I could hear the crowd shouting enthusiastically. A short slip and I had landed in Hermsdorf near Gera, 90 miles from the Wasserkuppe!

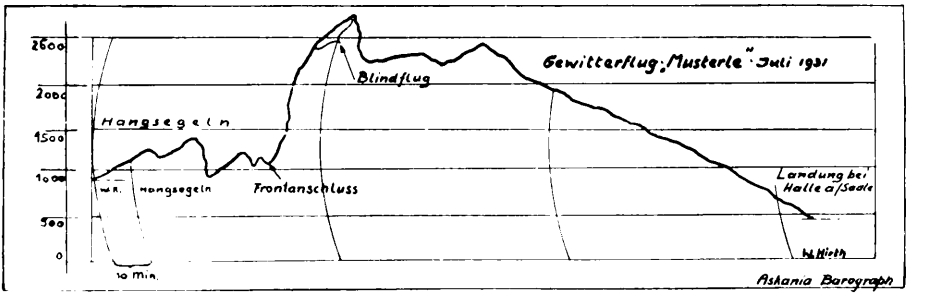
Some Remarks by Wolf Hirth

Somewhat different in character was the cross-country flight which Grönhoff and I made in 1931. This time we were the only ones out of twelve starters who were able to make contact with the front, which could easily be seen approaching from the West at a great height. As nobody attempted to go out to meet it, there was a general scramble to take-off once the storm set in. Height was quickly gained on the slope until it began to drizzle. This was the signal to wait no longer but to turn and fly downwind after the storm (Pos. 1). Behind the Wasserkuppe equally strong downcurrents were noticeable, so that, owing to much loss of height, it once more



a) Slope-soaring before contacting storm, July, 1931.
b) Hangsegeln: slope soaring. Frontanschluß: contact with storm. Blindflug: blind-flying. Landung: landing.

became necessary to cling to the Hohe Rhön (Pos. 2). The wind was literally too strong for slope-soaring. At Pos. 3 it began to drizzle again and I turned and flew downwind. (Compare, in the above diagram, each point of the flight with the corresponding position of the front.)



In the ensuing glide the downcurrents were particularly strong, so that most of those, who had been able to stay in the air until then, were forced to land. Grönhoff, however, who had taken-off about two minutes before the others, had, after an initial loss of height at last reached the steady upcurrents of the front, while I was once again forced to hill-soar. It is particularly remarkable that I was able to do this on a small slope, which in normal circumstances one would have overlooked. On observing the ground, however, it was apparent that the surface-wind had already reached a high velocity. Small trees were being bent over, wisps of hay were whirling in the air and trails of dust were sweeping along the roads. Everything was in motion.

Rapidly I gained height on this small slope (Pos. 4) and some time elapsed before it started to rain again. I had no difficulty in making up my mind what to do, as the air was extremely bumpy, and very soon I set off again in a long glide. This was accompanied by much loss of height until suddenly over the Valley of Meiningen* (Pos. 6) the turbulence ceased altogether and for a time a steady and increasing lift set in: I had reached the upcurrents of the front. After a few minutes I was able to cut in and out of the cloud. As it was not at all bumpy these short blind-flights offered no difficulty and could also have been carried out without any turn-and-bank indicator: just with a compass (see Figs. 14 and 16). Soon Grönhoff and I were flying together just in advance of the cloud-front. Grönhoff this time reached Meitzendorf near Magdeburg, while I landed at Friedeberg near Halle.

The outstanding points in this flight were:—

a. That smooth, exhilarating soaring is to be found just ahead of a cloud-front, and that one's height can be regulated by cutting in and out of the leading fringes of the cloud. This is a simple matter, because the air there is not usually turbulent (see Fig. 17).

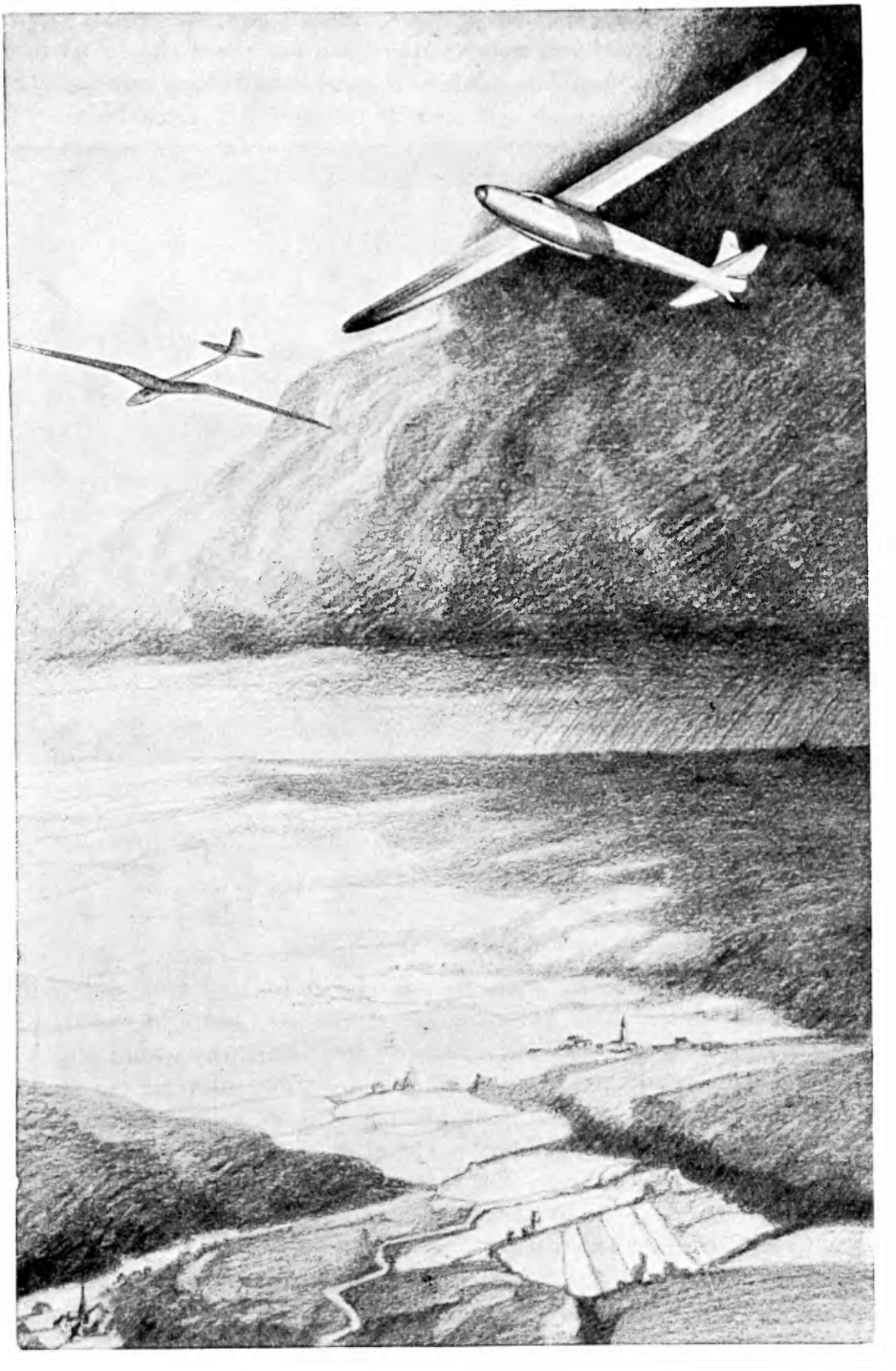
b. That in order to get a fair idea of the course the storm is taking, to see whether it is splitting and to avoid if possible so-called "air-rollers" which sometimes form very quickly, one should fly at least a mile or so ahead of the storm.

c. That it is essential to determine the direction in which the cloud-front is moving. In conjunction with this, one must ascertain the correct compass course enabling one to find a way out again, should one happen to get enveloped in a cloud.

Kronfeld wrote as follows: –

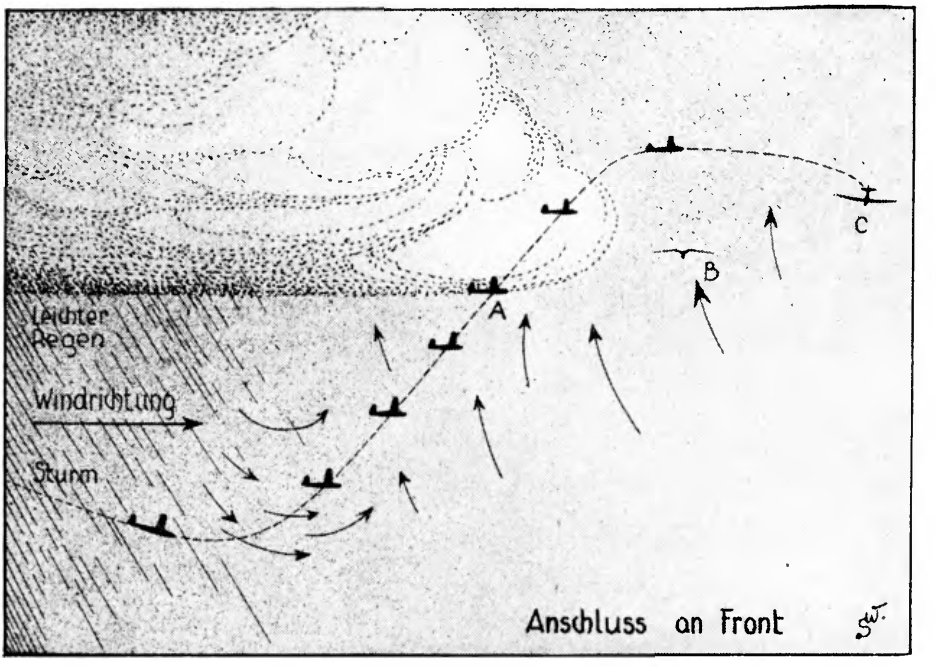
"A thunderstorm flight can be divided into three parts: the period

* Meiningen is an old town east of the Wasserkuppe.



"Fafnir" and "Musterle" storm-riding together.

of gaining height, the period of 'orientation', and the actual flight across-country." (Author's note: Experience has since shown us that yet another period should be added: that of establishing contact.)



Contacting a front.
Leichter Regen: light rain. Windrichtung: wind direction.
Sturm: storm.

The first thing to do is to fly on ahead of the rain and gain height. Once this is done, the ultimate success or failure of the flight will be determined by the pilot's ability to picture the whole phenomenon and correctly judge its development. An estimate of the speed of the oncoming front should be made as far as possible with map and stop-watch. It is, of course, essential to keep the ground in view when flying vertically above the forward part of the front. The pilot must maintain his position above the moving front irrespective of the actual wind direction at his altitude.

The cross-country flight itself is comparatively simple when once the pilot understands how to use this atmospheric phenomenon to his own advantage. One mile in advance of the front the air is not turbulent and perfectly steady upcurrents are prevalent. Height can

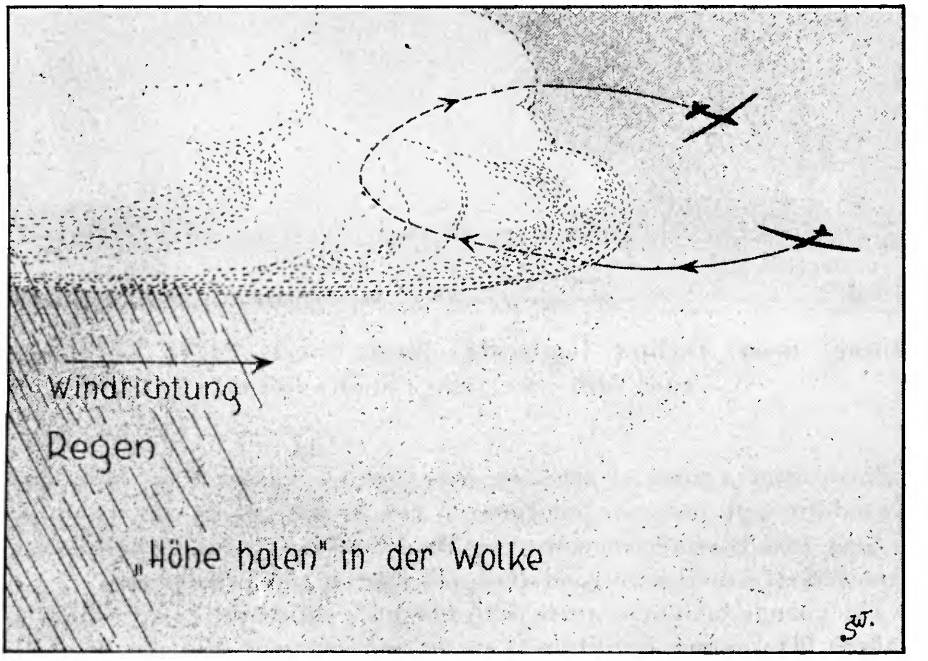
easily be regulated by moving nearer to or further away from the front.

Often the course of a front is not sharply defined, and it does not invariably approach from the West but may come from the East, as in the 13th Rhön Competitions 1932. Easterly fronts are not usually productive of flights of any importance, because they are nearly always short lived. It is sometimes possible to find a corner of lift somewhere or other, but it is unlikely to last very long.

The best way for the beginner to learn about thunderfronts is by observing them at every opportunity, whether he happens to be in the air or on the ground.

In brief, a thunderstorm flight offers beautiful and thrilling moments to the enthusiast; and with a well-defined front is by no means difficult to carry out, though it may be puzzling should the front change its shape or "air-rollers" form just ahead.

Unfortunately, fronts have one great disadvantage: they are comparatively rare, i. e. not nearly as common as thermal or cloud upcurrents, which are described in the following chapters.

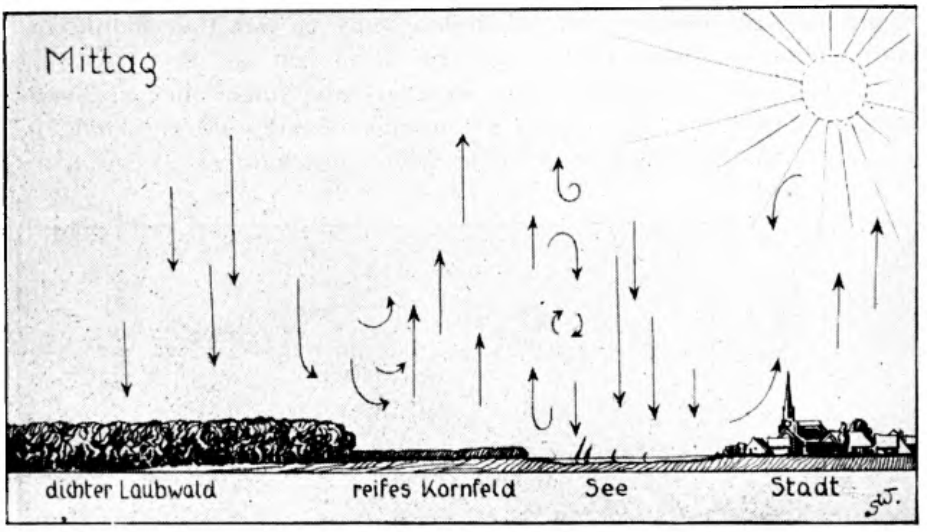


Gaining height inside cloud.

4. Thermal Soaring

The Formation of Thermals

On a fine morning, when the sun shines uninterruptedly on the earth, it heats the ground quickly or slowly according to the nature of the surface. Dry, sandy areas, cornfields, towns, etc. are rapidly affected by the heat, while water, woods and marshes take a long time to get warm. The hot, dry surfaces then impart their heat to the layer of air immediately above them, and this, being warmer and therefore lighter than the rest, starts to rise.



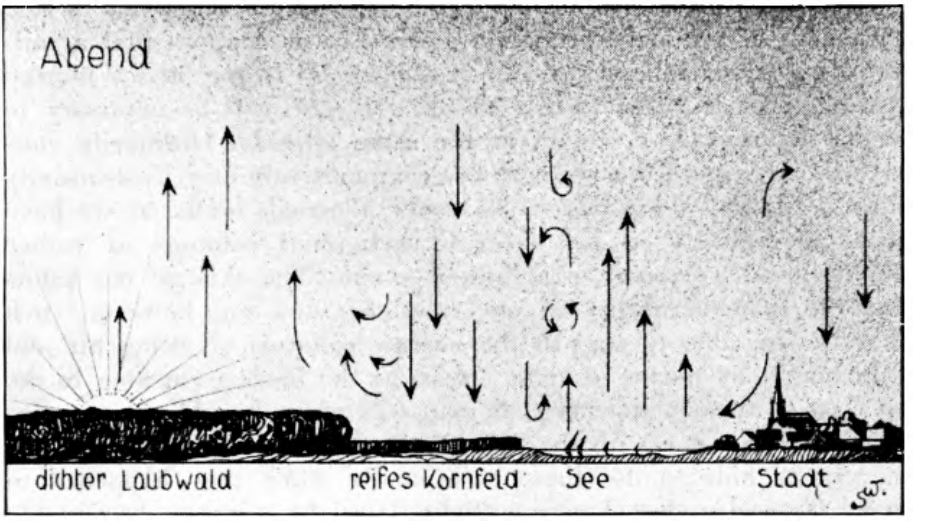
Mittag: noon. Dichter Laubwald: thick forest. Reifes Kornfeld: ripe corn. See: lake. Stadt: town.

Now, when a mass of air rises, its expansion causes it to cool. The heated air will, however, continue to rise in spite of its own cooling, so long as it is at all times warmer than the surrounding atmosphere. Under these conditions good thermal soaring can be expected.

The change of temperature with height is called the "Lapse Rate". Taking all weather conditions year in and year out, the *average* fall of temperature with height is 3.3°. per 1,000 ft. This is known as the "Normal Lapse Rate". However, as long as no condensation of moisture takes place it will cool at a uniform rate as it goes up, no matter what the condition or temperature of the air through which

it rises "en route". This rate of cooling can be very accurately calculated, and has been shown to be 5.6° F per 1,000 ft., which is known as the "Dry-Adiabatic Lapse Rate". In a thermal this dry-adiabatic lapse rate holds good as long as there is no condensation of moisture, but as soon as cloud-base is reached, the "Latent Heat of Condensation" of the rapidly forming cloud gives a new supply of warmth to the thermal. Condensation continues to take place as it goes on up, heat being liberated all the while; which means, of course, that the lapse rate is now different, and that cooling is less rapid than it was below cloud-base. This new rate is called the "Wet-Adiabatic Lapse Rate", and it *averages* about 3.1° F. per 1,000 ft.

Towards evening, when the sun's rays have become weaker, the



Abend: evening.

ground temperatures lose their differences, and later still may even become reversed. Lift is then to be expected where previously there were down-currents, and "vice versa". There are thus two distinct kinds of thermal soaring, both of which have been successfully exploited.

Day Thermals

The type of sailplane used in 1922 bore no comparison to the high-performance types we have been using since 1928/29, but it

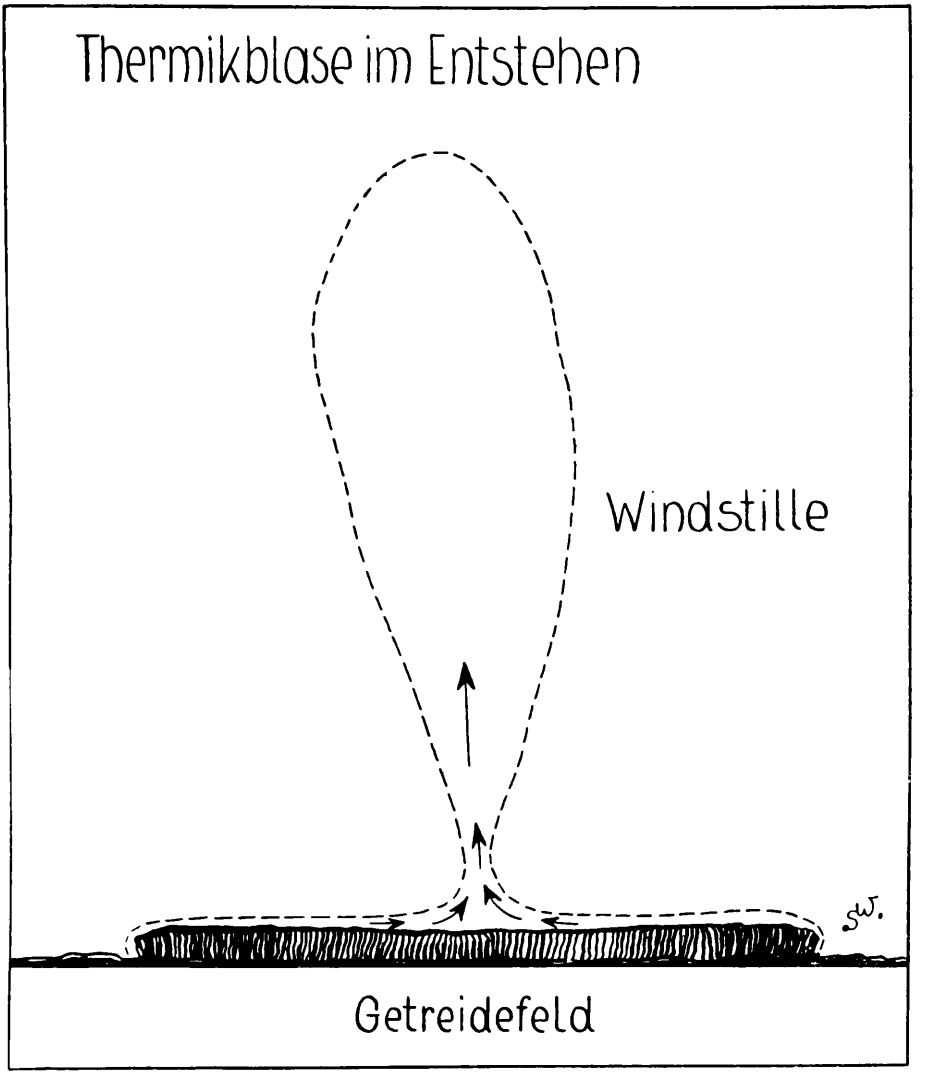
was at that time that Professor Georgii wrote in his book "Der Segelflug und seine Kraftquellen im Luftmeer" ("Soaring and its Sources of Power in the Air") after careful observations of soaring birds in India:—

"In our climate too one sometimes observes, in fine weather, birds beginning to soar at a height of 300 ft. after having risen above the lower layers of air. The question arises: is it possible for man also to utilise thermals? The even climatic conditions prevailing in the tropics, where light winds and intense heat are the chief characteristics, allow convection currents to develop to a far greater extent than in our part of the world. With us the wind varies so much in speed and direction that, owing to the resultant turbulence, the extent to which we can make use of upcurrents is very limited. The vertical wind forces are also not strong enough to enable one to soar by means of vertical upcurrents alone. Let us suppose that a sailplane has a normal speed of 40 m.p.h. or 60 ft./sec. and a natural gliding-ratio of 1:10; then a lift of 6 ft./sec. will be necessary to enable the plane to remain at the same altitude. Ordinarily convection currents of this strength are comparatively rare. Tests usually show a lift of only 3 ft./sec. Moreover, thermals occur, as we have seen, sporadically in the form of individual columns or rather bubbles, which expand to a limited extent. The skill of our pilots and the manœuvrability of our sailplanes are not, however, such that we are able to stay in the narrow columns of rising air and gain height by means of tight circles as the birds seem able to do. In view of this, it appears that man will never be able to soar for any length of time with the help of thermal upcurrents. One would merely be able to use them occasionally when they happened to make themselves felt during a flight. It might, perhaps, be possible to make some use of the fact that under single cloud-heaps steady upcurrents are to be found, for they can then be used as clues to the presence of rising columns of air."—

At that time, and also in later years, this opinion formed the basis of our efforts in the soaring world, until the scientific data obtained from actual soaring flights revealed the powers at our disposal and gave us great hopes for the future.

Success was eventually due to the discovery of the vertical air-current indicator, ultra-sensitive altimeter or "variometer". Kronfeld, advised by Herr Lippisch, was the first to use it to any great extent, with the result that he left his fellow-competitors far behind him in the competitions and became undisputed master in the art of utilising cumulus clouds. Here the upcurrents usually covered a comparatively wide area and were indicated by a cloud, so that it

was not necessary to adopt any particular flying technique. Where, however, pure thermal soaring in a much more limited area of lift was concerned, it was a different matter. Already in the Spring of 1930, Kronfeld wrote in his "Methodik":—



Formation of a thermal bubble.
Windstille: calm. Getreidefeld: cornfield.

"When flying in the upwind of a cloud, it seems to me that the only way to remain successfully within areas of lift, the cross-section

of which corresponds approximately to the outline of the cloud-base, is to circle continuously. The principle is none other than that used by a bird wheeling in a small, local column of warm, rising air. The relation between the size of the object in flight and the area of lift must, in both cases, be about the same."

Direct Sun-Thermals

In the early years, by far the most experience was gained during the Rhön Competitions. A West wind and clouds were necessary to break records. It is, therefore, not surprising that my first soaring flights in pure thermals, i. e. under a clear blue sky, were made in quite another part of the world, under entirely different weather conditions. This was at the first American Soaring Meet at Elmira in September 1930.

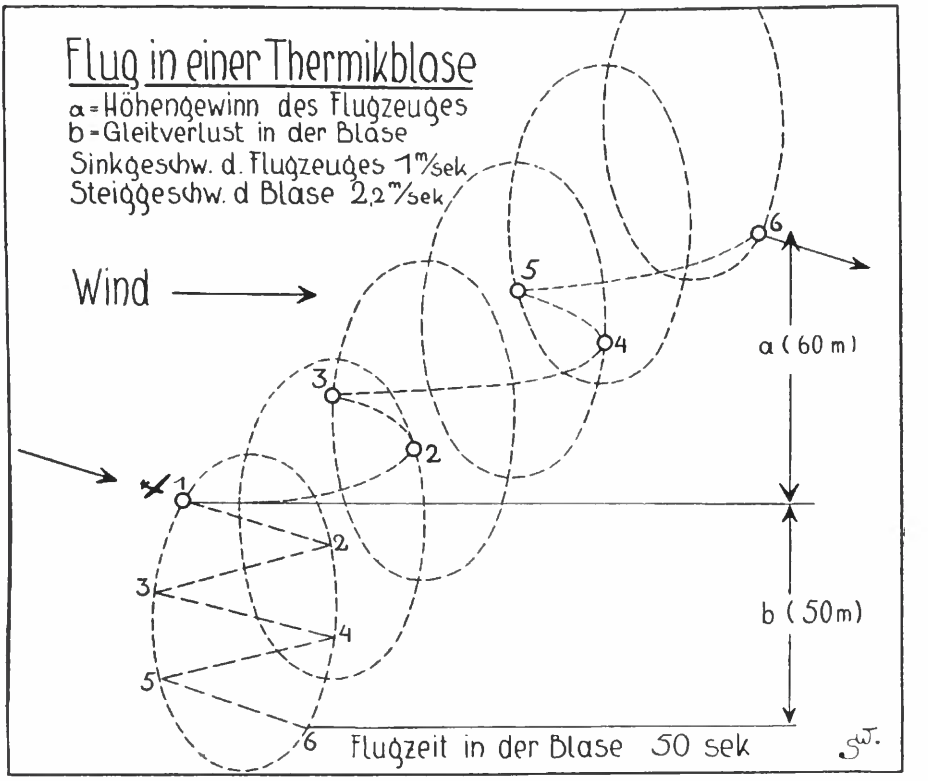
There we had mostly mediocre West to North-West winds and a cloudless blue sky. The country consists of wooded slopes with dry plains in the foreground. Moreover, Elmira lies at a more Southerly latitude than the Rhön: about the same as Rome. Two other favourable circumstances were of great help to me: I was by this time quite clear on the question of relative air-currents and for the first time I had in my plane a variometer. I had previously experimented with this instrument in my Klemm monoplane but had obtained no very definite results.

In the Rhön considerable comment had already been caused by the fact that inferior sailplanes sometimes rose higher when hill-soaring than other planes of superior design. This was usually ascribed either to a better pilot or to a local freshening of the wind. But in Elmira the differences were too pronounced, and it was the variometer that at last helped to clear up the matter.

After many hours of flying-time I had a fairly accurate conception of thermal upcurrents, and for the first time in the history of soaring I at last took advantage of a day when the weather conditions were particularly favourable to circle tightly using the variometer as a guide. As a result my "Musterle" spiraled steadily up to 3,000 ft. above starting-level (see Fig. 27 and "Flying High").

One reads and speaks of thermal "chimneys", "channels" and "columns". In most cases it would, perhaps, be more correct to imagine the thermal upcurrent as a bubble or invisible air-balloon, in motion probably similar to a ring of smoke. The air becomes warmed and accumulates over patches of ground which have been heated by the sun, until it breaks away at intervals varying according

to the wind-strength, the heat of the sun and the nature of the ground-surface; this warm mass of air then floats upwards and drifts away with the wind.

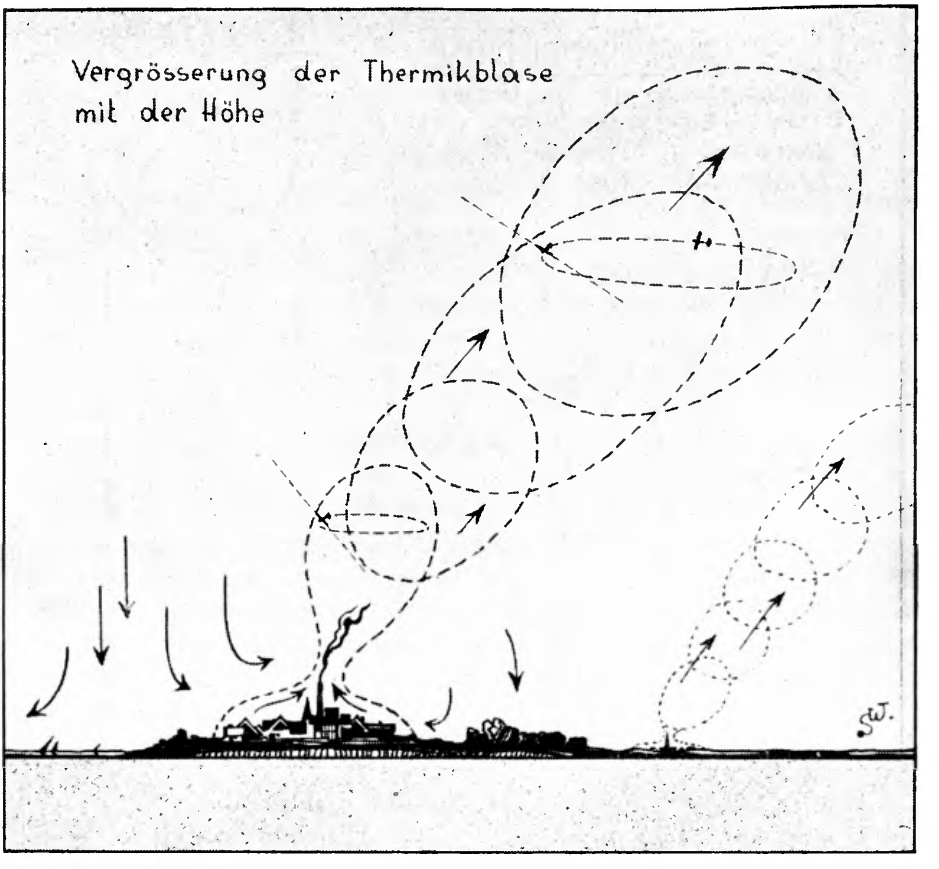


Flight in a thermal bubble.
a) Height gained by machine. b) Loss of height (owing to sinking-speed of machine) in bubble. Sinking speed of machine: 1 m./sec. Rate of ascent of bubble: 2.2 m./sec. Flugzeit in der Blase: flying time in bubble.

In the course of a four hour flight in pure thermals in Buenos Aires in 1934 I could definitely notice a 10—15 minute periodic liberation. I flew nearly the whole of the four hours over the same patch of ground and found myself regularly after every quarter of an hour in a rising column of air. On the other hand, I myself have never yet been able to discover a continuously rising column lasting for hours on end.

The rate at which the air ascends in a thermal is always proportional to the temperature of the layers of air through which it rises; eventually the bubble, which has gradually been cooling,

ascends less quickly until it finally ceases rising altogether (see Georgii, Flight Meteorology, P. 104). An inversion* could naturally cause all movement to cease at a very early stage



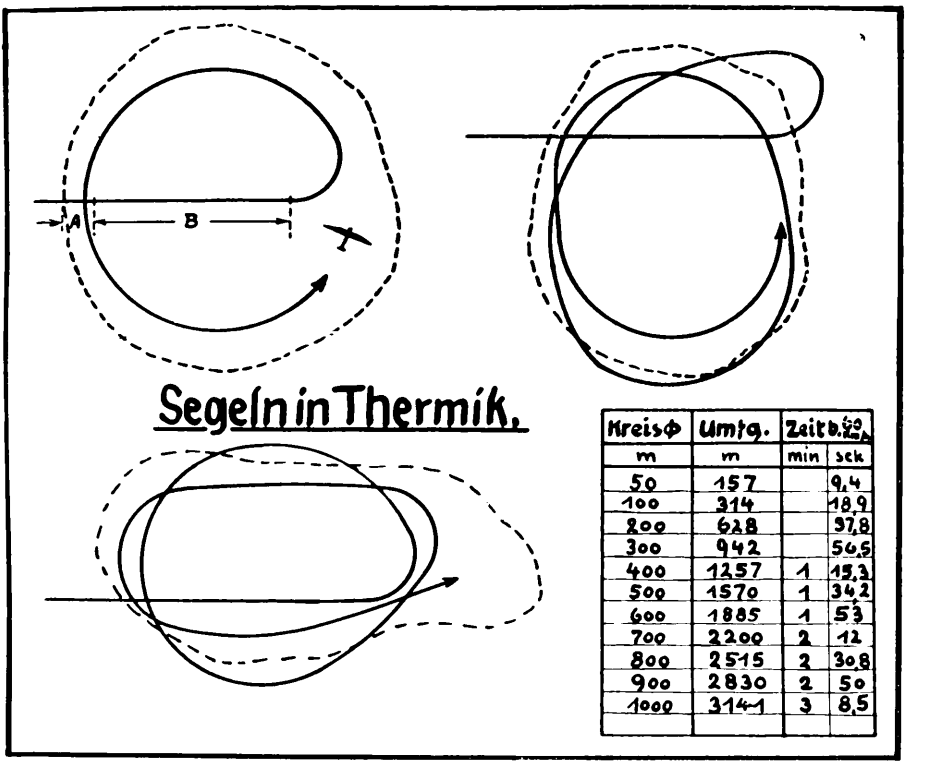
Expansion of thermal bubble with height.

Since a sailplane always "glides" in relation to the surrounding air (i. e. loses altitude owing to its sinking-speed) it cannot ascend quite as fast as the bubble itself, which slowly overtakes it. Fig. 22

* In certain conditions, temperature may actually increase with height forming an "inversion". Inversions occur at the top of a fog layer and generally above stratus clouds. They inveriably imply thermal stability of the atmosphere and absentee of appreciable turbulence. Near the ground an inversion is most readily produced during a dear night in Winter, when the great cooling of the surface chills the air in contact with it to such extent that its temperature falls considerable below that prevailing in this atmosphere a few hundred feet up.

depicts a comparatively small bubble, and only those with considerable experience would be able to make full use of it.

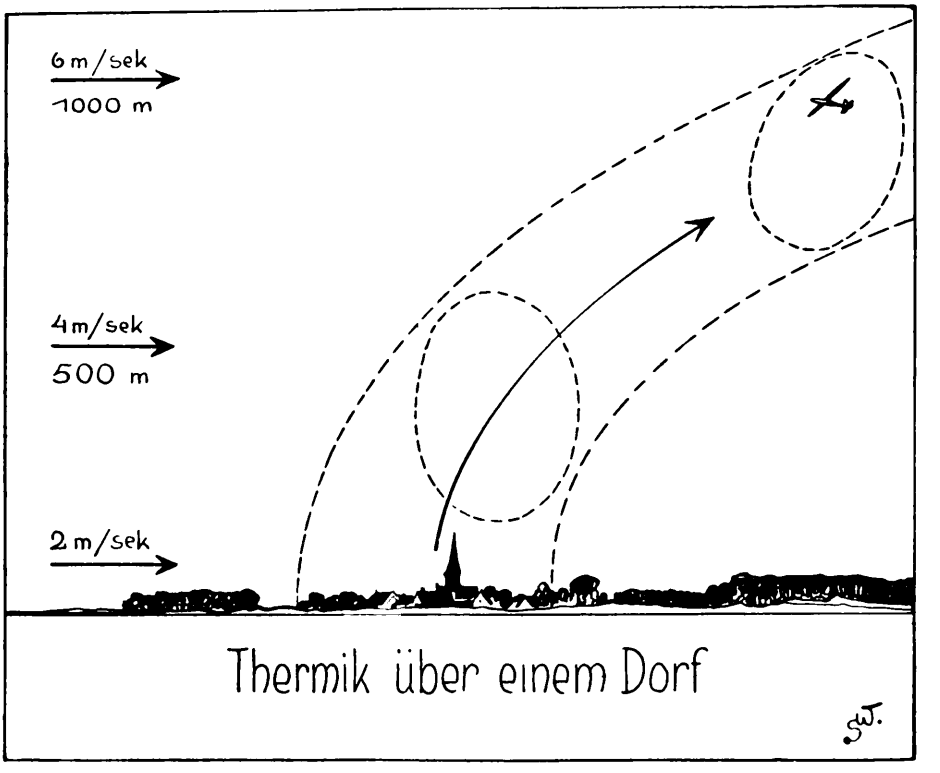
We can now see why a sailplane, flying 300 ft. below another one, need not necessarily feel the least trace of lift, even though the plane above it may be circling steadily and rapidly gaining height. The reverse is, of course, equally possible, except that in this case it would usually be worth while for the plane above to wait for the thermal to rise to its level. (As a matter of fact,this has often happened when I have flown across-country, and time and again the "other fellow" has been a soaring bird.)



Thermal soaring.
Kreis ⌀: diameter. Umfang: circumference. Zeit: time.

In order to determine as accurately as possible the diameter of a bubble, I made what were the first successful experiments in Grunau in the Spring of 1931. Circling steadily at the rate of 40 m. p. h. and keeping my eyes on the nose of my plane, I measured with a

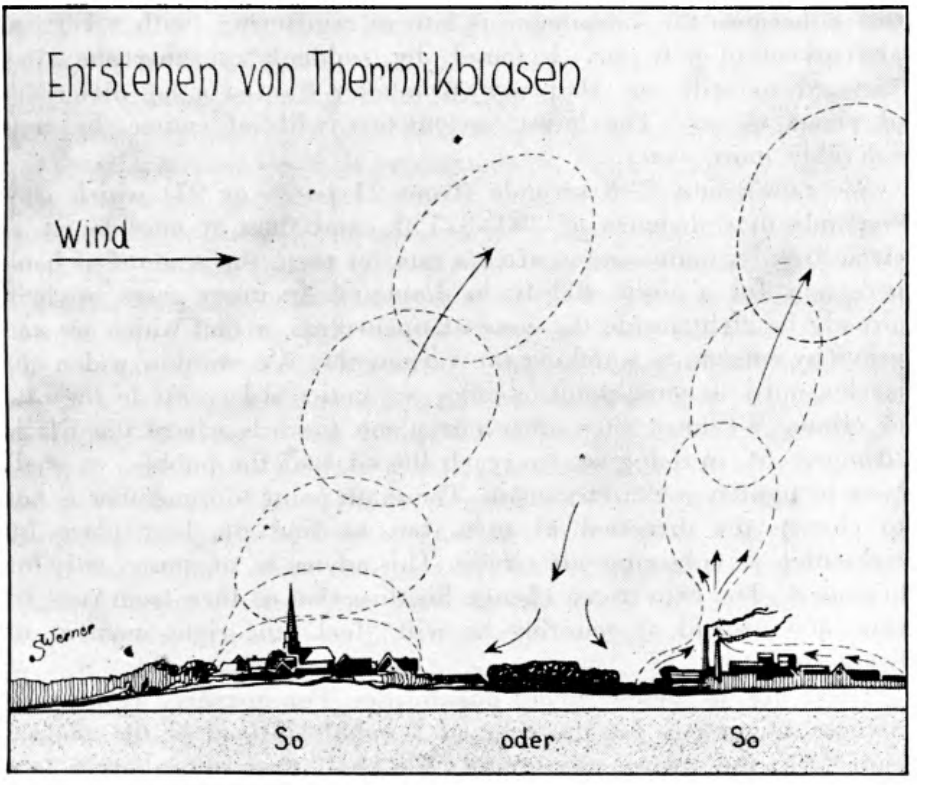
stop-watch the time it took to complete a circle at various heights. As a landmark over which to make my circles I chose the glistening surface of the water by the dam in Bobertal. At lower altitudes the average time taken to complete circles 3—400 ft. in diameter was 18—25 seconds. In the same bubble, higher up, it was possible to make considerably larger circles with diameters of up to 1,000 ft. and taking 50—56 seconds to complete, and yet still remain in the area of lift (see Fig. 23). At other times, circles 13—1600 ft. in diameter were completed without even reaching the edge of the area of lift.



Thermal over a town.

Lately, other observers have also "timed" circles in this way. At the 13th Rhön Competitions, for example, Dr. Slater of London recorded the following times from the ground:—Riedel: 38—48 secs., Kronfeld: 40 secs., Hirth: 21, 25, 35—45 secs. These times related to circles 350—800 ft. in diameter. On 18th December 1932. Paul Krekel

made some interesting test-flights with a sailplane in Böblingen, when, at an average speed of 35—40 m. p. h., he made circles of 20—26 secs. duration. The corresponding diameters of 350—450 ft. were very good for a sailplane with a wing span of 70 ft. Finally, on 13th March 1933, I accomplished circles of 17—10½ secs. duration. Here, however, the sinking-speed was certainly greater than could be desired. In May 1935, I also managed to make a good soaring flight with a Grunau Baby II by making very tight circles after a winch-launch to a height of 650 ft. By making a series of similar circles, 11—12 secs. duration, I spiralled with a lift of 8—10 ft./sec. to over 3,000 ft.



Formation of thermals.
Something is wrong with the picture. What is it? (The smoke!!)

It is always advisable to make as large circles as possible, since tight circles increase the sinking-speed of the machine. However, in many

cases, it is often preferable, especially at low altitudes, to make certain of the lift by making tight circles—and in consequence gain height more slowly—rather than to risk losing the bubble altogether, This can be done very profitably in good strong thermals ascending at say 10 ft./sec. (If the plane has a sinking-speed of $2\frac{1}{2}$ ft./sec., the variometer will then show a lift of $7\frac{1}{2}$ ft./sec.) Ludwig Hofmann attributes his many successful flights to this "tight-circle" technique.

Now what does thermal soaring by means of this circle technique look like in practice? (See Fig. 24.) Suppose we are flying straight ahead at the rate of 40 m. p. h. and are at the same time keeping a steadfast eye on the variometer. Suddenly our variometer shows us that we are beginning to rise, but by the time it does so we shall have already flown through section "A" in the thermal (see Fig. 24); this is because the variometer is late in registering (with a vertical air-current of 6 ft./sec. I found, by suddenly pushing the stick forward in still air, that my variometer showed a lag-difference of about $\frac{1}{2}$ sec. The latest variometers will, of course, be considerably more exact.).

We now count 5—6 seconds (from 21 to 26 or 27) which corresponds to a distance of 300—325 ft., and then at once begin to circle tightly, maintaining, after a quarter turn, the amount of bank necessary for a circle 400 ft. in diameter. In many cases, we will already be right inside the zone of upcurrents, a fact which we can prove by constantly watching the variometer. We can now widen our circles, until, at some point or other, we notice a decrease in the rate of climb. We must then steer our plane towards where the lift is strongest; if, in doing so, we reach the edge of the bubble, we shall have to tighten our circles again. The main point to remember is not to change the direction of turn, but to find the best place by tightening or enlarging our circles. This advice is, of course, only for beginners. The expert can change his direction of turn from time to time and instead of counting he will "feel" the right moment to begin circling.

There are, of course, many possibilities. For instance, we may be unlucky enough to hit the edge of a bubble instead of the middle and circle the wrong way round. We shall then immediately lose height and should quickly circle in the opposite direction (see Fig. 24). A keen sense of direction is of great value; while prominent landmarks and the position of the sun are very helpful.

In the 1931 Rhön Competitions, I began to regulate my circles with a turn-and-bank indicator. But it must be correctly adjusted, so that its movements will be neither too weak nor too violent when the air is turbulent. This "co-ordination" is, of course, not necessary

for thermal soaring, but it will be found useful for circling in clouds, provided one has first of all accustomed oneself to flying with it in the open.

When searching for thermals, close observation of the ground can be misleading, especially when flying at a high altitude in a strong wind. A number of experiments have proved, however, that over large cornfields, dry moorland and towns there are almost bound to be thermals. The "heat" emanating from the town of Ilmenau has helped me on two occasions, and if it had not been for the huge cornfields near Limburg-on-the-Lahn I would never have reached the Rhine in the 1931 Rhön Competitions. On the other hand, I remember with mixed feelings the complexities of the large wood between Bunzlau, Sprottau and Sagan, which, when flying Northwards from Grunau to Berlin, destroys a desirable continuity of thermal effects. Of course, we must never forget to allow for the drift of a bubble, owing to which there is often a considerable difference, especially at high altitudes, between its actual position and the place from which it originated.

Soaring birds are always reliable, and we meet them far more often than one used to imagine; while butterflies and other "involuntary" soarers also occasionally show us where lift is to be found.

Twice I have encountered flights of swallows, presumably in search of food (i. e. chasing the insects that had been drawn upwards), whereas birds of prey presumably fly for sheer pleasure at this height (sometimes 6,000 ft. above the earth), unless they happen to be migrating. In view of this, I have always longed to take a "trained" buzzard with me to help me find upcurrents when necessary! I do not know whether this would be practicable. Unfortunately, I myself have not time to make the experiment.

On very windy days thermals are not very effective over flat country, because what heat there is has to be distributed over a large expanse of air. Over hilly country, conditions are much more favourable, because the movement of the air in the valleys is more confined, i. e. the warm air can accumulate to better advantage. The most favourable conditions for cross-country flying are found on days with a slight surface wind but with a great wind velocity at the higher altitudes, which the upcurrents will enable us to reach.

If, on windy days, we find very small thermals, taking only 2—3 seconds to fly through, the only thing to do is to climb with the stick, pulling the plane up to the slowest possible speed, so as to keep it flying in the lift-area and gaining height for the longest possible space of time. It is no use trying to circle, because we cannot do so sufficiently tightly to remain within the circumference

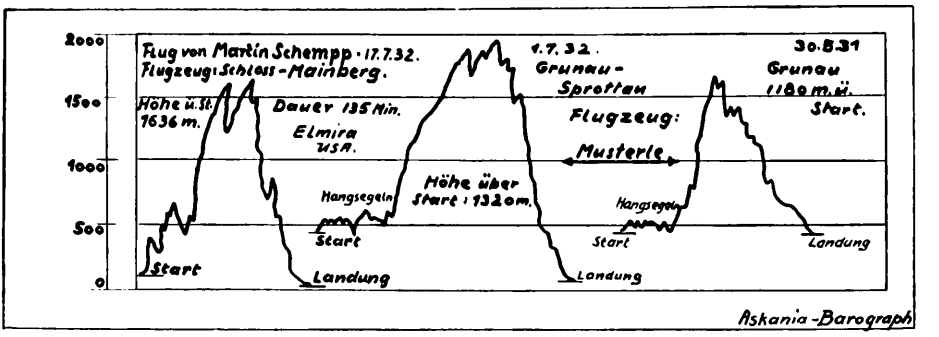
of the thermal. In downcurrents, on the other hand, the stick must be pushed forward in order to get away from them as rapidly as possible. On cross-country flights I have of late pushed the control column forward to a speed of over 60 m.p.h., though in doing this there is always the risk of shooting unawares through upcurrents that might have proved useful. This speed is possible for planes with a normal flying-speed of 35—40 m.p.h.

The last two years have shown plainly that it is far easier to find thermals after an aero-towed start rather than by using the arduous method of beating up and down the side of a hill to gain height or by being winch-launched off a field in flat country. Two facts should make this clear:—

1. Aero-towing enables us to be towed up to a greater height than does bungy-launching, auto-towing or winch-launching. This gives us more time in which to look for upcurrents and therefore enables us to explore a wider area.

2. If we are flying, say 3,000 ft. above the ground, we have more chance of making contact with a thermal bubble, 1,500 ft. from top to bottom, than if we are flying over flat country at a height of only 300 ft.

However, this makes one case hard to explain: my thermal flights in Grunau of 30th May 1931 and 1st July 1932 (see Fig. 27). In these



Three thermal flights from a slope.
Flug: flight. Flugzeug: machine. Höhe: height. Dauer: duration. Hangsegeln: slope soaring. Start: starting point. Landung: landing. Höhe über Start: height above starting point.

two flights it must be taken into consideration that though I began thermal soaring, i. e. circling, some 150 ft. above starting-level, the launching-ground itself was 350—500 ft. above the adjoining valley. The liberation of the thermal probably took shape as in Fig. 28. Over completely flat country the elongated bubble would not have

been blown upwards at an angle. This concurs with another experience of a long thermal flight after a winch-launch at Küstrin on 21st June 1932, when, after releasing the cable at 400 ft., a maximum height of 2,200 ft. was reached with a lift of 6—6½ ft./sec. Then the bubble passed on and, owing to the sinking-speed of the plane, there was no time in which to find another one with sufficient lift.

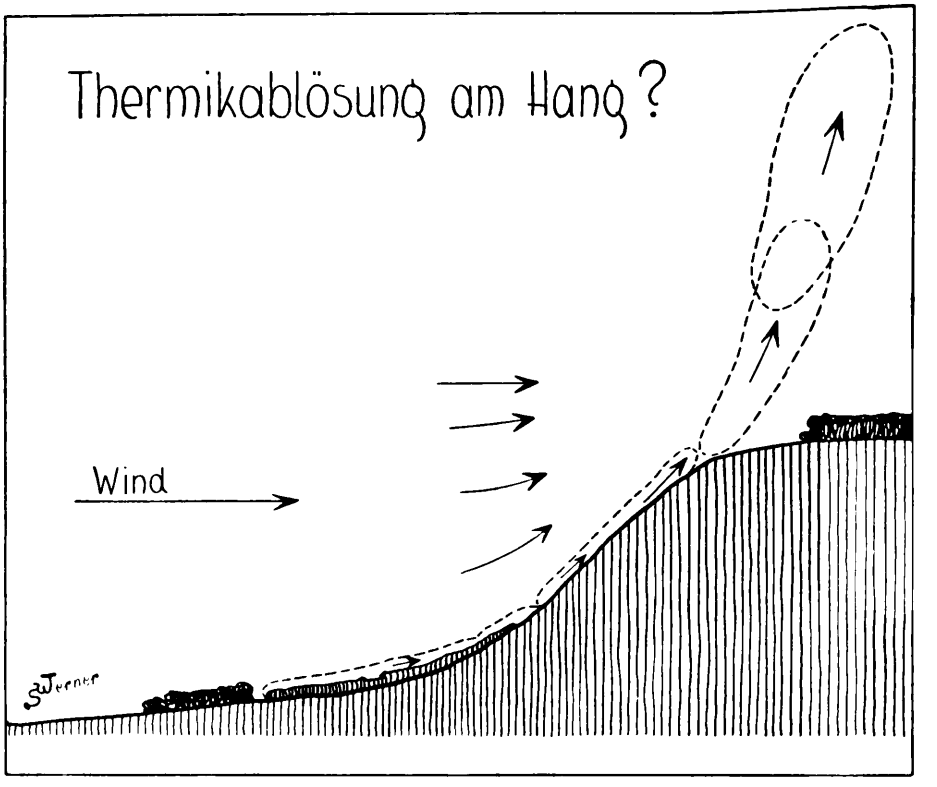
Regarding the amount of lift in a thermal, I have most frequently found 5—8 ft./sec. Over Berlin I once found a lift of 13 ft./sec., and over the Valley of the Werra near Meiningen 15 ft./sec. On cross-country flights, however, it sometimes pays to remain within even very weak thermals that only compensate for the sinking-speed and cause the needle of the variometer to rise no further than zero.

A problem now arises: how and when to leave the slope-wind? That it is not easy to recognize the right moment was proved by the many abortive attempts made by young sailplane pilots at the 1932 Rhön Competitions, and it is a thing that can only be learnt by experience. The rule for beginners should be to continue slope-soaring until the variometer indicates that the plane is rising at 4—6 ft./sec. as compared with a previous —1 to +1 ft./sec. The thermals will then usually have sufficient expansion to enable one to defeat the downcurrents on the lee-side of the hill. If, after making a few circles, the lift should then diminish, it is advisable to fly back to the slope and wait for another one. Here again, it is often a great help to keep an eye open for soaring birds or other sailplanes also in the air.

And now let us consider the seasons and times of day:—

If we are only flying for fun or to put in some practice, it is best, conditions being normal, to fly between 11.0 a.m. and 5.0 p.m. If, on the other hand, we want to stay up as long as possible, we can, in these latitudes, occasionally find thermals as early as 9.0 a.m. Not many systematic tests have as yet been made in this respect. It is advisable for beginners not to take-off too soon, especially in Competitions, but to wait until after 11.0 a. m. when the thermals are more reliable.

In the tropics, thermal soaring is very little different from what it is here, but the horizontal wind-currents are not nearly as strong or as lasting, so that long-distance record flights are out of the question. On the other hand, it is possible to soar almost the whole year round. Also, the tropical conditions are particularly favourable for altitude records, because the absolute temperature at which ice forms when cloud-flying is reached at a much greater height. The influences of sea-breezes are a much greater hindrance in the tropics



Liberation of thermals over a slope? e. g. West Slope of the Wasserkuppe and South Slope of the Galgenberg Mountain, Grunau.

than over here, for they confine the vertical air-currents near the coast to a very low altitude. This became unpleasantly noticeable during our South American Expedition to Rio de Janeiro.

May—August are the best months for thermal soaring in our part of the world, though many a successful thermal flight has also been made in April and September. The seasons are, of course, different in different hemispheres. In North America, for example, the so-called "Indian Summer" provides excellent thermal conditions in October.

Winter Thermals

During the Winter months of 1935 it was often rumoured that somebody or other had flown for the first time in Winter thermals.

But as early as 1932 I wrote in the first edition of this book:— "Some of my readers may remember that on 10th March 1931 I made a soaring flight over New York." (See Fig. 29.) The incentive to this flight was the hope of being able to maintain height in the "artificial" thermals of New York. The idea first came to me when, on my return flight from Florida in December 1930, I found a dense cloud over New York, whereas everywhere else there was not a cloud in the sky. If there is any place in the world with sufficient "artificial" heat for soaring, that place is New York! Here, as was the case with my flight in evening thermals, a comparatively small horizontal surface will radiate a great deal of heat: millions of people, thousands of cars, hundreds of sky-scrapers centrally-heated day and night, railways and undergrounds, all warming the air over Manhattan Island! These artificial thermals will give an impetus to the unstable air-masses and force them to rise.

Unfortunately, I was unable to carry out my plan, because aerotowing for my high-performance sailplane was at that time prohibited in the U.S.A. True, I managed to climb to 1,000 ft. after being catapulted into the air, but before I could fly over the middle of the town, the police signalled me to come down and land. However, even this short flight was sufficient to show that artificial thermals cause the air to rise, as was proved by many a later flight, especially in the Winter of 1934/35.

One Sunday in March 1935, the well-known airman Karl Bauer was towed up in a Grunau Baby, and in spite of the fact that the sky was completely overcast, found sufficient lift to enable him to make a good soaring flight: a thing that nobody had ever been known to do before. To the astonishment of his friends, he circled steadily and despite the dead calm and clouded grey sky stayed nearly half an hour in the air.

Soon after he had left the ground I also took-off in my "Musterle," with which, in 1931, I had already attempted the first Winter thermal flight over New York. After releasing the cable, I also rose steadily, and not until I had been in the air for 2 hrs. 18 mins. did I return to the Hornberg. This flight was the first time in the history of the Hornberg Gliding School that anybody had soared in Winter without the use of hill-lift. That neither of these feats was a matter of luck was proved by the fact that thirteen other pilots were also able to soar for periods ranging between half an hour and one hour.

A few weeks earlier it had also been proved possible to fly across-country with thermals even in the cold season. On 8th February, Heini Dittmar, Germany's world record-breaker, was towed up from Griesheim and landed near Neustadt-on-the-Haardt after a flight

lasting 1½ hrs. and having covered a distance of 40 miles. At the beginning of March, the well-known sailplane pilot Ludwig Hofmann flew from Darmstadt to the Luxemburg frontier with his Rhönsperber, a new design of Hans Jacob's, in just 2 hrs. covering a distance of 88 miles.

Hans Fischer from Darmstadt had perhaps the most interesting experience of soaring in Winter thermals in his sailplane the "Windspiel", when he made a carefully planned goal-flight from Darmstadt to Saarbrücken. The flight required much experience to be carried out successfully, as the thermal conditions were not of the best: many a cloud that seemed to promise good soaring facilities would suddenly disperse, there were hardly any ground-thermals, and the prevailing weather conditions in the flying area were rain, snow and hail, so that sometimes he was forced to fly in dangerous proximity to tree-tops and mountain-peaks.

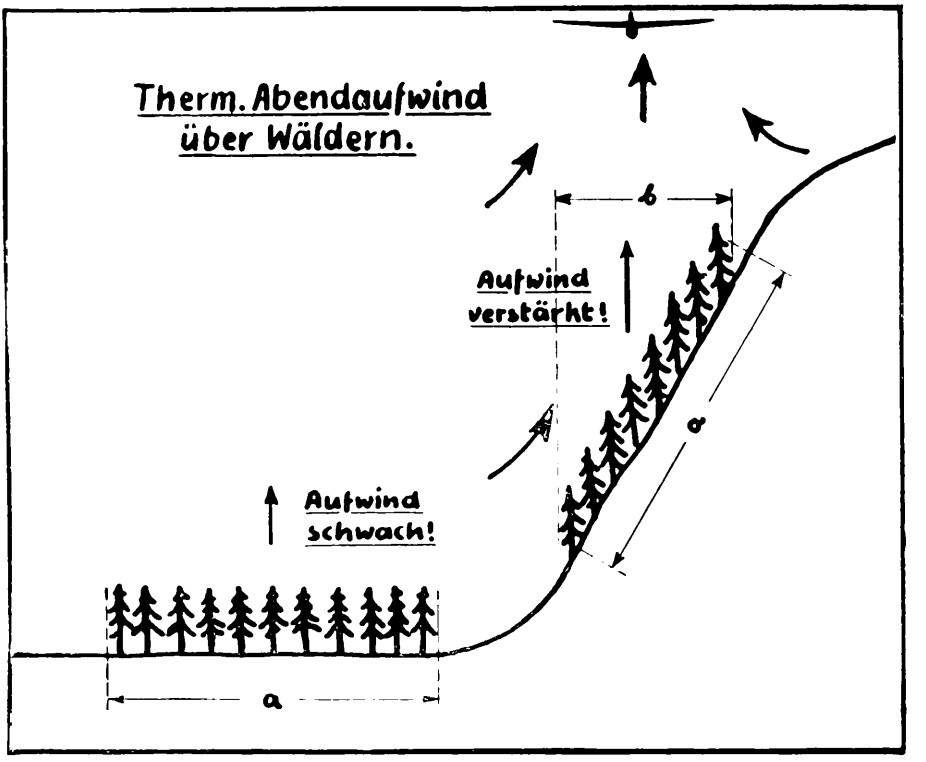
Fischer took-off at 11.15 a. m. from Griesheim. After being towed up by an aeroplane, he released the cable while still very low and soon found that he would have to fly with an open cockpit in order to equalize the temperature inside the cockpit and out, as the window-panes had grown thick with moisture. He followed the railway-line as far as Kaiserslautern at an average height of 4,000 ft. The most difficult part of the flight was in the vicinity of the Donnersberg mountains. It would have been foolhardy to climb any higher, for in snow-clouds the danger of icing-up is too great; also it is no fun circling upwards at a temperature of 10^0 below zero. He then flew through two strong downdraughts and lost some 2,000 ft. As he had forgotten to take a map with him, he had to rely entirely on his sense of direction, and over Neunkirchen he wondered for a moment if he had already reached Saarbrücken. No, not yet! But shortly afterwards he saw the name clearly printed on the roof of the hangars, and he still had 4,000 ft. in hand! What a thrill! Hans Fischer let off steam by "aerobatting" down, and after a series of "loops" and "rolls" soon landed on the aerodrome, where a warm welcome awaited him.

To all those who for ever sustain a longing to emulate the effortless flight of birds, I would commend this wonderful art of thermal soaring. It is undoubtedly the most delightful form of motorless flight; and though turbulent conditions may sometimes cause anxious moments, speaking generally it is neither difficult nor dangerous; while in having the freedom of the clear blue skies, there is also the added interest of the continual search for new upcurrents.

Evening Thermals

The use of these was first demonstrated by Nehring, who, in 1926, soared with the help of such thermals in a wind that was of itself not strong enough for hill-soaring. In 1930 I succeeded in soaring for one hour in America (Elmira) with pure evening thermals on an absolutely calm day.

During the day a light breeze, which had been blowing over the dry ground at about 5—6 m. p. h., had "heated" the South Hill at Elmira. The upwind had been just sufficient to prolong the time taken to glide down into the valley from three to five minutes.



Evening thermals over woods.
Aufwind schwach: weak lift. Aufwind verstärkt: lift increasing.

When I took-off some ten minutes before sundown, the ground temperatures had already become reversed. While the cool air over the flat valley was sinking, the woods began to radiate some of the heat which they had accumulated. Over the slope a pure upcurrent

had developed, which was sucking in air from its surroundings and even created a slight tail-wind on the starting-place. It was therefore all the more puzzling to the uninformed spectators how I was able to stay in the air for a whole hour until nightfall.

Though the slope-wind did not play any role in this flight, the fact that the slope was wooded was the main factor contributing to its success. I do not know of any instance where this type of evening thermal over flat, wooded country would have sufficed to hold a fully-loaded sailplane in the air. However, on a hillside, where the same wooded area "a" has a smaller horizontal projection "b" the lift can increase in strength until it becomes sufficient to enable a sailplane to soar (see Fig. 20). Other factors have, of course, also to be considered, such as the angle of the sun's rays on the slope in the daytime and in the evening, the surface of the land both in front of and behind the slope, and the absence of other woods in the neighbourhood.

Even though it may seldom be possible to soar in pure evening thermals, one may often enjoy a pleasant flight by using both evening thermals and a slope-wind, which in itself would not be strong enough for soaring.

This simple explanation will no doubt suffice for the sailplane pilot. However, an amplification is here added, taken from a lecture by Professor Georgii:—

"In the case of evening thermals we are concerned with a residual thermic activity, due to the diurnal heating, still continuing at high levels. While the lower layers of air near the ground have already been cooled under the influence of the commencing nocturnal radiation and are therefore very stable and consequently free from vertical movements, there appears at heights above 3,000 ft. an increasing instability in the atmosphere. Accordingly, at heights above 3,000 ft. in the given conditions, free vertical movements can arise even in the late evening. The instability of the atmosphere, and therewith the free vertical movements in the air, need, however, to be released; i. e. portions of air must, by some means, be raised within the unstable layer from their position of rest at which they are in thermic equilibrium. Such means of release are: the forcible raising of air-masses over obstructions on the earth's surface; release due to differences in roughness of the earth's surface (transition of air flow from sea to land or from open fields to woods); release through turbulence in the boundary layer between two air-masses moving at different speeds. By day, the release of thermic activity causing vertical motion usually takes place at the earth's surface, where the differing forms of ground provide numerous opportuni-

ties for this release. In the case of evening thermals the release can no longer take place at the earth's surface, upon which the lower, cooled, very stable air-layer lies. The instability up above can only be released by hills which project into the upper unstable air-layer, and which forcibly raise the oncoming air-stream. In consequence of this, evening thermals can, excepting in the case of release through turbulence, only be utilised for soaring flight from mountains. Many flights, which have been carried out in Rhön Competitions, and by which a steady soaring-flight at great heights has actually been possible during the hours of evening, are easily explained by these evening thermals."

My flight at Elmira, and many others carried out in recent years, can also be explained in the same way. However, I am of the opinion that a slight slope-wind is not always necessary, but that the accumulated heat in a wood is in itself sufficient impetus to cause the unstable air-layer to rise more rapidly.

Wind Thermals

The Ideal Weather for Cross-Country Flights

The long cross-country flights of the 1934 Rhön Competitions were made possible only through the combination of good thermals and high wind-speeds, resulting in the high ground-speed maintained by the sailplanes used. Heini Dittmar covered a distance of 235 miles in the "São Paulo," while on the previous day I had flown 220 miles in the "Moazagotl" and Ludwig Hofmann 194 miles.

In the 16th Rhön Competitions of 1935 even better wind thermals prevailed. The opening day provided perfect weather conditions with a wind-speed of 20—25 m.p.h. Ludwig Hofmann set the ball rolling by breaking the world record with a distance of 296 miles, and thanks to the strong wind thermals which in 1935 were as common as "fronts" had been in previous competitions, many other excellent flights were made. However, easily the best day of all was the Monday of the second week, when no less than four pilots set up a combined world-record of 315 miles: Bräutigam in "D.B.10," Oltzschner in a Condor, Steinhoff in a Rhönadler, and Heinemann in a Rhönsperber. That same day Bartaune flew 302 miles, Heini Dittmar 263 and Späte 262.

In cross-country flying, "time" has become the most important factor. Fast sailplanes are essential if we are to make full use of

the thermals, which are active, even in summer, only for a period of 6—8 hours.

Where local sun-thermals are concerned, a fairly calm day offers the most favourable conditions for soaring; for then the bubbles will be large, contain sufficient lift, and only be slightly displaced. So-called wind thermals, on the other hand, are not caused by local solar radiation only, but also by the movement of the warm, moist, unstable air-masses, which in European countries probably originate South of the Azores. These form during great wind velocities into long, trailing "air-rollers," the axes of which lie in the direction of the wind. The rising portion of these "air-rollers" supplies us with a region of strong upcurrents, which can usually be recognised by a long cloud-street. If one can count on a tail-wind of 25—30 m.p.h., as was the case during Dittmar's flight in the 1934 Rhön Competitions, we can understand how it is that such long cross-country flights are made. Also, as these cloud-streets extend for some distance, it often becomes quite unnecessary to waste valuable time circling. There are, of course, not many days when one can rely entirely on wind thermals without paying any attention to local sources of upcurrents. In the course of my 218 mile flight, for example, I twice had to make use of slope-currents, and several times I was helped on my way by direct sun-thermals; whereas on the following day Dittmar seems to have flown exclusively with wind-thermals. In view of this, it is obvious that wind thermals provide the ideal conditions for long-distance flights.

In the following pages will be found descriptions of some of the more important thermal flights that have been made. I will begin with the first flight that I ever made in pure thermals, which also happened to be the first time that the "tight-circle" technique had ever been used for gaining height: a method which enabled thermal soaring to be rapidly developed and is now well-known and widely practised.

Flying High

A Short Description of a Soaring Flight

By Wolf Hirth

(Written in New York in the Autumn of 1930)

The first soaring-flight to be made in pure thermals by means of the "circle" technique. See Barograph and map: Figs. 30 and 31.

In the United States of America, much has been done in the past few years to make the public air-minded. Lindbergh's trans-atlantic flight caused a great wave of enthusiasm, which, however, three years later, suffered a severe set-back. That is why, once again, all possible methods are being used to popularise flying.

The latest idea is the revival of soaring, with which it is quite rightly hoped to bring flying nearer to the people.

The secret of a successful cross-country flight lies both in finding and in making the best possible use of every upcurrent lying in the path of flight; and in either avoiding downcurrents altogether or in flying through them as quickly as possible.

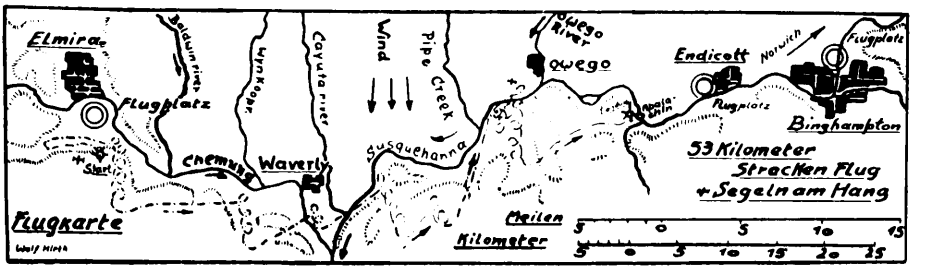
But how is this done? In the course of time, the sailplane pilot has discovered for himself several kinds of rising air-currents, the best-known being the slope-wind, which originates when the wind meets a long line of hills and is forced up over them. Another kind, the cloud-upcurrent, is formed by the uneven heating of the earth's surface by the sun, to which phenomenon all winds owe their derivation. Last of all, we come to the thunderstorm-upcurrents, which offer by far the widest scope for cross-country records.

In the U.S.A. many cross-country flights had certainly been attempted, but it was only during the Soaring Competitions in Elmira, N.Y. in October 1930 that any great success was achieved. A. Haller from Pittsburg Pa., who had learnt to soar in Germany, made first a flight of 15 miles and then one of 20 miles.

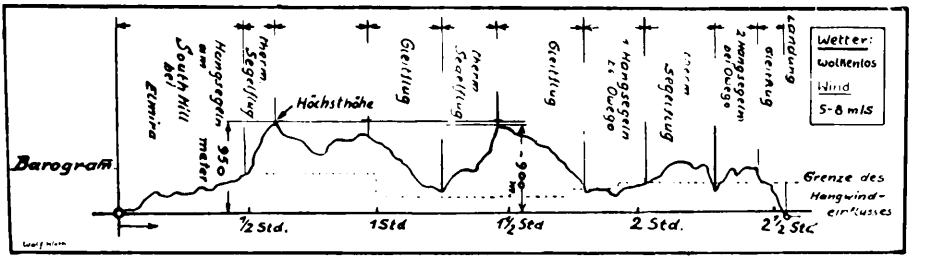
On the last day of the Competitions, I myself succeeded in making the following flight, which, far from being a haphazard cross-country flight, was a planned long-distance goal-flight to Norwich, N.Y. The Soaring Society of Norwich had offered a prize for which I was anxious to compete. Long before the Competitions had begun, I had thought out two possible ways of making this flight, both of which necessitated clouds for locating thermal upcurrents.

Six machines were already in the air when I was launched off the South slope of the soaring site near Elmira in my sailplane. In a few minutes I had risen above the school-machines, and after 20 minutes had caught up with Haller, who was flying at a height of about 1,000 ft. For a time my "Musterle" flew together with Haller's "Schloss Mainberg" in long drawn-out figures of eight far above the other sailplanes; then in the middle of a turn I suddenly noticed that my companion was going up like a lift at the other end of the slope. I at once steered my plane in that direction and to my joy found a vast area of thermal upcurrents, in which, after 10 minutes of uninterrupted tight circling, I climbed to 3,000 ft. above starting-level. This was the greatest height that had ever been

Eight views **of** the first soaring flight over New York City.



The first thermal soaring flight under a clear sky on 2nd Oct. 1930.



Landung: landing. Gleitflug: glide. Hangsegeln: slope soaring. Segelflug: soaring flight.

reached in America, either during the Competitions or at any other time. However, on this beautiful sunny day there was not a cloud in the sky, and for a moment the absence of this upcurrent indicator made me wonder whether there was any point in setting off along the prescribed course with a cross-wind. Then the temptation to make the flight became too great, and I soon found myself flying down the broad Chemung Valley. During the next 15 minutes I lost a great deal of my precious height, when suddenly, not far from Waverley, I caught sight of two soaring birds wheeling and gaining height rapidly. What were they doing at such a height? These vagrants usually only fly in search of prey, but sometimes they undoubtedly consider it great fun to soar higher and higher for sheer pleasure. This time I could share in their joy, for they showed me where I could find further lift. A small detour brought me above them and for a short while I too rose steadily. The birds did not pay the slightest attention to me; possibly they did not even see me, as they much prefer to look down rather than to strain their necks by looking up.

Far below lay Waverly. From now on the way lay up the Susque-

hanna Valley. Haller had flown Southwards down the valley with the wind behind him in order to make as long a flight as possible and was already out of sight. Once again I was losing height foot by foot. Were there no more upcurrents to be found? The ground was approaching rapidly and the only slope which appeared to hold out any hope of an upwind lay far ahead of me. Fortunately, down below there were not, as is often the case in this part of the country, many miles of woodland, but several suitable-looking landing-grounds; and I had already chosen a lovely long field ahead of me in which to land when, in surroundings which, according to the rules of slope-winds, should have produced downcurrents, I suddenly felt myself being lifted up. Once more I gained height, though not for very long. Then I lost it again, only soon afterwards to find another and still stronger upcurrent. My altimeter showed me that I was climbing steadily and in a short while I was once more 3,000 ft. above starting-level.

I can well remember, as though it only happened five minutes ago, how at this height I tried to take a deep breath because I felt so elated. I say "tried", because I was so tightly wedged in the cockpit of my machine that there was only room to take very small breaths at a time! However, to make up for that, I felt myself completely identified with my sailplane, and at that moment would not have exchanged it for the fastest and most expensive power-plane in the world. I was only saddened by the thought that its designer, who had himself been a keen sailplane pilot, had never had the chance of experiencing the joy of flying his own creation: for some time has already passed since Paul Laubenthal was taken from us for ever. While these memories were crowding in on me, I suddenly noticed, quite by chance, a chain of mountains to the South. The visibility was marvellous—at least 50 miles—and it struck me that there, in the direction in which the wind was blowing, was a perfect soaring-slope. It could easily have been 30 or 40 miles away, but its appearance promised hours of easy slope-soaring. Unfortunately, I had not been able to get hold of a very good map of the country beyond the immediate vicinity of the Camp and only learned afterwards that these mountains were the Northern Range of the Alleghanies. I could not help feeling tempted to break my flight to Norwich on the chance of being able to reach them. However, I continued my flight in the same direction as before, until, after losing height all the way, I eventually found a good slope near Owego. There I soared for about 20 minutes and amused myself by watching the people moving about on the golf-course down below. They remained quite oblivious of the huge man-bird above them and I had no wish to call to them,

for the utter silence of a sailplane flight is one of its great beauties. So I soared to and fro, watching them quietly, until a thermal once more drew me up a thousand feet or so. While hill-soaring, I had come to the conclusion that it was too late in the day and too much a case of flying against the wind to continue in the direction of Norwich. This led me into making a mistake. For a short while I tried to fly South towards the wonderful looking mountains, but soon noticed that I had not time to do this either. Evening set in, and as it did so the thermals gradually weakened. Once more I headed Eastwards, but again too late! Had I continued my flight from Owego along the valley slopes, I would probably have reached Binghampton or anyway Endicott Aerodrome. As it was, I had to make a forced-landing just short of the valley slopes near Apalchin, and conveniently came to a standstill 50 yds. from a farm-house. At this tiny village I was able to telephone the organisers of the Competitions. My first motorless flight over country formerly inhabited by Red Indians was at an end. A quick glance at the barograph! O. K.! It had functioned perfectly.

Even though I had failed to make the difficult flight to Norwich, it had been a wonderful experience, and incidentally I had set up a new American height and distance record. At that time, it was generally believed that clouds were essential for distance flying; but my flight had clearly disproved this theory, while being, as far as I am aware, the first thermal flight carried out under an absolutely cloudless blue sky.

Thermal Soaring

By Ludwig Hofmann

It is essential to remember that the starting-ground is nearly always a carefully selected place, which has been thoroughly tested, so that the thermals in the immediate locality will usually be above the average. Cross-country flights, on the other hand, must necessarily be made over less favourable and absolutely new terrain, and the sun must therefore shine for a longer period of time in order to create sufficiently strong upcurrents for soaring. Moreover, it is advisable, epsecially when slope-soaring, not to set off across-country with the first good lift-cloud but to try at least two or three others to see if they also provide sufficient lift. Only then can one

be reasonably certain of finding lift at sufficiently frequent intervals. The same thing, of course, holds good when upcurrents are found after an aero-towed start or a winch-launch. If, on a cross-country flight, it should be necessary to fly on the lee-side of a mountain, it is advisable, especially when an early start has been made, to gain as much height as possible by blind-flying inside a cloud situated on the windward side of the mountain and using all the upcurrents it contains, in order to be able to bridge the "dead zone" at as great a height as possible.

Inexperienced sailplane pilots will be well recommended to reach at least cloud-base above the starting-ground before setting off across-country. Those pilots who have mastered blind-flying should put it to use at every opportunity. In clouds, where the lift is considerable, the circle technique should be adopted, while in good weather one should fly straight through less potent upcurrents. This is obvious when one reflects that when circling in a bubble that is rising at the rate of 1 ft./sec., it will take ten times as long to reach a given height than if one were circling in a bubble rising at the rate of 10 ft./sec. The time saved will increase the ground-speed, besides which it is less tiring for the pilot not to have to circle so much.

A great deal of time is saved by flying through downcurrents at high speed; though should one unexpectedly encounter a small thermal, it is sometimes difficult to turn quickly enough so as to accommodate oneself within its limits. Therefore, on finding an upcurrent, the simplest and most effective thing to do is to pull the stick hard back and go straight into a steep turn. This manœuvre will look something like a tight stall-turn.

A critical moment is always that in which the cable is released. The pupil is often apt to watch the variometer too closely. But this tiny instrument cannot do everything! Like the A.S.I. and turn-and-bank indicator, it is slow in registering. In towed-flight, with its comparatively high flying speed, one passes rapidly through upcurrents, and the variometer is not only unable to show the full amount of lift, but often fails to indicate it until it has already passed; so that a few moments after releasing, the pilot is surprised to find himself circling in nothing but downcurrents. The most propitious moment to release the cable can best be determined by dividing one's attention between the variometer and the power-plane. The power-plane will be the first to rise, and the sailplane pilot will not be able to pull the stick back either fast or hard enough to keep up with it. However, a few moments later, he will also find himself rising rapidly and just as high without any effort on his part. By this time, the power-plane will be sinking again in a nearby

downdraught, and the sailplane will find itself in the centre of the upcurrent-area. The releasing of the cable and the moving of the rudder-bar and stick must all be done simultaneously or else one will immediately find oneself in downcurrents again.

If, for some reason or other, very much height has been lost on a cross-country flight, then:—

a) Should there be only a slight wind blowing or none at all, it is imperative, if lower than 1,000 ft. or so, to combine the search for upcurrents with the selection of a suitable landing-ground. Should one happen to be in very strong downcurrents, and assuming, of course, that the countryside is sufficiently variegated, one should steer in the direction of the greatest contrast in the colour and nature of the ground-surface. It has also proved helpful, on sunny days, to fly over spots where the sun is shining. The sailplane pilot must never be discouraged by powerful downcurrents, for in close proximity there are nearly always strong upcurrents to be found. It is then only a matter of having sufficient height with which to bridge the downdraughts. This can best be accomplished by flying straight ahead at high speed. It is essential that the pilot should use descrimination when deciding whether to make an impromptu landing or continue the search for new upcurrents. He can, in any case, always fly back a short stretch or deviate slightly from his course, if in that way he thinks he may find some more lift.

b) Whereas in a) it was immaterial in which direction we flew in the search for upcurrents, here, in the case of wind thermals, it is of the utmost importance: i. e. it is imperative to fly downwind when searching for thermals and not remain over one spot, for only in this way can we hope to cover ground quickly and at the same time find the necessary lift. Care must be taken not to return to or circle around in downcurrents, when looking for lift. Should we find ourselves over mountainous country, the best thing to do is to remain in the slope-upwind of a hill-side until a thermal-bubble is blown past, to which we can attach ourselves.

As an illustration where practical experience proved superior to theoretical study, it may be mentioned that in the 1934 Rhön Competitions, when Dittmar, Riedel, Reitsch, a few others and myself set off across-country, Dittmar flew the longest distance: the strange part about it being that we all flew close together except for Dittmar, who took a course about 20—30 degrees away from ours. Only when discussing it with him afterwards did I realise what had happened. Apparently, he had headed for clouds that looked as though they were in process of dissolving and yet in spite of a heavy shower of rain he found about 10 ft. of lift per second underneath them.

It is sometimes very difficult to differentiate between the breaking-up and formation of a cloud. Moreover, in the air a cloud looks very different from what it does from the ground, owing to the difference in distance and perspective.

Thermals have quite definite characteristics, which, with a little practice, enable them to be distinguished from slope-currents. Their chief distinction is that they are sharply outlined by strong down-currents. Consequently, the variometer jumps comparatively quickly from "Fall" to "Rise". This sudden change in vertical air-currents cannot possibly be caused by an irregularity in the contour of the hill or a change in the speed of the wind. Also, just before entering a thermal, one flies through an absolutely characteristic zone of eddies, which I would describe as the first "breath" of a column of rising air. (Heini Dittmar always speaks of a light vibration of the wings!!) When approaching a thermal, the speed of the plane suddenly increases; while inside a thermal-bubble the sound of flight is peculiarly "hoarse". Whether it really is different or whether our ears (the human variometer) only make it seem so does not interest us just now. The fact that it is so is in itself sufficient to enable us to use it as a means of recognising thermals. A few years ago, Wolf Hirth thermal soared for as much as half an hour only by ear and without a variometer.

It is a good idea to procure a table from the constructor of the sailplane used and stick it in the cockpit, so as to be able to see, while in the air, the best speeds at which to fly the plane in the different currents: some strong, others weak.

More Soaring Flights with Particular Reference to Aero-Towing

By Peter Riedel

It may encourage those who sigh and say:—"I shall never be able to fly like that!" to know that I passed the "official C" test in September 1931 and did not start soaring properly until the Spring of 1932.

Aero-towing is an excellent means of teaching a pupil how to thermal soar. The instructor tows him up to a bubble and then signals him, as previously arranged, to release the cable and begin circling immediately. The pupil sees on the variometer (which it is,

of course, essential that he should have in the machine) that he is rising, and he is then able to search for further lift on his own.

The best way in which I can describe the technique of thermal soaring is by relating briefly how I began, what mistakes I made and what helped me.

When I made my first aero-towed start in the Spring of 1932, I noticed with envy how, after a short towed-flight, Grönhoff immediately found a strong upcurrent and rose with it to well over 3,000 ft. while I was very soon forced to land. Mistake No. 1: I was not sufficiently high up to be able to look for upcurrents at my leisure; in other words, I had released too soon. So next time I made a point of not releasing the cable below 2,500 ft., however much lift should be indicated on the variometer, with the result that I managed to soar for over an hour, for this gave me more time in which to look for other upcurrents without getting out of reach of the first strong column of rising air in which I had released. It is nearly always hopeless for the beginner to release the cable below 1,500 ft., and for the first few starts it is best always to be towed up to 3,000 ft. The next thing I learnt was that however small a cloud might be and even if it should be 6,000 ft. above the ground, it could, in thermal weather, induce a column of rising air as much as 3,000 ft. below itself.

The first long flight I ever made was to Plauen in Vogtland on 19th May, 1932. All the morning a flat, domeless cloudbank had remained stationary more than 6,000 ft. above sea-level to the East of the Wasserkuppe above the Hohe Rhön. It was a hot, still day without a breath of wind in the air. Towards noon I was towed up underneath this cloudbank to about 4,000 ft., but I was not expecting great things. Then suddenly I began to rise at the rate of 9 ft./sec. instead of the usual 3 ft./sec., and the air became very turbulent. The second time that the variometer indicated a pronounced lift I released the cable still nearly 3,000 ft. below cloudbase, and immediately rose at the rate of 8—9 ft./sec., finding myself in a few minutes at a height of 6,000 ft. Such was my beginning, and I still remember how hard it is for the beginner to continue circling in very bumpy thermals. Once this difficulty has been overcome, he will be astonished to find how stable a sailplane can be in a turn. While pushing on to the next cloud, which lay some 6—7 miles to the North-East, I found myself sinking heavily at the rate of 2—3 ft./sec. Rapidly I lost all my precious height and over the River Geba was not more than 3,000 ft. up. This was again due to an error on my part. I still had not sufficient faith in the duration of thermal upcurrents under clouds, and therefore, fearing that the

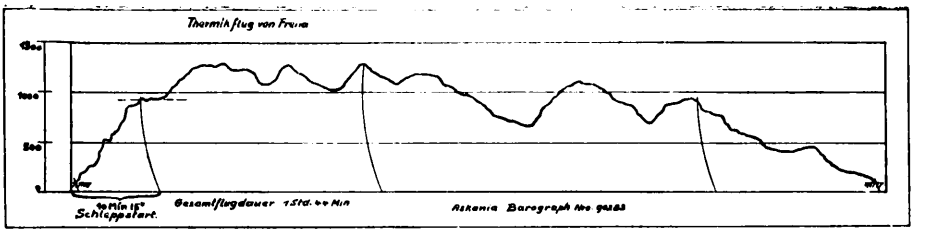
bubble would at any moment dissolve and cause me to lose the height I had gained, I flew away from the first cloud before reaching its base. Actually, there had only been a temporary decrease in the lift within the bubble, but taking this as a warning, I had left the cloud still 1.000 ft. below its base. Three times I made the same mistake, and was consequently always in great haste to convert height into distance. In this way, I eventually reached Ilmenau and was about to abandon the flight, as I was now only 1.000 ft. up, when I at last climbed right to the cloud-base which lay at about 7,000 ft. From then on I lost much less height between the clouds, so that from Ilmenau to Planau I was always at a "safe height", i. e. between 5,000 and 7.000 ft. In this flight, as was later so often the case, a soaring bird rescued me at a critical moment. At times I have found these birds as high as 6,000 ft. beneath clouds. Wherever a soaring bird can be seen wheeling, there are bound to be upcurrents and usually very strong ones either above or below it.

On a calm day or when there was very little wind blowing, I often found a belt of downcurrents round the edge of a cloud, and I always made a point of flying through them as rapidly as possible, for in this case the upcurrents are all the stronger under the base. Once, during a cross-country flight, I found a belt of upcurrents where there should have been downcurrents, and I was promptly rewarded with downcurrents underneath the base. The lesson I learnt from this was not to fly under any thermal cloud without first finding downcurrents.

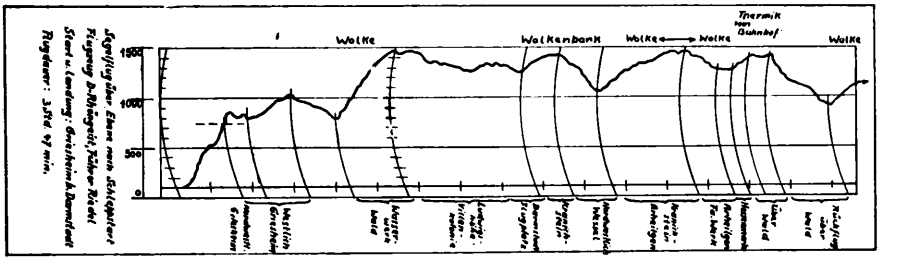
While flying in pure thermals under a clear blue sky, I have often "controlled" my turns by watching the shadow of my "plane" on the ground, for it is usually surrounded with an unmistakeable aura. I have then noticed the spot through which the shadow passed when there was a maximum amount of lift in the air, and made my circles accordingly, i. e. so that the shadow very often touched this spot, or moved slowly along with it in the direction of the wind. On dark coloured woods the bright spot of light can be seen instead of the shadow from a height of 2.500—3,000 ft.

The higher the cloud-base or inversion-layer, the easier it is to make a cross-country flight. Below 3,000 ft. it is almost impossible for the beginner to go across-country, up to 4,500 ft. difficult, and above 6,000 ft. easy, always provided that he has sufficient height — at least half that of the cloud-base — with which to commence his flight.

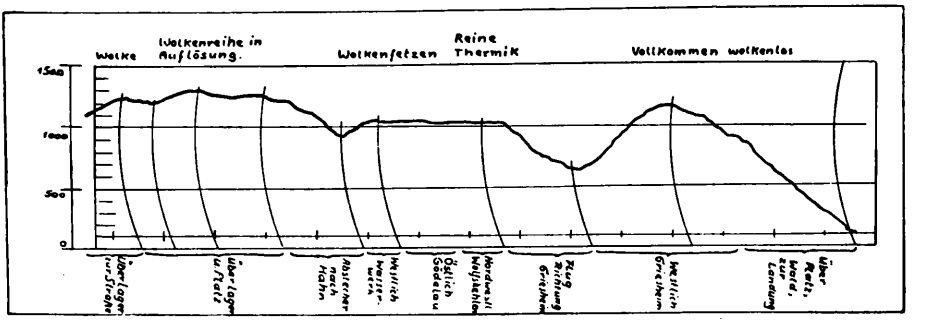
The flight which I made on 18th May, 1932, i. e. the day previous to my flight to Plauen, will serve as an example:—The cloud-base was then at about 5,000 ft. i. e. barely high enough for a beginner.



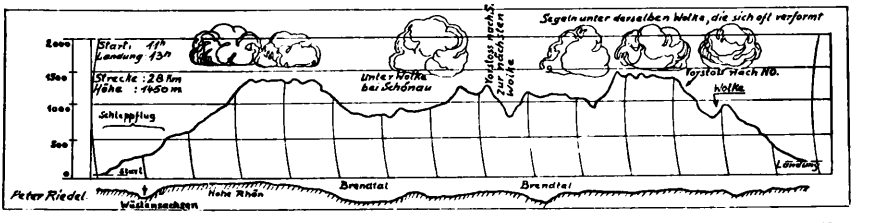
a) Thermikflug: thermal flight. Schleppstart: aero-tow. Gesamtflugdauer: duration of flight.



b) Thermal soaring flights after aero-towed starts. Wolke: cloud.



c) Continuation of b). Wolkenreihe in Auflösung: clouds dissolving. Reine Thermik: pure thermals. Vollkommen wolkenlos: absolutely cloudless.



d) Start: start. Landung: landing. Strecke: distance. Schleppflug: aero-tow. Unter Wolke bei Schönau: under a cloud at Schönau. Vorstoß nach S. zur nächsten Wolke: pushing on to the next cloud. Segeln unter derselben Wolke, die sich oft verformt: soaring under the same cloud, which is still forming.

In the middle of the barograph chart a sharp fall is noticeable. This was when I pushed on to the next cloud-street for the first time, and only by returning hurriedly was I able to remain in the air at all. Once more I climbed to a good height and tried again in another direction. This time I almost succeeded in reaching the cloud for which I was aiming, but losing a small bubble under an intervening cloud, I found myself in such strong downcurrents that I was forced to land. That came of having no height in reserve.

On 10th June, 1932, when I was more experienced, I succeeded in soaring over Darmstadt and Griesheim for 3 hrs. 45 mins. As the cloud-base was at only 4,500 ft., a cross-country flight with my slow machine seemed inadvisable, and I therefore remained in the vicinity of the aerodrome. As low as 2,000 ft. above the ground it seemed safe to release the cable, but the bubble was only a small one and I lost height. However, after a short search, I at last found a strong thermal at a height of 2,300 ft., and climbed with it right up to cloud-base. On this hot, still day, the clouds were flat, plate-like structures, and they had no domed-tops by which it would have been possible from below to classify them as lift-clouds. At 6,000 ft. an inversion-layer impeded my ascent. From what I have observed, this inversion just above condensation-height is very favourable for soaring purposes. The thermal forces cannot use up all their energy by shooting on upwards, but must rise in an even flow until they coincide with the inversion-ceiling. On such days thermals are almost as constant as slope-winds, only very much more bumpy. A lift of 6 ft./sec. is usually a good average, but this can increase to 13 ft./sec. Near cloud-base the upcurrents whirling against the inversion-ceiling cause such turbulence that once, sacrificing height and lift, I steered my "Cumulus" (Professor) away from the cloud and out into blue sky simply in order to give my arm-muscles a rest, for I had been running the risk of physical exhaustion.

On 10th June 1932 I took-off at 2.0 p.m. On the barograph chart, which ends at 6.0 p. m. one can see how the thermals gradually weakened, but also became more uniform in character. In the first half, there were sharp rises and falls, in the middle they became less violent, and then for about half an hour I did nothing more than maintain height. After that the last cloud dissolved and, losing height, I was on the point of landing when the evening thermals set in, which a year earlier Fuchs had also found over Darmstadt. Under a clear blue sky I was able to gain another 2,000 ft. of height. Then there was nothing more to be done.

To what extent the upcurrents can be relied upon in this kind of weather was demonstrated the following day, when I took-off at

10.30 a. m. (i. e. as soon as the blue sky became dotted with the first white puffs of cloud) with the intention of staying up longer—if possible until evening. At noon cirrus clouds appeared; then the weather underwent a complete change, and I had to come down after being in the air 3 hrs. 15 mins. I can only recommend every pupil first to make protracted thermal flights such as this rather than to go straight off across-country. He will learn an enormous amount and be spared the cost of transporting the machine back again.

The third chart is that of a pupil who was sent across-country during a course of aero-towing in the summer. I was able to send him off without a qualm, for although he had had only 12 towed-starts, he had already done two hours' cloud-soaring. He succeeded in soaring for 1½ hrs. and in covering a distance of 24 miles.

The fact that all these flights were carried out on the old "Professor" must be taken into consideration. This type of machine is not by any means the most up-to-date, but does not deserve to be discarded just because a "Fafnir" is not available. It is possible to soar with all sailplanes with a sinking-speed of 3.25 ft./sec. and less. The main essential is to be able to see what is happening in the zenith and to have a machine with a certain amount of manœuvrability.

Later on I had the pleasure of soaring with Schleicher's "Rhönadler 32". The controls of this machine were so sensitive that by making tight circles I was able to remain within the narrowest limits of a thermal. Thus, I was able to release the cable at 1,000 ft. or even 700 ft. and yet at once gain a few thousand feet. However, it does a beginner no harm to struggle with an older machine: he will find things all the easier when he eventually steps into a more modern one.

A good sailplane for thermal soaring must be easily manœuvrable, have a good gliding-angle and at the same time possess a good speed-range. It is far more important to be able to escape quickly from downcurrents or make rapid hops from one bubble to another than it is to save an inch or two of sinking-speed. Among other things the pilot should make sure that he is sitting comfortably, for thermal soaring will need all his attention. It is a great drawback when one's legs fall asleep or one's back gets stiff. With the right plane, I consider thermal soaring the most enjoyable kind of flying in the world.

Motorless from the Rhön. across the Rhine. and as far as the Moselle

By Wolf Hirth

To the absolutely uninitiated, the pure thermal flights of the 12th Rhön Competitions, 1931 came as a surprise. For Kronfeld, Grönhoff and me, they afforded the opportunity to put to trial all that we had so carefully worked out in theory.

One of our number, who would undoubtedly have had an interesting contribution to make, namely Otto Fuchs, had been made "hors de combat" by an unfortunate accident.

I have described elsewhere my American long-distance record flight from Elmira to Alpalachin in October 1930, when I flew across-country for $2\frac{1}{2}$ hrs. under a clear blue sky at heights varying between 2 3,000 ft. above starting-level. It was the first flight that had ever been made in pure thermals, and in character it was exactly similar to the flights which were carried out from the Wasserkuppe in 1931, when accumulated experience certainly enabled longer distances to be covered.

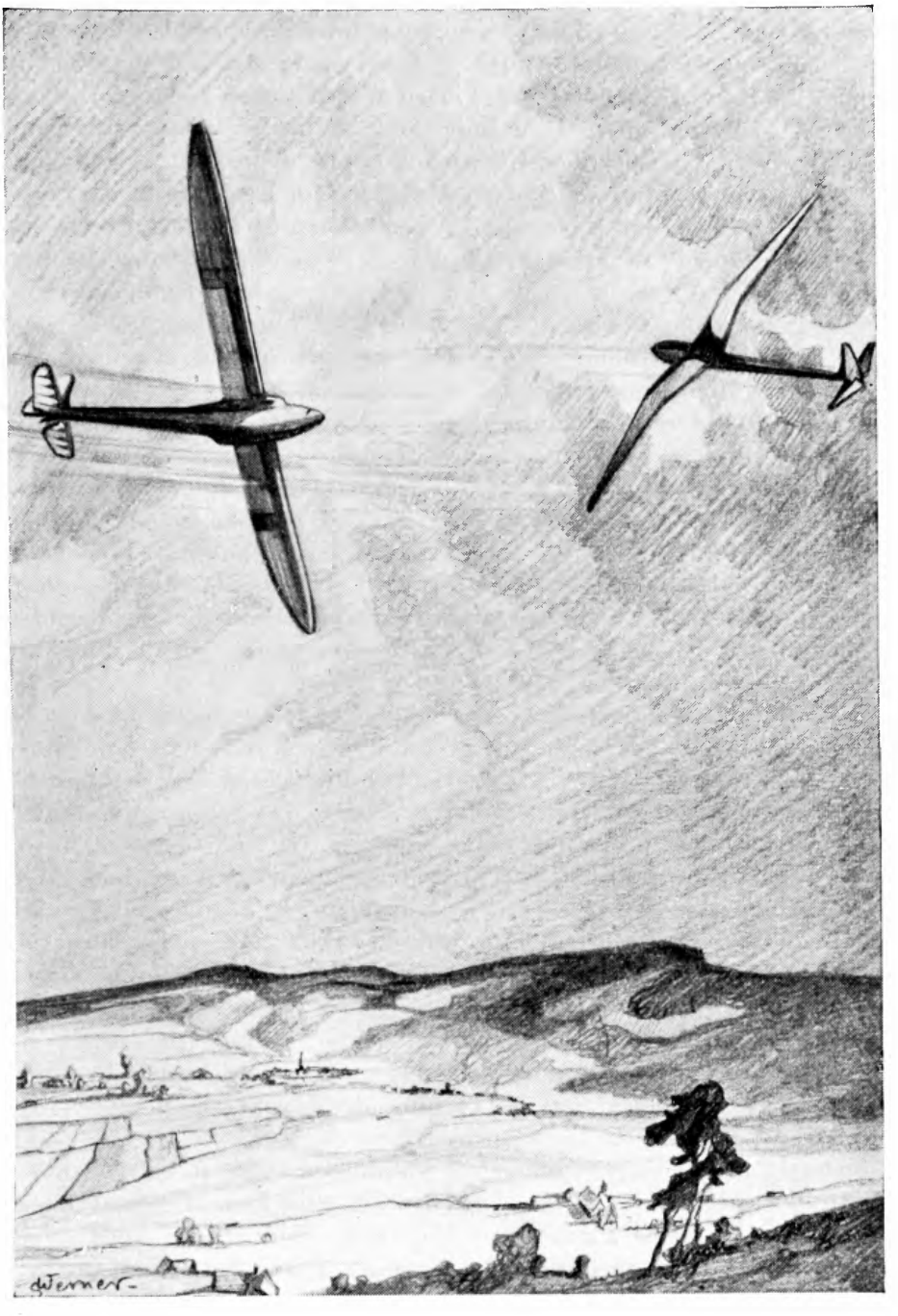
On 2nd August, the weather conditions were unusual for the Rhön Competitions, for there was a sharp East Wind blowing.

Circumstances prevented me from appearing at the start until noon, after others, headed by Marcho-Silese Pfeiffer, had already reached nearly 3,000 ft. above starting-level from the East slope of the Eube.

Grönhoff was already out of sight, and by the time I took off the wind had abated considerably, with the result that I was only just able to maintain height.

For a time three of us flew backwards and forwards skimming the tree-tops by inches, and only very occasionally were we lifted up over the Obenhausen Valley by spasmodic thermals. At last, after about 40 mins., I found a thermal-bubble, which, without containing very much lift, was sufficiently expansive to enable me to remain within its limits.

I had first exploited the idea of "tight-circling" in thermals in America the previous year, and having further practised this method in the course of five flights in Grunau, I was now once again able to gain height steadily without clouds and independent of the slope-wind. At a height of approximately 650 ft. I left the slopes of the Wasserkuppe and circled steadily up to 2,000 ft. Five or six miles away from the Kuppe it became apparent that there was no more lift in my original bubble, and I was unable to find any new up-



We circled round each other as if in a dog-fight.

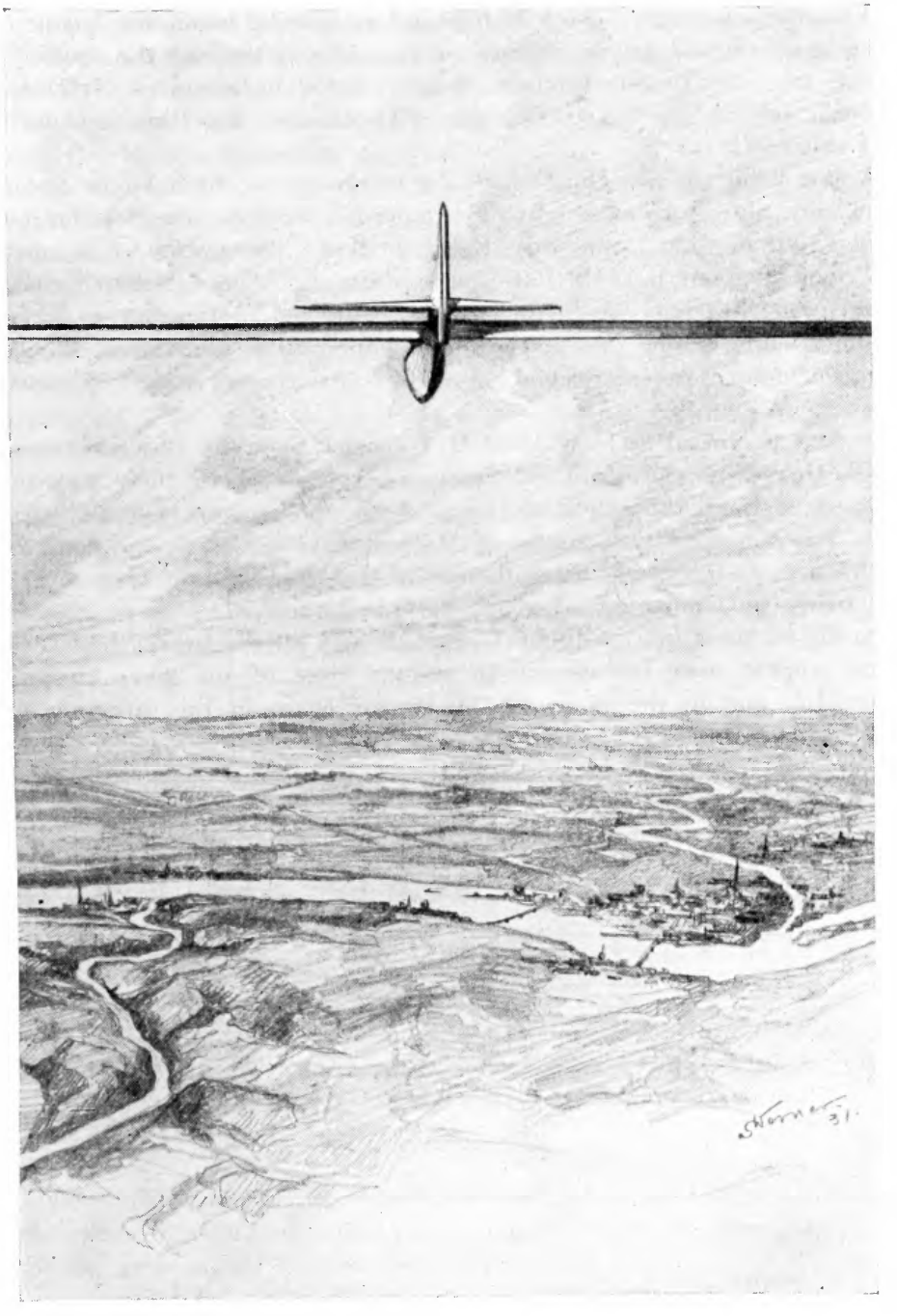
currents in my immediate vicinity. However, I suddenly caught sight of some butterflies which had obviously reached that height under thermal influences, and I hastened to make use of the same locality. This did not get me much higher, but at least enabled me to cover a few more miles without much loss of height.

Not far away, somewhat South of the Fulda, a soaring bird wheeling 300 ft. below me then called my attention to further air-masses that were apparently pressing upwards. When I had made a few circles and was taking a look round, I saw a plane flying straight towards me from the North. For the second time I had met Grönhoff in mid-air, without having made any previous arrangements to do so. The first time was in a thunderstorm, when it was natural that we should see each other again on the "front" of the storm. But this time it was pure chance that brought us together after many hours' flying, and in spite of having taken-off at different times.

We now stayed together, which was, of course, to our mutual advantage, for first one then the other found a bubble which both of us were able to use. In this way, we circled around each other for often as many as ten consecutive turns. From below, it must almost have looked like a dog-fight, whereas in reality we were helping each other.

The country over which we were now flying was unknown to me; but I supposed that Grönhoff was familiar with it and that we were flying approximately in the direction of Frankfurt. We maintained an average height of 3,000—3,500 ft. above the Wasserkuppe, and in the search for lift often found ourselves far apart, one of us at times even flying 4/500 ft. above the other. When we had been soaring together for about 1½ hrs. a large river appeared on the landscape. At first I thought it was the Main, but soon realised I must have been mistaken. At this point I lost sight of Grönhoff, and in spite of looking for him everywhere was unable to find him again. So there was nothing for it but to continue the flight by myself. Hitherto the thermals had occasionally been capped by fine, white puffs of cloud; but as evening drew near, these gradually dissolved.

Shortly after losing Grönhoff, I was forced down to 650 ft. above starting-level, and as I later discovered, this loss of height must have occurred near Limburg-on-the-Lahn. Here, there were some large, half-reaped cornfields from which I hoped to find further lift, and as it turned out I did quite right in changing my course and heading straight for them. With the help of a sustained thermal, I covered several more miles, and climbed so high that I had no difficulty in crossing some mountains which had appeared below.

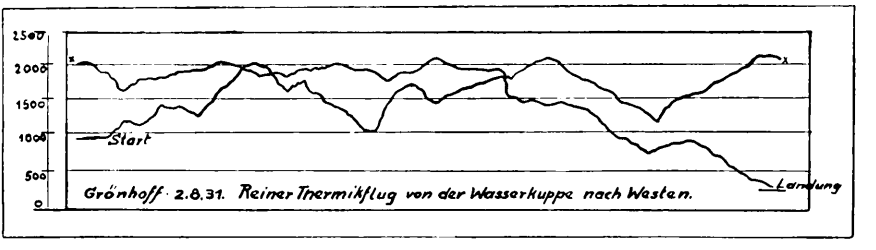


Far below me appeared the Rhine.

I had now been flying for 3½ hrs. and on looking about me I caught sight of a broad, silver ribbon, winding its way through the countryside far away in the distance. A suspicion soon became a certainty. Joyfully I whispered to myself:—"The Rhine, the Rhine—if only I can reach it!"

But I did not like the look of the terrain over which I now found myself. Slowly I lost height! The mountains before me grew larger, and at Bad Ems I was only 1,000 ft. above the ground. Anxiously I looked about me. How to continue flying? The solution seemed difficult; but once again luck came to my aid. After soaring for a short while behind one of the bowl-shaped Lahn Mountains, I once more found a perfectly good bubble of warm air and with it spiralled away up and on.

At a height of at least 3,000 ft. I crossed over the Rhine between Oberlahnstein and Koblenz. Steamers were working their way up the river, and thousands of people were sun-bathing near Koblenz. It was the first time many of them had ever seen a sailplane in the air, and one of the bathers whom I had met on my return journey next morning asked me a typical question:—"Is it possible to fly straight in a sailplane?" For he and all the others had seen me appear over the mountains on the edge of the river circling steadily and in the same way disappear again in the direction of the River Moselle.



Barograph chart of Grönhoff's pure thermal flight and mine from the Wasserkuppe in a Westerly direction. My barograph had failed; at that time I had not yet the reliable Askania.

As I crossed over the Moselle there was no more lift evident, so I proceeded to steer my plane in a more Northerly direction. In the old days I had often toured this part of the country on my motorcycle and I knew that owing to the thermals subsiding towards evening my only hope lay in the slope-wind of the Eifel. But the Eifel was too far away. I lost height more rapidly than was comfortable, and therefore turned back South towards the Moselle,

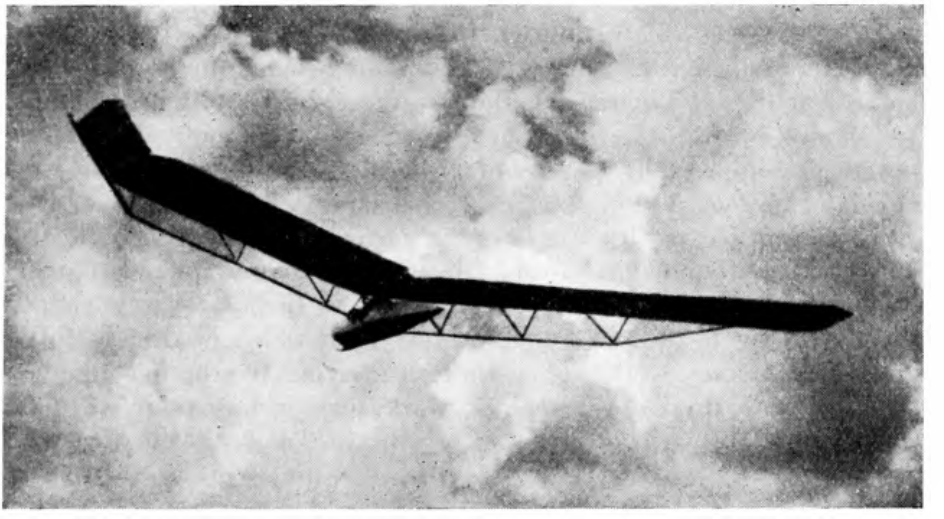
There remained one more difficulty to be overcome: that of landing in a place full of small orchard trees, high-tension cables and fields surrounded by hedges. But my luck held and my 23rd cross-country flight in a sailplane ended, as had previously always been the case, without damage to my plane.

Less fortunate was my choice of Brohl as a landing-place. There were three other Brohls in the district, so that my friends, who came to fetch me back, made several unnecessary detours in search of me and only arrived next morning!

The distance I had covered measured 120 miles. But more important to me than the length of the flight was the fact that I had flown from the Rhön to the Rhine. This was the first time in the history of Rhön soaring that a notable distance had been covered in a Westerly direction.

So it goes on: every day more cross-country flights are made, and every time they become more independent of the formation of the ground and the direction in which they are made.

The most astounding flight from the Rhön in 1931 was certainly that of Kronfeld, who, on the last day of the Competitions, flew 103 miles North-West to Westfalen—without clouds and almost without wind.



Dr. Wenks tailless glider (Rhoen 1921).

5. Cloud-Flying

As with thermal soaring, there are also several different kinds of cloud-soaring.

Hitherto we have usually flown beneath cumulus clouds. In other words, we have used the clouds to show us the whereabouts of rising air-currents.

A cumulus cloud forms when a thermal bubble reaches condensation height, i. e. when the vapour which is always present in the air, though invisible because it is a gas component, rises, cools and consequently condenses into water. Clouds do not, therefore, consist of vapour, but of small drops of water.

The process of condensation is the reverse of what happens when boiling water. Here the water must be heated in order to turn it into steam; whereas for condensation to take place this heat must once more be liberated.

This renewed supply of heat considerably increases the amount of lift not only inside clouds but also underneath them, because the air-masses pressing upwards inside a cloud are also sucking up air from below. We then say that the cloud is "drawing". But not every cloud "draws", because very often, especially in the lower part of a cloud the process of condensation has already ceased. In this case, there may even be downcurrents underneath a cloud, while at the same time strong upcurrents may still be evident in the upper part of it.

The technique of utilising lift beneath clouds is exactly the same as in thermal soaring. We can often only know for certain, by looking at the variometer, whether we are rising or falling: whether we should remain where we are or proceed to a new area. It is practically impossible to give precise rules regarding good or bad cloud-formations. Often I have been circling up in a region of lift (which I had located by watching the variometer) and then suddenly noticed that a cloud had formed overhead. So if we see that near us a cloud has just formed, we can expect to find upcurrents there. But if we fly towards a more distant cloud which is already fully developed, it may well happen that on arriving five or ten minutes later, we only find downcurrents, while on our way to it we may have flown through several newly forming and as yet invisible regions of lift. As this is so often the case, it is always better to circle at once and soar in "pure thermals", rather than to rely on any likely-looking cloud in the distance, which may prove ineffective

for the reasons outlined. Choose, therefore, a newly forming patch of cloud (on the light of what has already been said) rather than a well-established mass.

Thermal soaring beneath a cloud as described above can also be called "cloud thermal soaring", and as it offers, together with "front soaring", the greatest possibilities, it is necessary to go thoroughly into the question.

In the same way as the pupil should first practise circling in preparation for thermal soaring, so he must also practise flying by his instruments with a clear horizon before actually blind-flying inside clouds. Assuming he has reached a height of at least 300 ft. above the highest ground in the vicinity either by slope-soaring or after a towed-flight, he should then keep his eyes fixed on the turn-and-bank indicator and try, with the help of the compass, to hold a straight course. At first, this is not at all easy, especially in bumpy weather and in a plane with a sensitive elevator. Power-planes are usually trimmed before being used for blind-flying. There is then no necessity to look at the A.S.I., and one can safely neglect the stick and concentrate entirely on the compass and turn-and-bank indicator. Of course, one should also try to do this when soaring, but it is not absolutely necessary.

When tacking back and forth above a long slope, one can first determine a compass-course with visibility and then try to hold it solely by use of instruments. Of course, to do this the speed of the wind must be more or less constant, or one will suddenly find oneself behind the slope.

When a certain amount of skill has been achieved at blind-flying on a straight course, one can then practise changing direction until one is at last able to make circles the diameter of which will with increasing skill gradually become smaller and smaller. Naturally, it is advisable to be towed up to a good height before practising these circles, and only when feeling absolutely confident should one proceed to do the same thing inside clouds.

There are a few points of paramount importance, which must be borne in mind:—

1. It is advisable to practise flying for some time with the same sailplane. Every new machine needs a certain amount of understanding.

2. The turn-and-bank indicator should be fixed according to the flying-speed of the sailplane, so that when making circles it is not too sensitive to the control-movements.

3. In turbulent conditions the needle of the turn-and-bank indicator swings to and fro. The point, which lies half way between

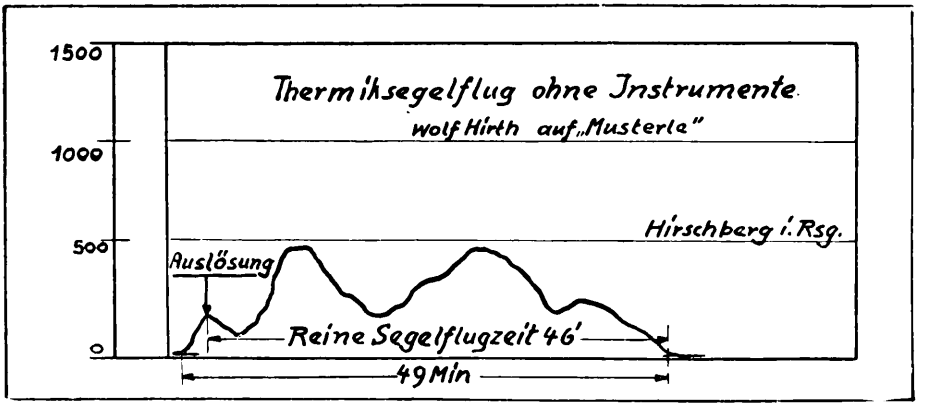
the extremities of the swings, is the mark which shows us our turning radius, as previously determined; thus, in straight flight this point is at the centre. (See Fig. 41.)

4. The steel ball should always stay in the middle.

Nothing further need be said, except that constant practice is the only way of mastering blind-flying. Each pilot will then hit on his own methods, in the same way as each one also has his own particular good or bad habits when flying.

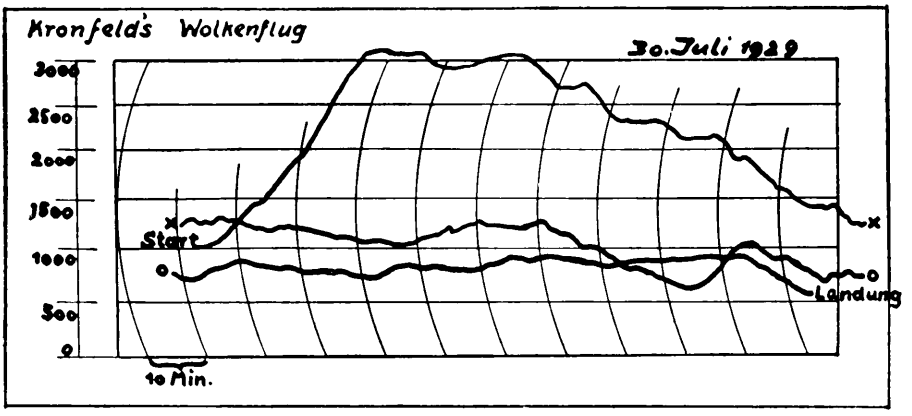
As there is a considerable danger of the turn-and-bank indicator and A.S.I. becoming iced-up, and though ways and means of overcoming this difficulty have been tried, they have not yet been perfected; so one must also make use of one's sense of hearing and the wind in one's face to regulate speed. Kronfeld says:—"In the course of my 1929 cloud-flight, I flew by keeping the stick in its correct position, as exactly determined beforehand and by noting the wind-stream against my face. As the 'Wien' whistles when skidding on a turn, I was also able to fly by ear."

To this I must add that hitherto I have reacted too slowly in this respect, or rather my plane has reacted too quickly. Also, I have definitely proved that the sound of flight is quite different when flying in up or downcurrents. However, it is only of late that I have cultivated this means of flying by "feel" and by "natural senses", and the success I achieved is reflected in my thermal flight of 28th March, 1933, when I soared for 46 minutes entirely without instruments (I did not even take the instrument-board with me). The barograph-chart of this flight is shown in Fig. 42. I was unable to watch the barograph during the flight.



Wolf Hirth's thermal flight in the "Musterle" without instruments. Actual soaring time: 46'. Auslösung: release.

I am not yet certain as to the cause of these different noises, but that they are different is indisputable. As soon as I heard the "upcurrent noise" I began circling in the usual way and always gained height, whereas whenever I heard the "downcurrent noise" I always lost height. Perhaps even a small change of pressure is sufficiently perceptible to the human ear, such as we presume to be the case with birds. (Systematic experiments in this connection would be very welcome.)



Kronfeld's cloud flight.

Should the turn-and-bank indicator fail, owing to possible ice-formation in the venturi, the difficulty can be temporarily overcome by removing the rubber tube connecting the instrument to the venturi and either blowing or sucking through it. Of course, this may prove very exhausting. During the last two years, electric gyroscopic turn-and-bank indicators, which cannot freeze up, have been invented for sailplanes as well as for power-planes. Whenever I flew in the "Moazagotl", I always had both an air-driven turn-and-bank indicator and an electric one: the latter, after various modifications, proved highly satisfactory and enabled me to fly with the maximum amount of safety. As turn-and-bank indicators are very expensive, several simple substitutes have been put forward, many of them ingenious in conception, but all lacking in the essential.

In the following pages will be found some further interesting accounts of cloud-flights.

How I Practised Blind-Flying

By Ludwig Hofmann

Before attempting blind-flying, it is essential to be able to fly faultlessly with visibility and to be able to do simple aerobatics. One should then experience no difficulty in learning blind-flying by oneself, and I would suggest this should be done in the following manner, which is how I myself learnt it:—

Fly with visibility, using only the turn-and-bank indicator and A.S.I., and make a point of practising this particularly when circling in thermals. Keep your eyes on the instruments in the machine and only glance at the horizon when loss of control is imminent.

A little theoretical practice will also be found helpful: Draw on a piece of paper, or better still on a bit of cardboard, all the possible positions of the turn-and-bank indicator, cut out the different diagrams, shuffle them and lay them on the table in a row. Then imagine that you want to fly in a straight line and make the necessary hand and foot control-movements, which correspond to the diagrams in order to make the machine fly straight. The same procedure can then be adopted for right and left hand turns. Of course, this can result in innumerable variations. Shuffling the cards alters the sequence of the diagrams, and consequently the movements which one must make will always vary. When the weather is unsuitable for flying, several people can play this game at once, and after a little practice they will find themselves giving the correct control-movements without any hesitation.

How to make correct allowance for instrument-lag can be achieved only after considerable practical experience. For the first blind-flight one should not attempt circles, but should fly straight through the cloud by means of the compass and turn-and-bank indicator. At first, and also later in very turbulent conditions or in a thunderstorm, one will be tempted over and over again to distrust the instruments and be directed by one's sense of feel: this is easily the most dangerous thing one can possibly do. It is essential to pay no attention to one's sense of feel but to rely entirely on the instruments. When blind-flying one's sense of feel is often extraordinarily deceptive and will give one the impression of bumps where none exist. This is because in very rough weather one gets a certain unsteady feeling which persists even when once more in calmer air-currents. As long as the needles of the instruments move, they will

be functioning correctly, but just before ice forms, lag will be evident, and when iced-up they will point to zero. That is the first indication that one should immediately try and fly straight out of the cloud as well as possible by feel, compass and turn-and-bank indicator. Once ice has begun to form, the rest follows quickly. When blind-flying, it is important to be well strapped in, and maps, etc. should be stuffed away, so that when the plane gets into abnormal positions they will not be liable to cause obstructions.

Cloud-Flying in the 1932 Rhön Competitions

By A. Mayer

My chief object in saying a few words about my two long cloud-flights in the 1932 Rhön Competitions is not to tell of the wonders of my experiences, which, in mere words, is barely possible, but to mention particularly those points which might prove useful to the reader.

The Competitions were nearly over, and we had had a great deal of bad luck, when at last the weather became favourable for soaring.

On 27th July, I had been hill-soaring for some time on the West Slope of the Wasserkuppe when I saw a storm approaching. It was moving from South-West to North-East, and directly the needle of the variometer began to get active, I at once set off across-country in company with Kronfeld. At first, many years ago, it always took me a long time to make up my mind whether or not to leave the hill, because once I set off I did not know where I should land, whereas many flights in the vicinity had made me familiar with every corner of the Wasserkuppe. Since then, I have found that it is easier to land almost anywhere rather than on the difficult Wasserkuppe: I therefore always leave it at the earliest opportunity.

While Kronfeld flew off in an Easterly direction, I went straight downwind before the storm. On the way I lost height rapidly, and with a heavy heart decided to return to the Wasserkuppe and let the rather sinister looking cloud pass over me. The result was stupendous. No sooner had the first wisps streaked by me than I was pulled forcibly right inside the cloud. Visibility vanished, and the variometer jumped from —3 ft./sec. to +10, 13, 16 ft./sec., where it then stayed for about ten minutes. As soon as it became obvious that I was rising rapidly, I began to circle cautiously, using the turn-and-bank indicator to enable me to maintain the same

radius, i. e. I kept the needle always pointing in the same direction, so as to remain in the rising air-stream. As I had anticipated, in spite of the turbulence of the air, I could always bring the plane back into a normal position with the help of the turn-and-bank indicator; and as was later always the case inside a cloud, I was at all times in complete control of the plane.

Here I must mention that it was entirely thanks to Wolf Hirth that I attempted to circle inside clouds, for shortly before this flight, he had of his own accord explained to me his technique of thermal soaring. On a clear day, when he sees by the variometer that he is rising, he begins circling in order to remain in the rising air-current. That, of course, was already common knowledge. What was new was that Hirth always maintained the same radius when making his circles by keeping the needle of the turn-and-bank indicator scrupulously in the same position. In this way, the plane is sure to make true circles in relation to the surrounding air, and remain within the area of lift. It then struck me that what Wolf Hirth did outside clouds must also be equally possible inside them, and as I have already said it proved highly effective with my very stable sailplane "MS H". My fellow-competitors, on the other hand, did not enter the clouds, either because they had no turn-and-bank indicator or no parachute, or because their planes were not sufficiently stable or strong.

To return to the flight: when I had reached a height of 3,000 ft. above starting-level, it began to rain, and then the rain turned to hail. As is seen in Fig. 42, I was in an open cockpit. I therefore crouched down as far as possible, so that only the top of my head projected. However, it was not exactly pleasant, and after a short while my back began to ache badly, and my hair felt as if whole tufts of it were being plucked out by the roots. I have described further down the remedy, which I discovered the following day when in a similar predicament and which saved me from the necessity of sitting in an uncomfortable position. Suddenly I saw the variometer jumping from +16 to —16 ft./sec.; at the same time, the altimeter registered a slow but steady loss of height. A glance at the turn-and-bank indicator showed me that all was well. Thereupon, I straightened out and tried to fly away from the downcurrents as quickly as possible; but I went on gaily losing height, until I eventually left the cloud behind me. Then I saw a chain of hills, which I presumed to be the mountains of the Hohe Rhön. I looked closer, and to my joy recognised Wartburg Castle, the Burschenschafts Monument, and the town of Eisenach just away to the North. I must add that my mother comes from Eisenach, so

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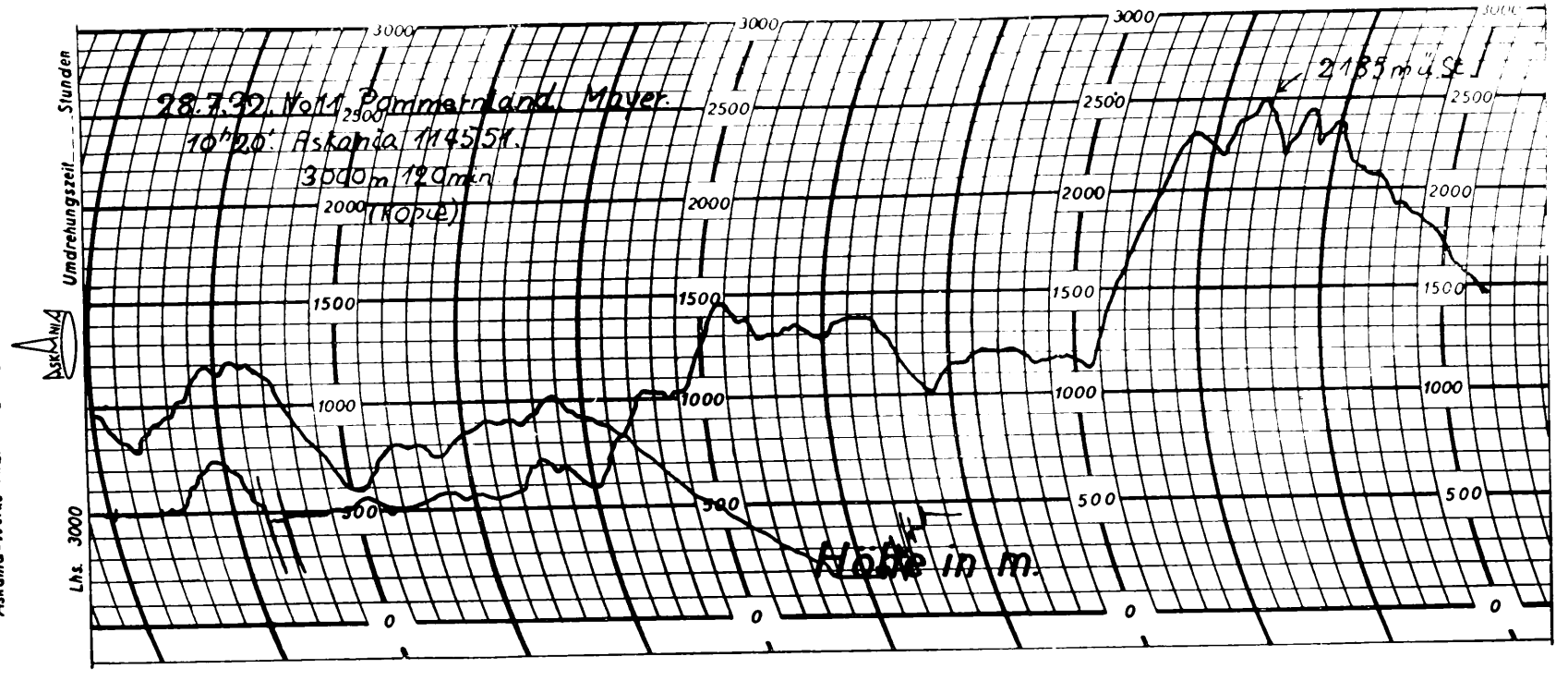
that I know it very well, and have always longed to fly there some day in a sailplane.

I had lost so much height inside the cloud that by the time I reached the Thüringian Forest. I was at a very low altitude, and therefore hill-soared for some time over a good slope in the hope of being able to attach myself to the next cloud that came my way. In the end, it began to rain heavily, a mist enveloped the wood, and the storm for which I was waiting never arrived; so I flew on through the downcurrents over the Thüringian Forest in the direction of Gotha. The rest of the flight consisted of a pure glide along the road to Gotha as far as Trügleben, which is one mile this side of Gotha.

Next day I was very nearly unable to fly, for on the way back, near Tann, the towing-car broke down, and I had to ride on on my motorcycle to rout out another car. Fortunately, a friend of mine came to the rescue, in spite of the fact that we had to disturb him in the middle of the night; and later in the grey dawn of the morning, I was able to re-assemble my plane on the Wasserkuppe.

This time, totally different weather conditions prevailed. Early in the morning, lovely cumulus clouds were already forming under a clear blue sky, though as they were small and not very productive I decided to land after a short flight and to wait a bit longer. Towards noon, when things looked better, I took-off again, and after hill-soaring for half an hour, flew towards a cumulus cloud. On entering the cloud, my "Pommernland" at once began to rise steadily, and I flew in a series of even circles until I eventually came out of it again more or less at the top at a height of 3,000 ft. As I had by now exhausted all the lift, and in the meantime had reached the mountains of the Hohe Rhön, I set off across-country with the wind behind me in a North-Easterly direction, in order to overtake as soon as possible a cloud that was moving away in front of me. Some way ahead, I saw another sailplane circling a little below me. At first I could not see who it was, but reflecting that there is bound to be some lift where any sailplane is circling, I pushed the stick slightly forward and hastened towards it. As I drew nearer, I was delighted to find that it was Wolf Hirth. (This happened not far from Meiningen.) We both began circling for all we were worth, and Hirth soon crept up to me. I tried to attract his attention by waving and calling to him, but just as he had almost reached my own level, I was caught up in the midst of the magnificent cloud above us. The variometer showed me that I was rising at an ever-increasing rate, until eventually it stopped still at 16 ft./sec. Actually, it was obvious that I was rising considerably faster. Once again, I began circling, and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succeeded in remaining in this area of strong lift. At 5,000 ft. above starting-level the machine dripped with moisture and the next moment ice had formed. The turn-and-bank indicator ceased functioning, the instruments were no longer visible owing to the frozen celluloid pane, and I could hardly keep my eyes open owing to the ice that was forming. However, I was determined at all costs to reach 6,500 ft., which was the height required to win the much coveted "Altitude Prize," and I decided to throw out the celluloid pane, which was no longer transparent. At this point I hit, quite by chance, on the solution of the problem (see Fig. 46). By pushing up the rear edge of the pane with my left hand, I could so arrange things that the instruments were plainly visible and what is more my head was protected from the wind, rain and hail. In this way, all those who, for one reason or another, prefer to fly in an open cockpit, are able to obtain some shelter when necessary by means of an adjustable pane.

Owing to the turn-and-bank indicator becoming iced-up, it was, of course, no longer any use circling, and I now flew due East only by compass. In spite of the ice having affected the aerodynamic qualities of the machine, the "Pommernland" continued to rise, and on passing the 6,500 ft. limit, I could not repress a shout of joy, especially as I was certain no-one could hear me. When I came out of the cloud, I saw that I only had a comparatively small cloud-summit beside me, and by flying through it several times, I succeeded in exhausting every atom of remaining lift. What followed was indescribably beautiful: a long smooth glide in brilliant sunshine, while around me and below were clouds through which appeared here and there the Eastern slopes of the Thüringian Forest. In the plains ahead could be seen the town of Arnstadt and Erfurt. Two cloud-streets were moving towards me and of these I chose the left-hand or Northerly one. As I later discovered, it would have been better to have taken the Southerly street, for I would then have reache the slopes of the Valley of the Saale and thus had a chance of increasing my distance as Wolf Hirth actually did. Twice more I succeeded in attaching myself to clouds near Arnstadt and Erfurt; then I made a long glide over Weimar with its alluring aerodrome complete with landing T, and continued as far as Apolda, where, finding no more cumulus clouds, I looked for a suitable landing-ground at my leisure on the edge of the town. The exceedingly hearty welcome which I received at Apolda made a wonderful conclusion to this eventful flight. My maximum height of 7,100 ft. above starting-level, i. e. 10,774 ft. above sea-level, created a German altitude record, and I had covered a distance of 78 miles.

As a result of these flights, I would like to suggest the following rules for cloud-flying:—

1. Never enter clouds without a parachute.

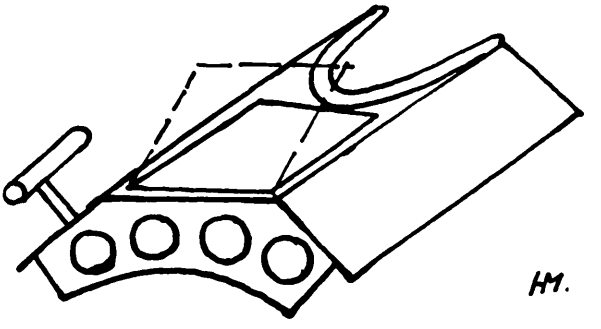
2. Reliable instruments are indispensable: it is essential to have a turn-and-bank indicator, a compass (to take the place of the turn-and-bank indicator should the latter fail), an air-speed indicator, an altimeter, and last but not least a variometer.

3. Only experienced pilots should enter clouds. It is essential first to practise instrument-flying with a clear horizon and without looking at the ground. One can then try flying straight through small clouds and finally attempt a few circles.

4. Never enter clouds without a sufficiently stable and strong 'plane, capable of a good T. V. dive, and with a safety factor of 8.

5. When flying in an open cock-pit, fix an adjustable celluloid pane to hold off rain and hail (which one may always encounter) and to enable the instruments to be seen.

In conclusion, if all these precautions are taken, cloud-flying becomes one of the most important aspects of cross-country work for in this way one can make use of one cloud after another and thereby cover a far greater distance than would otherwise be possible.



Detachable cockpit cover of MS 11, showing adjustable celluloid pane.

An Interesting Cloud-Flight

By Wolf Hirth

The least dangerous and most fascinating kind of motorless flight in existence is undoubtedly thermal soaring, by means of which we sailplane pilots have often flown many miles across-country under a cloudless blue sky. More interesting, however, and also more exciting is cloud-flying, which we have understood for many years, but have only lately systematically attacked with all the means in our power, using the most modern instruments. Moreover, in the 1932 Rhön Competitions, we at last realised that it was necessary to build sailplanes which were specially designed for cloud-flying.

I, myself, certainly managed to make blind-flights of up to 10 mins. duration with my "Musterle", but my friend Hermann Mayer was able to gain height by circling inside a cumulus cloud for half an hour with his more stable "Pommernland", until his blind-flying instruments became iced-up.

On 28th July, 1932, we took-off simultaneously from the Wasserkuppe, but lost sight of each other as we disappeared into different clouds. As a cloud-street extended as far as the Thüringian Forest, it was not particularly difficult to gain height between each glide. I made a few circles beneath a cloud whenever necessary and then, as soon as I lost visibility, flew straight on by compass in an Easterly direction.

A huge dark cloud had been building itself up to an enormous height between Meiningen and the Thüringian Forest; and as I contemplated this vast structure somewhat distrustfully from below, I suddenly caught sight of Mayer emerging from another cloud. He was about 600 ft. above me and was likewise steering towards this dark, threatening mass, the lift from which was already noticeable on my variometer. I went on circling quietly and at the same time watched Mayer, who, after a short respite, disappeared into the darkness above.

In a few minutes, I found myself getting close to the cloud-base, which soon enveloped me in a grey mist. I at once concentrated on my blind-flying instruments, i. e. turn-and-bank indicator, compass, and air-speed indicator, and tried to make large circles. Once again, it was brought home to me how difficult it was to control my machine in pitch on account of the sensitive elevator. In the com-

paratively calm air, however, I was able to make two complete circles. But then I must have reached the fringe of the upcurrent, for it became very bumpy. Suddenly my machine was thrown over on to its nose so violently that the dirt and sand, which had collected in the rear of the fuselage, was whirled forwards. So I gave up circling and sought visibility as quickly as possible. However, things moved with an even greater rapidity than I wished, for my air-speed indicator was registering 55 m.p.h. instead of the normal 37. As the speed began to increase, I pulled the stick back a little, or so I imagined. As my sensitive elevator only permits of very slight movements of the stick, directly the machine gathers speed it is very difficult to use the elevator properly, especially when concentrating on the turn-and-bank indicator, which, in rough weather, demands one's whole attention. Consequently, although I certainly had more pressure in my hand and was under the impression that I had moved the elevator, in reality I had done nothing at all. The speed of the machine, therefore, continued to increase, until I forced myself really to pull the stick back.

At last it grew somewhat lighter, and I found myself in a gaping chasm some 500 ft. broad between two immense walls of cloud. The ensuing flight in the dim and winding paths of this cloud-range became a terrifying but wonderful voyage of discovery: it reminded me of a flight which I had made in a 40 h.p. Klemm over the Alps in October 1929, when the low-hanging clouds forced me to dive into a gap near the Simplon Pass and fly recklessly along between the narrow mountain-sides over Domodossola as far as Milan.

Today, the mountain-sides were fortunately only cloud-walls, and one could confidently bump into them! I soon anticipated difficulties in the greyness which had by now enveloped me, but by flying straight ahead I found myself in less than ten minutes in the open below the cloud, almost directly over the Thüringian Forest, without having experienced anything unduly exciting.

For the time being there was no more cloud-lift to be found; so once again I had to resort to hill-soaring. For three quarters of an hour I thought over my position above the slopes of the "Beerberg" and then flew on to the "Kickelhahn", which two days earlier had been my "resting-place" for quite a long time. But this time I could not make a long sojourn there, for I knew that the locality was unproductive of warm upcurrents. However, I did find the "hoped for" thermal over Ilmenau and by circling let myself be drawn along with it as far as the valley of the River Rinne.

At the foot of each mountain, there invariably lay a village, and in a few minutes the youthful inhabitants would come pouring out

of the houses to gaze in astonishment at the huge man-bird above them.

But I did not stay anywhere for longer than ten minutes, fortuitous thermals advancing my flight to each successive bit of rising ground. At last the Valley of the Saale lay below me, and negotiating it with the same technique, I eventually reached the steep and wonderful soaring-slopes in the neighbourhood of Jena.

For nearly two hours I was an object of interest to the people of Jena, during which time I waited anxiously for a lift-cloud, my patience only being rewarded after a long interval. So I had ample time in which to interest myself with what was going on beneath me, certainly not without "internal" worries, as my cushion had shifted out of place and I was horribly uncomfortable. One must have personal experience of the cramped space in the cockpit of a sailplane to appreciate the vain attempts which I made to get into a better sitting-position. Although the plane began to toss about in the process, I did not feel any easier. Also the fact that my bag of fruit had slipped so far down into the front of the cockpit that it was out of reach, did not help to put me in a good humour!

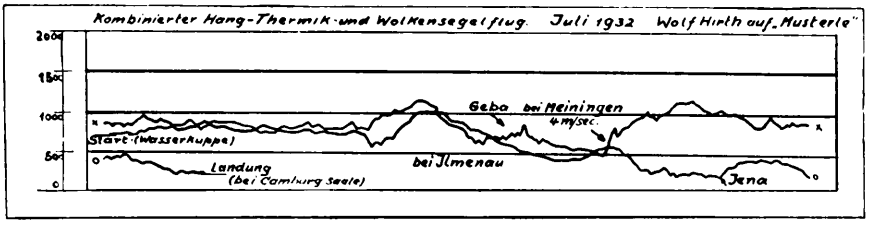
Finally, however, sheer perfection of flight prevailed over all trifling annoyances. The landscape was wondrously beautiful in the swiftly changing evening light, and there was much indeed to watch.

In the animated picture below could be seen: a small game of football on the playing-field, a motor-car with a puncture, and a chimney suddenly active for no apparent reason, while above a hawk passed by, also without cloud-lift! Evening was already drawing in, and girls who had been sun-bathing in the woods were putting on their clothes again, when I saw a large black cloud slowly drifting towards me.

Should I succeed in attaching myself to it? Four times I tried and failed, and was repeatedly obliged to return to the slope-winds, where I made one figure of eight after another and quickly reached the maximum possible height by their aid. At last, in spite of the fact that the cloud was dissolving, I managed to gain another 300 ft. of height and in consequence some 6 miles in distance. But that was all!

A passenger 'plane passed by on my right, and in a long glide Northwards I made nearer and nearer to the earth, eventually landing in the last of the twilight in a lonely cornfield by the Valley of the Elster.

The longest cross-country flight of the 13th Rhön Competitions was at an end.



Barograph chart of Wolf Hirth's 90 mile cross-country flight in "Musterle" (a combination of slope, thermal and cloud soaring) which was almost identical in distance and manner of execution as the cloud flight described here, but without much slope soaring at Jena.

Soon after I had landed, a small peasant-girl appeared on the scene, but after one look at my large and curious bird, she fled in consternation and only re-appeared accompanied by grown-ups.

Ready to help as usual, the peasants assisted me in dismantling my "Musterle" and in carrying it away, at the same time asking me the most impossible questions. One of them wanted to know whether the engine had exploded or whether I had lost the propellor! Others, whether I would be able to fly away again next morning, etc.

However, I was spared the necessity of answering most of the questions, for a few boys present, aged 12—14, readily vouchsafed the necessary information: evidence of the keen interest and sometimes superior knowledge of soaring among the youth of the country.

169 Miles Across-Country (1935)

By W. Späte

I took-off in a strong West wind of 35—40 m. p. h. on the Laucha Slope and soared for about 1½ hrs. in the slope-wind of a hill, lying to the South of it. At the same time, apart from the breeze blowing up the hill, ever-increasing bursts of thermal and cloud-upcurrents were in evidence. At 10.30 am. I succeeded in circling up to 2,300 ft. above the slope in such an upcurrent. However, I once more returned to the slope, as I had insufficient altitude with which to set off across-country. At about 11.0 a. m. I managed to circle up to the base of a cloud, which I reached at a height of 3,000 ft. The strong

wind had carried me a long way to the East of Laucha, and I worked hard to maintain the height which I had gained. This called for concentration, as the thermals were very poor, and there was a lift of only 2—3 ft. per sec. In fact, near Grimma, it was touch and go as to whether I should succeed in remaining in the air at all!

My altimeter was registering not more than 1,000 ft., when at last a lift-cloud came to my rescue and drew me up to my original height. Circling steadily with intervals of 6—12 miles straight flying, I saw between 12.0 and 1.0 p.m. the dull grey ribbon of the Elba, which I crossed at Riesa. As I did so, I was reminded of the flight, which I had made the previous year and which had terminated just short of the Elba near Dresden, whereas this time I was crossing the river at a height of 4.000 ft. Steinhoff, who had accompanied me from Laucha to Leipzig with his "Rhönadler", landed here in Riesa. I was very glad when I was joined by another competitor, for in many respects it is much easier to make a cross-country flight "a-deux" than alone, so I was disappointed when Steinhoff left me over Leipzig and went off on his own.

The greater part of the distance had hitherto been covered with the help of a large cloud-structure, which was moving rapidly Eastwards; but in keeping contact with this cloud it was soon evident that though I imagined myself and it to be travelling at the same speed, I could gain no height without drifting to the rear of the structure: the obvious discrepancy in speeds was observable by the cloud-shadow moving ahead of me on the ground, resulting in a continual battle to keep contact in a forward position of the cloud-base, where the best lift influences were located.

From behind Riesa, I made another of my hasty advances in an Easterly direction, and soon found myself below a particularly black cloud-burst with a lift of 7—10 ft./sec. Here, for the first time that day I succeeded in circling into a cloud. From a height of 5.000 ft., my machine rose more and more rapidly, until my variometer finally registered a lift of 20 ft./sec. and my altimeter was soon nearing the 10.000 ft. mark. At this height drops of rain hit my celluloid cockpit-cover. Suddenly the sound of the impact hardened—ice! Looking out I saw how a crust of ice, as thick as one's finger, was forming on the fuselage ahead, on the wings and on the struts, etc. Now it was only a matter of seconds before the turn-and-bank indicator and A.S.I., which work by means of external venturi, ceased functioning, and I lost control of the machine.

What followed was most unpleasant! I soon had to give up making my circles by compass, for the card was careering round wildly. My trusty "Condor" hummed through the milky whiteness at untold

miles an hour, and judging by the roar of the wind and the flickering needle-movements of the variometer, I must have made some wonderful evolutions. It was a good thing nobody could see me. As I could hardly use the elevator owing to the precipitation of ice, I longed for a glimpse of blue sky, and it seemed ages before it suddenly appeared. I steered towards it, and shot out into brilliant sunshine many hundred feet above tiny white puffs of cloud, which were floating over the dark surface of a well-wooded country. I then indulged in a peaceful glide round the whole of the surrounding cloud-world through which I had flown. Slowly one ice-crystal after another dissolved and splashed back into the air as a clear drop of water.

The instruments began functioning again. What a joy it was to be in the air now! A little later I was gliding over giant forests, once more in a normal manner, under more benign clouds.

Near the River Queis between two large wooded districts I landed on a potato field about half a mile East of the village of Lorenzdorf near Bunzlau. I had covered a distance of 169 miles from Laucha and had reached a height of 9.100 ft. above starting-level: my best soaring-flight up-to-date. (During the 16th Rhön Competitions, Späte flew 262 miles and was second to Oeltzschner in the total number of points awarded in the Competitions.)

Regarding my two Laucha cross-country flights (Lorenzdorf, 169 miles, and Sonnewalde, 94 miles) I would like to make the following observations: both flights were accomplished with the aid of cold fronts. Whenever there had been a heavy thunderstorm at night, wind-speeds of up to 45 m.p.h. were recorded on the following day. By clinging to selected portions of fronts, I covered a greater distance than would have been possible with my own flying-speed. During the Sonnewald flight, I always found lift only in the heaviest rain and flew for some two hours almost entirely in "rain-thermals" with a climbing rate of 7—10 ft./sec. (!!). I always remained in the cloud-rain until such time as ice formed. In my opinion, Dittmar's world's height record can, with suitable instruments, easily be bettered in our part of the world.*

* The present altitude record of 23200 ft. was created by Herr Flugkapitaen Drechsel in a „Minimoa" during the 19th Rhoenmeeting August 1938.

Heini Dittmar's World Altitude-Record in South America

The description of my world's height-record flight is very simple. On Saturday, 16th February, 1934, perfect soaring conditions prevailed in Rio with wonderful cloud-formations. We drove to the aerodrome "Campo dos Affonsos" and brought all the sailplanes to the starting-ground. Hanna Reitsch was the first to take-off in a Grunau Baby, then Wolf Hirth with his "Moazagotl" and Peter Riedel with "Fafnir". I was towed up at 11.0 a.m. with my sailplane the "Condor", and releasing at a height of 1.100 ft. rose in stable lift conditions at the rate of 4—6 ft./sec. The cloud-base lay at 2.600 ft. and it was obvious from the shape of the structures that a great height could only be reached by blind-flying within them. As I knew from previous experience how turbulent the air can be inside clouds, I took good care to fasten my safety-belt securely to prevent myself being lifted out of my seat by very heavy bumps. One more quick glance at the buckle of my parachute and I ventured into a cloud. By circling steadily, using the instruments in my machine (which is essential in order to remain in a region of lift), I slowly and steadily gained height until I had flown right through the cloud from base to ceiling up to 5.000 ft. The lift in the cloud slowly subsided; so I flew a little away from it in order to discover what further cumuli would provide me with the lift I required. I picked out one of the biggest dome-shaped clouds I could see and commenced the second spell of blind-flying, which was to prove less pleasant than the first. By means of the compass I flew right into the centre of the cloud, first in very strong downcurrents, where I was so tossed about that I could barely keep the machine in a normal position. Slowly the variometer indicated an increasing lift, until it eventually registered 13 ft./sec. Soon I had also risen to the top of this cloud, which brought me to a height of 8.125 ft.

8.125 ft. — The German height record was broken! But it should be possible to improve upon it still further. Everything had been all right so far; there was no reason why it should not continue in the same way. I knew that the "Condor" was strong enough, for I had built it myself. In order to obtain a compass bearing aligned on the largest cloud-dome, which I could not for the moment see properly, owing to my proximity to the cloud-walls, I flew a little away from them. Hardly was I inside the cloud than I was caught up in the most violent eddies and the further I flew the more my

plane was at the mercy of the general turbulence. The variometer, which shows the rate of "Rise" and "Fall" had long reached the end of the scale, the A.S.I. registered over 80 m.p.h., and the next moment jumped back to zero. A terrible jerk, and I was hanging on the safety-belt, though I cannot state definitely what position I was in. My one endeavour was to keep the flying-speed as low as possible in order to prevent the plane from breaking up in mid-air; but I only just managed it! The compass-card was circling madly, and the turn-and-bank indicator was also temporarily deranged; while the dirt off the floor of the cockpit was flying into my eyes. However, the altimeter was registering a steady ascent, and in 3—4 mins. I had, from 8,125 ft., reached a height of 15,200 ft., i. e. 14,100 ft. above releasing-point. The lift at times could be estimated at 35—75 ft./sec.!!

Author's Note:—

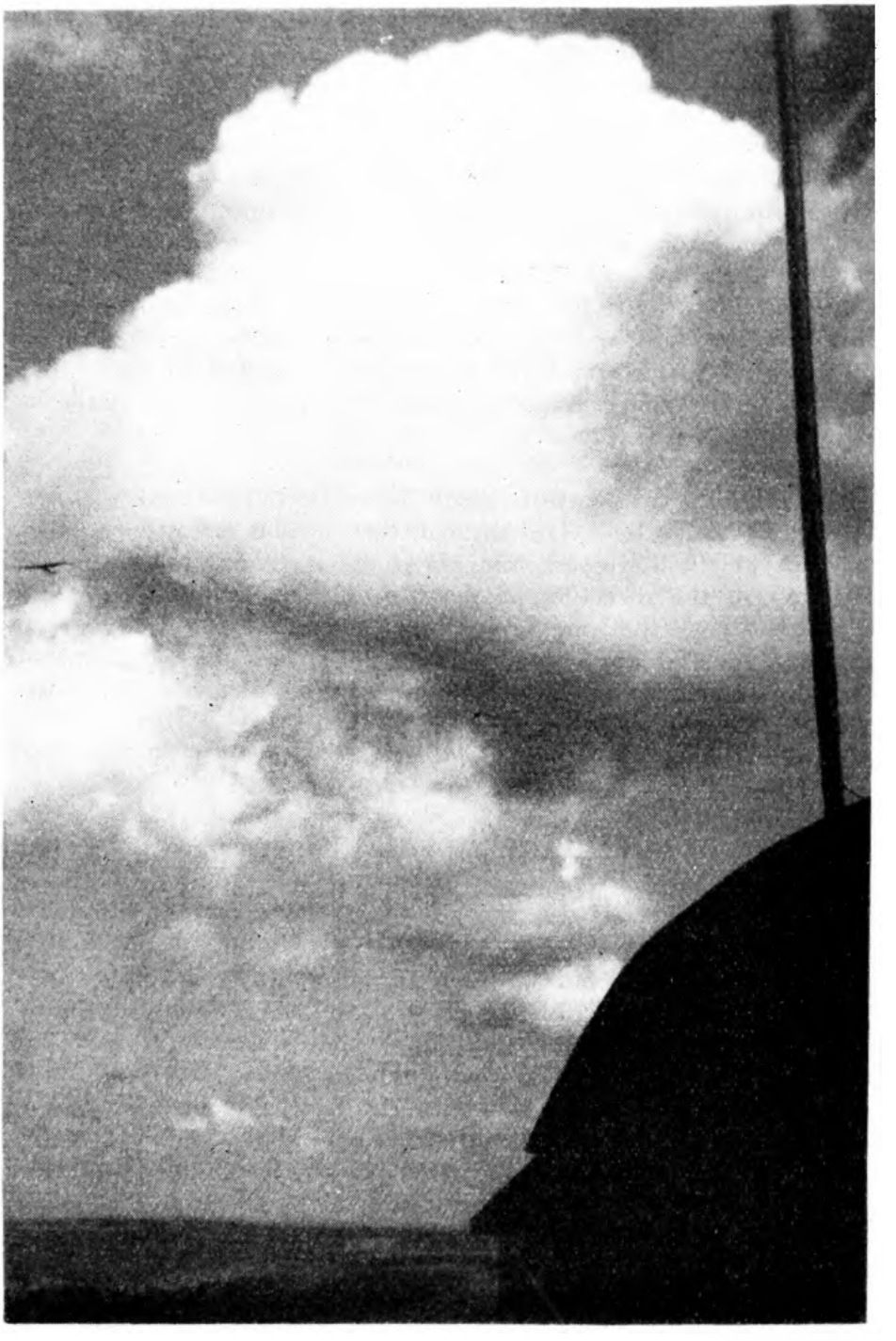
The characteristic feature about this record flight was the way in which Dittmar flew right through three clouds one after another and out at the top: each time he took a compass bearing with visibility in the direction of the highest part of the cloud, and adhered to it all the time he was blind-flying, until he had reached a good region of upcurrents; he then began circling by means of the turn-and-bank indicator, following the practice laid down originally by Hermann Mayer.

A Cloud Thermal Flight

By Dr. A. E. Slater, London

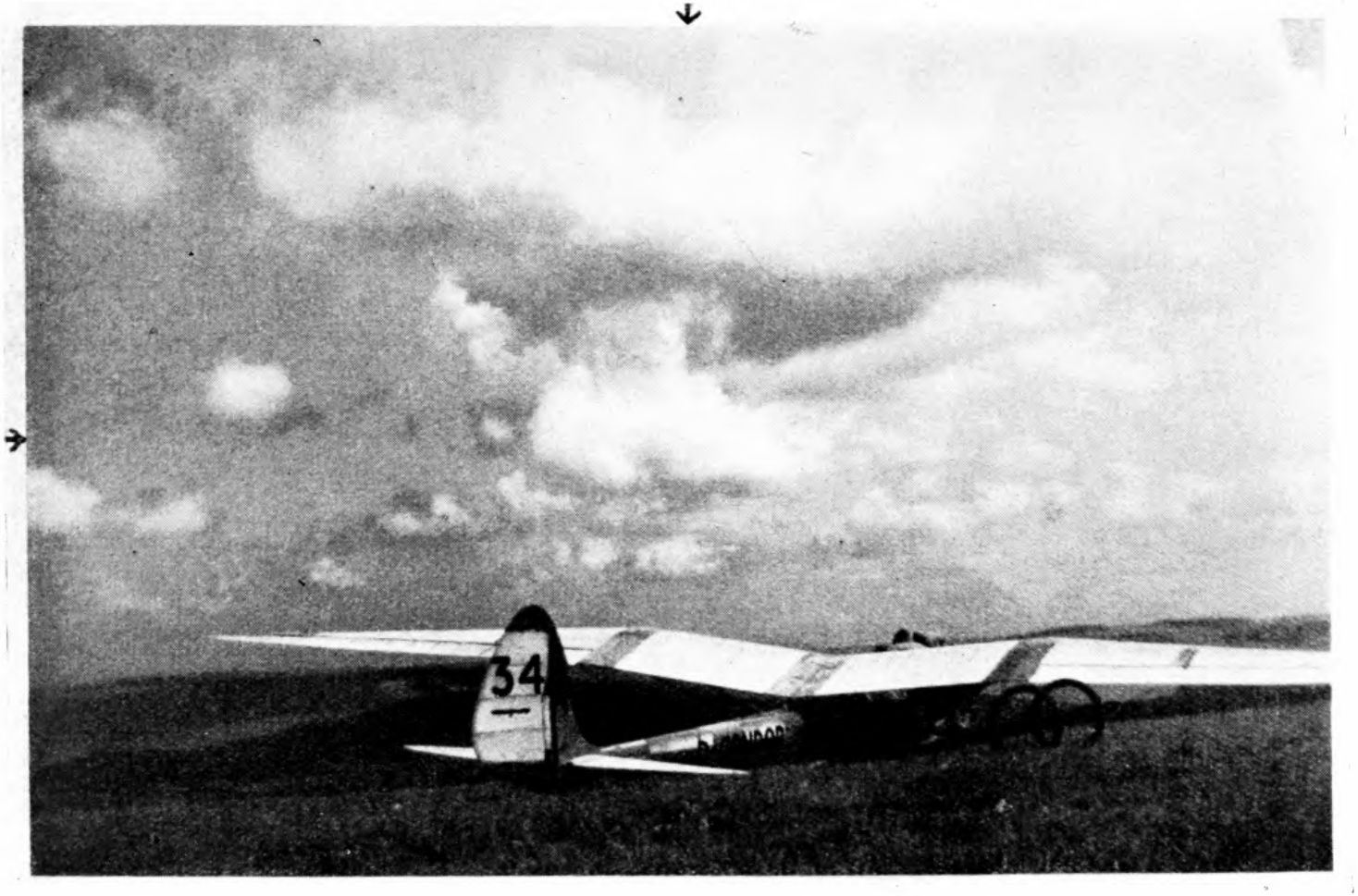
The following account is taken from an article in "*The Sailplane and Glider*" describing my visit to the 1932 Rhön meeting:—

Several machines were flying over the West Slope, most of them in close proximity to Hirth, though all, or nearly all, at a greater height. Suddenly the "Musterle" started going round in a series of extraordinarily tight circles of only about 25 seconds each. In spite of considerable "bank" (Hirth always banks his "Musterle" like an aeroplane) he rose rapidly past his neighbours, *not one of whom attempted to follow him.* One would have expected a concerted rush to the spot, especially as there was a cloud overhead, but apparently the time has not yet come when we shall see the human counterpart of dozens of gulls circling together in the same thermal current. The "Condor" certainly had a try at Hirth's cloud,



12.23 p.m. The cloud which enabled Hirth to leave the Wasserkuppe. Left: the "Condor" returning, having failed to get away under the same cloud.

12.28 p.m. Hirth is flying at the point where the two arrow-lines intersect. The Condor has just landed.



12.35 p.m. Hirth's position is roughly indicated by the arrows in the photograph.

Arrows show Hirth's position. Two new clouds have appeared. which, however, nobody has as yet utilized. Formation of a cloud-street by means of quick liberation of successive thermals over the same spot.

but wandered about under it so aimlessly that he finally had to give it up and make a hurried return to the Kuppe. In the meantime Hirth had gone right into the cloud. (See Figs. 48 to 51. The small arrows at the edge of the pictures show, at the point where their directions intersect, the position of Hirth's sailplane.)

It is noteworthy that Hirth, having found his rising column, made no attempt to explore its boundaries, but stuck to his circling until he reached cloud-level; not till then did he allow himself to cruise about once more and examine the surrounding air.

Hirth's distance on this day was 97 miles to Silbitz—the longest flight of this year's meeting.

[In the matter of co-operative effort, soaring pilots have, in the last few years, given practical expression to the wish contained in the above. In 1931, I had, it is true, made two long flights together with Grönhoff, but in the years 1932/33 pilots once more reverted to single flights. Not until 1934 did the specific clauses of the Rhön Competitions encourage the practice of combined flights, special prizes being awarded for team-flying, i. e. flights with three machines landing in the same direction. However, it became evident that it was more practical for only two machines to fly together, a thermal bubble seldom being sufficiently expansive for three machines to utilize it simultaneously. — Author's note.]

How I was flung out of a Sailplane while Cloud-Flying

By Rudi Pätz

This flight was made in the "Cumulus", a "Professor" type sailplane, which was now standing in the hangars, and with which Peter Riedel had, a week previously, made his 100 mile flight from the Wasserkuppe to Plauen. The weather appeared good, and almost a dead calm prevailed. An unbroken cloud-street stretched from South-West to North-East: a direct invitation for a cross-country soaring flight! But for us sailplane pilots that did not come into the question; there were twelve of us, and as we only had a few days left, landings away from the aerodrome were discouraged. Riedel once more entrusted me with his beloved "Cumulus", and we prepared for the take-off. I had a brief struggle with the para-

chute-harness, for I had never used a parachute before. But our good Chinese friend Sun, who understood all its intricacies, stowed me correctly into the cockpit. Stamer, the flying instructor, tested the strength of the cord and safety-belt, and then we were off! A last "thumbs up!" and all my attention was centred on keeping the correct height and distance from the towing-aeroplane "Flamingo". With a forward speed of 40 m.p.h. we climbed rapidly. At a height of 1,300 ft. Riedel gave the signal for me to release, and I disconnected myself from the "Flamingo", which proceeded to shoot down with lightning speed, leaving me, as a "beau-geste", a patch of turbulent air, to which the "Cumulus" reacted in a most unpleasant manner. I steered towards Wiesbaden, gradually decelerating, until I reached the optimum flying speed of 28 m.p.h. The variometer indicated a lift of $1\frac{1}{2}$ ft./sec., which was presently confirmed by the altimeter. Over Wiesbaden I had already gained 300 ft., but I soon lost it; and however much I tapped the instruments to verify their reading, the machine continued to sink at the rate of 3 ft./sec.

I strove to locate a larger region of upcurrents, and managed to maintain height. Once again I tapped the variometer, and the needle moved ever so slightly towards "Rise". That looked hopeful; soon it rose still further and eventually remained constant at between 2 and 3 ft./sec.

I was now 2,000 ft. above Wiesbaden, and everywhere people stood gazing up at me. I was in high spirits and continued flying towards those clouds denoting lift, which were still 1,000 ft. or so above me. Sometimes I lost height, and every now and again drops of rain tried to impede me; but I was set on winning the prize offered for a sustained flight of at least one hour over the town of Wiesbaden. Moreover, I was suddenly siezed by an ambition to gain a height of 3,000 ft. above releasing-point.

I had now completed forty-five minutes over Wiesbaden, and was only worried by the rain approaching from the South-West over the Rhine. Air conditions became extremely unstable; nevertheless the lift increased, and sometimes I was rising at the rate of 6 ft./sec. The rain fell faster, and every now and again I was obliged to wipe away the drops from my goggles.

At last the required height was reached, the altimeter registered 4,500 ft., and my time was up, 55 mins. having elapsed since I released the cable. I was satisfied and ready to return to the aerodrome. It was high time too, for I was right under cloud-base and over the Rhine. The clouds were lowering rapidly, and I was anxious to avoid the turbulence inside the rain-clouds without blind-flying

instruments. However, I thought there should just be time for me to make one more circle over Wiesbaden. The "Cumulus" continued to rise; suddenly a few wisps of cloud swept past me, and the next moment I found myself in the midst of churning vapours! I pushed the stick forward to 40—45 m.p.h., but the plane rose precipitately. At 50 m.p.h. I gave it up; for in spite of everything I had risen to 5,500 ft. Slowly, I pulled the stick back to 37 m.p.h. and waited. I still hoped to come out of the side of the cloud, for I had been near the edge of the cloud-street. But the milky whiteness around me remained unchanged. I had no idea what position the plane was in. The variometer registered a lift of 10—12 ft. per sec., while the forward speed showed a tendency to increase. Slowly I eased the stick back, but to no avail—6,000, 6,500 ft. was indicated on the altimeter. There was nothing to do but wait. I knew that sooner or later I should lose control, and the plane would stall and probably spin. 6, 7,000 ft.! There was a sudden acceleration of speed: 40—50 55 m.p.h.! Severe bumps hit the plane—60 m.p.h.: the needle of the A.S.I. had reached its limit. Suddenly, a violent jerk! And I hit my head on the side of the cockpit! Another one! And I banged my head first on the back of the cockpit, then on the front! My left hand lost its grip, while my right was torn from the stick! I heard an ominous cracking and rending; then suddenly quietude prevailed—but I was alone! Twin thoughts flashed through my mind: "The plane has fallen to bits—what will Peter Riedel say when he learns the unhappy fate of the 'Cumulus'?" I felt extremely thankful that I had a parachute with me, and I now waited for its opening jerk; but nothing happened! "Torn off! Lost! 26 years old! 6,500 ft. up! There is nothing I can do!" Such were my vivid and disjointed thoughts as I fell through the air. All around me there was nothing but a pervading whiteness. A few feet away, some small object passed me on its headlong rush to earth—and there behind me on my straps was a brown parcel: the parachute! I drew it towards me, stuck it between my legs, and pulled the rip-cord, whereupon everything went again! "That's finished me!" I thought. But no! There was the cream-coloured canopy billowing above me: quite gently the parachute had opened, and I was saved!

Slowly, I swung to and fro, and as drops of rain fell on to the taut silk of the parachute I gradually recovered my composure. In my left hand I was still holding the handkerchief for wiping my goggles, but the goggles themselves were gone! I looked at my watch: 4.0 o'clock! "What will happen now?" I thought. "Will the upcurrents be strong enough to keep me in the clouds?" It would not be impossible. When still in the sailplane I had been rising at the

rate of 13 ft./sec., so that there must have been a lift of at least 16 ft./sec., which is equivalent to the sinking-speed of a parachute.

In a few moments a gap appeared in the clouds, and soon afterwards I found myself already beneath them, drifting over a wood. Behind me was Wiesbaden, where it was pouring with rain, while ahead stretched the first peaks of the Taunus Mountains. I wondered where we would find the wreckage of the "Cumulus"! But what was that, hurtling down below there just above the forest? Doubtless a sailplane, can it be—? Hardly possible, and yet? From my height of about 1,000 ft. I could hear it whistling through the air. Now it was perched on the tree-tops. It must be the "Cumulus"! But how could I have been thrown out in such a manner? I had no more time for reflection, for I was rapidly approaching the earth. Making a quick survey of my position, I mentally noted the position of the "Cumulus", which was lying on the trees just before an "S" turn in the road through the forest leading to Wiesbaden. It seemed that I myself would land on the other side of it, further away from Wiesbaden on a meadow. But no, the wind was too strong, so it would be the wood! I braced myself for the landing and at the last moment instinctively pulled myself up on the harness, full of optimism, with the idea of lessening the force of the impact. I do not expect it had the slightest effect, but on the other hand it did not do any harm! A branch hit me behind the ear, and I found myself lying on the top of a pine-tree! Rustling softly, the parachute wrapped itself round the adjacent tree.

During the salvage of the plane the following day, the last riddle was solved: the pain in my arm and the fact that the parachute had failed to open. While subject to the violent disturbance in the cloud, I was probably thrown through the right-hand side of the cockpit, and in doing so had cut through a longeron and also the 2 mm. plywood covering. The rip-cord of the parachute (static type) which had been fastened to the plane then either got torn on a metal fitting or was sawn in two by a jagged edge of the torn plywood. The cord-end that was torn off remained whole, so that the entire affair, which might have a sad ending, really seemed more like a fairy-tale than anything else. And to complete the story, I received 100 Marks for the first sustained flight of one hour over Wiesbaden.

More Cloud-Flights

Muschik, of Dresden, who in April, 1933, made some fine cross-country flights of over 60 miles each, writes as follows:—

"When I am without blind-flying instruments, I always keep a straight course inside clouds by means of the compass and A.S.I. until I find myself in the open again. If I come out of the side of the cloud, I quickly turn round and repeat the performance. The only unpleasant part about this is the number of times I am forced to fly through the very turbulent region of downcurrents round the edge of the cloud.

At the beginning of my flight to Rabishau, which is 81 miles from Dresden, I entered a cloud at its base with a lift of 6½ ft./sec. After gaining about 650 ft., the lift gradually diminished, until I eventually found myself sinking at the rate of 8 ft./sec., and I was thrust out of the base of the cloud again still on an even keel. The same thing happened to me on another occasion, when, after reaching a height of 7,000 ft. above sea-level inside a cloud, I was interrupted by a fall of some 6 ft./sec. while still inside the cloud.

My flight to Börnersdorf (Gottleuba) was particularly unpleasant, as the general turbulence inside the clouds made 'orientation' almost impossible."

Hanna Reitsch, a young Hirschberg sailplane pilot, describes her first cloud-flight as follows:—

On 19th April, 1933, I took-off from the Hirschberg Aerodrome, which lies at an altitude of 1,000 ft., and was towed up in a Grunau Baby II by a Klemm monoplane to 3,000 ft. It did not look as if I should be able to make contact with a cloud, as the cumuli were already very ragged and obviously dissolving. However, a sudden rising of the power-plane ahead caused me to release the cable, and looking at the variometer, which denoted a lift of up to 8 ft./sec., I at once began to circle. I had never before realised the necessity of a variometer, as when slope-soaring the rising air makes itself felt far quicker than is shown on the variometer. Without my altimeter, I would probably not have believed that I was rising, but as the first wisps of cloud passed by me and the earth gradually disappeared from view, there were no two ways about it. All around me, there was nothing but a deep and impenetrable whiteness, and it began to snow heavily. As conditions remained stable, it was easy to keep the machine circling steadily with the correct bank. The variometer showed a lift of almost 10 ft./sec. How long I remained inside the cloud I cannot say: to me it seemed an eternity!

Nevertheless, it gradually grew lighter, and presently I found myself flying in brilliant sunshine above the cloud at a height of 6.200 ft. My joy did not last long, for I suddenly began to sink at the rate of 10 ft./sec. Diving into the cloud from above, I tried to leave the region of downcurrents as quickly as possible, but fell out of the side of it. However shortly afterwards, once more losing visibility, I arrived in a new area of lift, and eventually reached a height of 6.000 ft. From then on, I sank slowly but steadily and landed after three quarters of an hour back at my starting-place.

Lift-Clouds

There have not yet been many successful flights made in local thunderstorms, viz. giant piles of cumulo-nimbus clouds. They demand the most advanced flying technique of all, but at the same time provide the means of reaching great heights. The large area of these cloud-masses together with the terrific up and downcurrents which prevail within them, sudden downpours of rain and hail, lightning and ice-precipitation, all involve great danger and necessitate the utmost care.

Kronfeld and Mayer were the first to fly right through large cumulus clouds from base to ceiling; and from year to year, pilots with improved sailplanes find these fine-weather clouds an ideal playground for altitude-flights.

Apart from the clouds mentioned above, there are also other varieties, such as "dust" or "powder" clouds, which are also worthy of note.

A light wind, which of itself is not strong enough for slope-soaring, can, in certain conditions, cause the formation of a cloud (see Lenticular Clouds), which in turn produces sufficient lift for soaring purposes. We can therefore call this additional lift "condensation-lift". This was exemplified in the 1932 Rhön Competitions, when many an altitude-flight could be attributed to the same cause, in spite of the prevailing conditions of sun-thermals! Quite apart from many soaring flights, I was able, during the 1931 German National Light-Aeroplane Competitions, to utilize this condensation-lift for the purpose of increasing my average speed from Munich to Vienna.

Newly-formed and stationary clouds are nearly always indicative

of these particular conditions. Even so, one should not be over-confident, but should check the lift by means of the variometer.

In this category we also have "wave-clouds". In the same way as waves are formed by the wind sweeping over the water, so in the atmosphere we have, between two layers of air of unequal temperature and moving at different speeds, a long series of undulations or billowing air-masses. Owing to the difference in temperature, condensation can take place and "wave-clouds" materialise: the air moves up and down. Upcurrents of over 3 ft. sec. have been measured from the Lindenberg Observatory, while storks have been observed soaring in the van of "wave-clouds". Aero-towing may one day enable sailplane pilots to experiment in this as yet unexplored type of upcurrent. Moreover, these inversion waves need not necessarily produce clouds. Many a sailplane pilot will, to his astonishment, have found himself being drawn up by them perhaps even at low altitudes and held there in a region where he least expected to find lift.

There are many kinds of upcurrents, which have not yet been put to advantage, and many we will never be able to use at all. For instance, the size and weight of our sailplanes will probably prevent us from ever being able to utilize the breaking eddies that flow round the peaks of hills, about which Professor Idrac has written in his book.

Guenther Groenhoff †.

6. Local Thunderstorms

My Soaring Flight in a Local Thunderstorm

By Heinz Huth

At 1.0 p.m. on 13th July, 1932, I made preparations for a flight. As the sun was burning hot and large cumulus clouds promised good lift. I proposed to try out the soaring capabilities of the "Kassel 20". In spite of the bumpy conditions, the towed-flight was effected without incident. At 1.15 p. m. I released at a height of 3,000 ft. under a cumulus cloud, and with the help of the variometer, which I had myself constructed, ascertained and utilised rising air-currents. The plane rose higher and higher, and I was soon at 4,500 ft. Far below me lay the aerodrome, and the aeroplanes lined up in front of the hangars looked like small white birds. Hamburg, with the glittering shores of the River Alster, was also visible behind a veil of mist. In order to discover the diameter of the rising column of air, I flew to and fro under the cumulus cloud, which comprised an enormous area, but I did not always find sufficient lift, so that in the course of this tour of inspection my height often fluctuated as much as 300 ft.

In the meantime, however, in consequence of a light S.E. wind I had drifted away from the aerodrome, and I now flew on the edge of the "cloudbank" to the next cloud approaching from the S.E. and chose a spot on the edge of the huge cloud-structure, where there seemed to be the strongest lift.

After I had patrolled this new cloud a few times, the plane rose first to 5,000 ft. then to 5,500 ft. As I flew South towards Hamburg, at about this altitude, I was for the first time sucked up into a cloud, and I then flew on in a grey mist. As it was not very bumpy inside the cloud, I could easily keep to my course by use of the compass, and I eventually came out of the cloud on the other side into brilliant sunshine, with Hamburg well in sight.

In this way, I glided down beyond the region of cloud-lift, took a side-view of the clouds, and then after losing about 650 ft., once more soared beneath them. Slowly regaining height, I suddenly found myself between two long clouds, which looked like a pair of scissors, and stretched as far as the horizon. As the variometer was showing only a slight lift and I had no intention of being drawn up into a cloud of excessive turbulence, my wish was to glide gently

down and possibly cut through the lower part of the cloud and out into where I could once more lose height. Barely had I flown anywhere near the clouds, however, than it was as if two giant hands had suddenly gripped me and pulled me up into the grey mists above. As this happened close to the walls of the cloud, I wanted to fly Southwards as before and out of it again. But what was that??? The plane was plunging like a wild horse, while the compass was dancing madly, and the needle pointing in every direction except South, for which I searched in vain, while the "Kassel" continued to rise unceasingly.

At 8.000 ft. it suddenly struck me that I was in a thunderstorm, which must have come up on me from the East unawares. No sooner did I realise this than all hell was let loose! Suddenly, without any actions on my part, the speed increased to over 60 m.p.h., and I was pressed forcibly into my seat, so that I was curled up into the most horribly cramped position. As quickly as the speed had increased, so it now swiftly returned to zero, and the force pressing me into my seat suddenly became negative, i.e. I was hanging from the shoulder-straps. So it went on: at one moment I was lying on the edge of the cockpit and the next hanging from the safety-belt: and it was such a nightmare that it was quite impossible for me to make out where the ground was! It was certainly a wonder that the spars withstood the strain. During this mêlée the plane had continued to rise: and as the altimeter exceeded the 10.000 ft. mark, it suddenly became icy cold; while the rain which, in the meanwhile, had drenched me to the skin, turned into hail and began to be very unpleasant. I tried to pull my head in, but thanks to its size was only able to hide half of it, so that the back was still exposed to the hail, which fell on it like pebbles and was very painful, in spite of my wollen cap. I also had to give up trying to protect my head with my hand, as the hail was just as painful there as elsewhere—which fact was later amply evidenced by a very swollen hand.

When the hail ceased, I saw right in front of me a cloud-wall, but I was unable to determine its boundaries, as its peaks and walls were of an undefined greyness, which closed behind me. Far below, I then noticed a small black triangle consisting of grey balls of cloud. Back and forth I circled in a vain attempt to see the ground. Then, remembering my original course, I flew South again into the clouds. But hardly was I within them than hell was again let loose. The "Kassel" began to prance about, and I once more had to crouch down in the cockpit. So there I sat with my head tucked down, sopping wet and shivering with cold, holding the rudder in a neutral

position, in order not to overstrain the machine, while moisture blurred my goggles and made everything indistinct and hazy.

Up till now, the lightning had not been in any way unpleasant. But when a flash blazed past me, it seemed as if it had gone right through my body, while my hand felt as if it had been chopped off, and everything went black! "That's done it!" I thought. As I gradually came to myself again, the first thing I did was to inspect my limbs. I could not feel my right hand, and I had a pain in the upper part of my left thigh. After wiping as much as was necessary of the water off my goggles with my left hand, I was relieved to find that although my sense of touch was paralyzed, my muscles and reflex actions appeared to be all right.

Gradually the turbulence subsided; the hail changing first into snow and then into rain. Now I could risk putting my head out, and to my surprise saw that the altimeter registered only 3,000 ft. But I could not bring myself to believe that the turbulence had subsided once and for all, for during the storm there had often been intervals of calm. So I was very glad when the altimeter continued to fall and I at last came out of the cloud at 1,500 ft.

Ahead of me lay a large estate, and I was preparing to land there, when I found to my astonishment that my gliding-angle was not as flat as it should be and that I was badly under-shooting. In a steep glide, the "Kassel" headed straight for a mound, and as it was impossible to pull her over it, I had to push the stick forward, and fortunately came to rest on a clover field, half a dozen feet short of what looked like disaster.

I was immediately surrounded by peasants from the neighbouring villages, who helped to unfasten me. With chattering teeth, and covered in ice and snow, I climbed out of the plane and soon saw the cause of my bad gliding-angle. The hail had perforated the leading-edge and also torn the fabric a little way behind it. The peasants, who thought I had lost my propeller in the storm gladly undertook to keep watch over my sailplane, and one of them took me into his house, where I was at once given dry clothing and something warm to eat and drink.

Hofmann's Flight through four Local Thunderstorms

By G. Brütting

On the very first day of the eventful 15th Rhön Meeting, 1934, Ludwig Hofmann made a superb flight in a Rhönadler. He was the only pilot to make a long cross-country flight on this day, and succeeded in flying 72 miles to a place not far from Naila. As Hofmann himself told me, he flew through four local thunderstorms one after the other. This fact makes his flight particularly noteworthy, as hitherto, although such flights had certainly been made, heat-thunderstorms had never been so deliberately exploited that it had been possible to fly across-country with them.

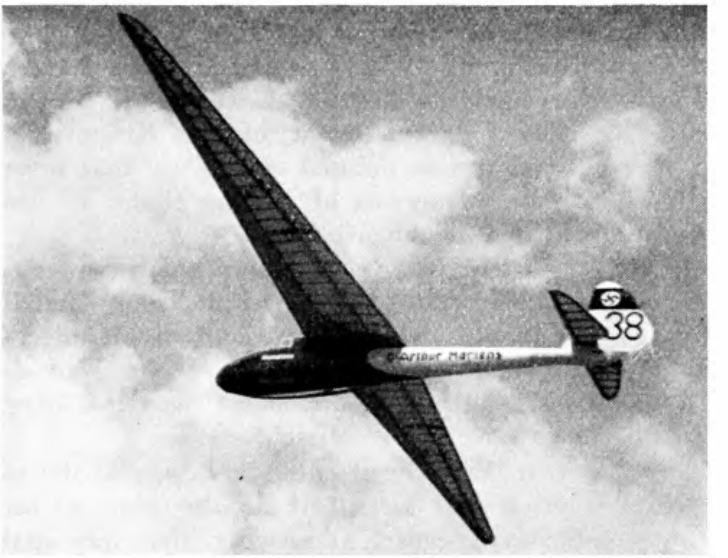
After slope-soaring for a short while, he found a passing thermal, and with it climbed to 3,000 ft., where he entered a cloud, and flying blind rose steadily at the rate of 8—10 ft./sec., until eventually the variometer registered a lift of as much as 16 ft./sec. From somewhere or other came a low rumbling; Hofmann thought his eyes must be swimming, for every now and again there appeared inexplicable flashes before them. It never struck him that strong upcurrents had drawn him up into a thunderstorm and that he was carrying out his first thunderstorm-flight. He only realised what was happening when the tattoo of the hail on his wing-surfaces completely drowned the howling of the wind, and his A.S.I. and turn-and-bank indicator became iced-up, so that he could only fly by compass and by instinct.

As he was still rising, he very much regretted having no barograph with him, as with his estimated height of over 11,000 ft. he would have been certain to win the altitude prize. After flying blind for some time, he came out of the clouds at about 8,000 ft., and a wonderful sight met his gaze: a cloud-tunnel: on the one side the deepest black and on the other dazzling white, on which the sun was shining—refraction causing a thousand different colours. Soon he was overtaken by a second thunderstorm, out of which he suddenly fell at a height of only 250 ft., and he was already preparing to land when an ascending whirlwind of dust-clouds gave him the clue to further upcurrents. He flew towards them, spiralled upwards and in a short while found himself again at 6,500 ft. He then re-entered the second thunderstorm and flew straight through it.

Once more in the open, he located some way off yet a third

thunderstorm which he approached rapidly. When the two thunderstorms met, he found himself in the midst of the "thunderstorm-corridor", where it was so bumpy, that the Rhönadler groaned in all its joints under the strain, obeyed none of the controls, and threatened to break up at any moment. The machine was pulled hither and thither, and executed a kind of "falling-leaf" without remaining controllable for more than a moment. However, as soon as the end of the column had been reached, all was calm again and the Rhönadler once more responded to the controls. When he had flown right through this thunderstorm, he was once more able to steer towards a fourth. Unfortunately, it lay in the opposite direction, so that he was not able to cover any great distance, even though it was the longest that day, and for him 72 miles was certainly a very promising beginning. He could see yet another thunderstorm, but was unable to reach it, as he had insufficient height with which to cross a chain of hills of the Franconian Forest.

The newspapers brought, on the following day, confirmation of his unique and exciting flight, for they reported heavy thunderstorms over Franconia and Thuringia. Hofmann had flown blind half the time and mostly without instruments.



Sailplane Rhoenadler.

7. The Long Wave

The Secret of "The Moazagotl"

By Wolf Hirth

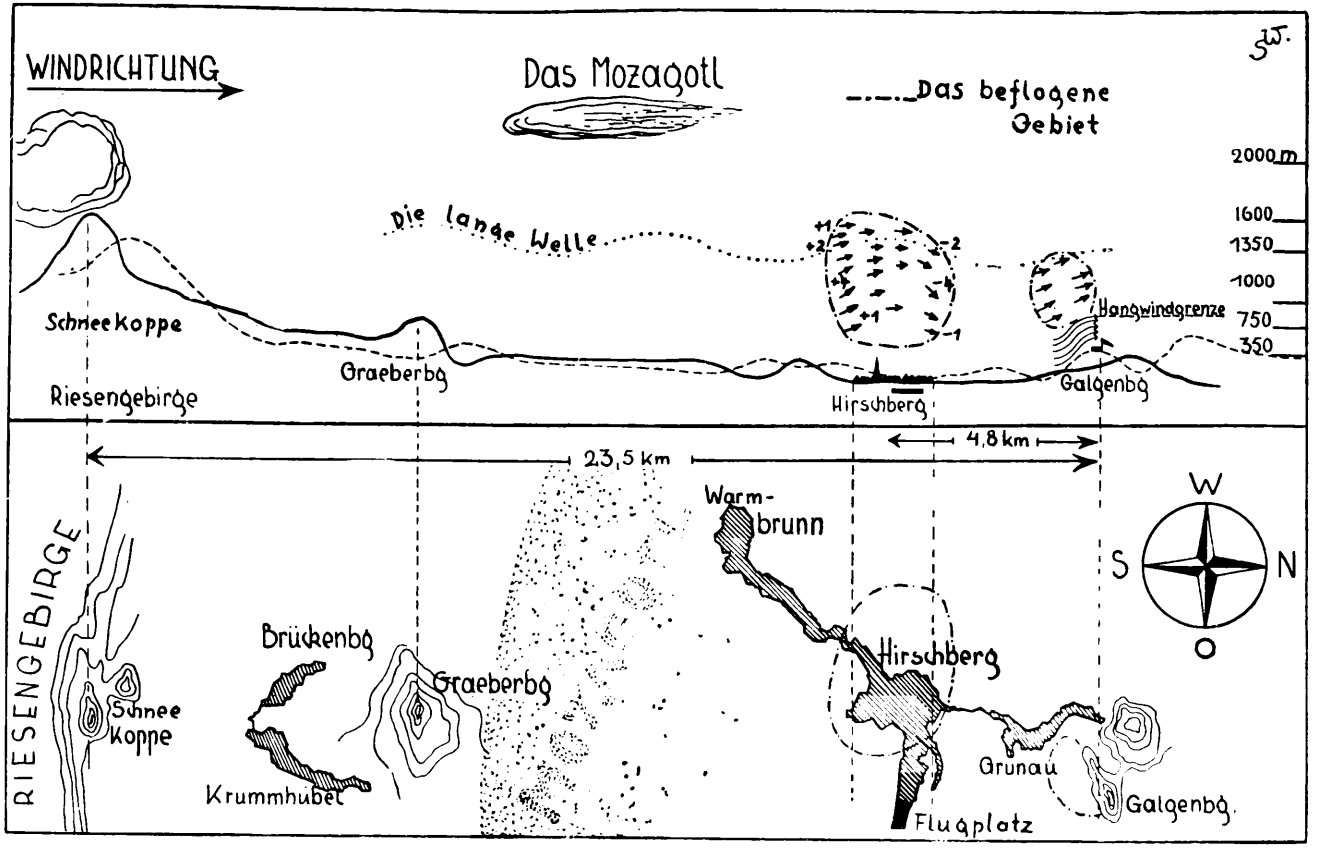
In order not to attract the wrong circle of readers, it should be made clear at the outset that this article does not deal with an adventurous story from Mexico, but with a "stationary cloud", which, in a strong South or South-West wind, is to be found day and night at a high altitude over the centre of the valley between the Riesengebirge and Hirschberg mountains, and has, since olden times, borne the name of "Das Moazagotl". What that means is not definitely known. There is a story going about which tells of an eccentric fellow, who, many years ago, instead of merely driving his plough, was in the habit of looking up at the sky and the clouds. He would tell others that there must be some special significance about a cloud, which, whenever the wind was in the South, would not move along with the wind like other respectable clouds, but would stay constantly in the same place. This man's name is said to have been Gottlieb Motz, or in Silesian dialect "Der Moaza Gotl". But that, as has been said, is only a legend.

When, in the Spring of 1931, I returned from New York to Grunau in the Riesengebirge district, I was made aware of the "Moazagotl" by Herr Feige, Director of the Krietern Observatory near Breslau, and it was pointed out to me that it would be well worth while, in the interests of soaring flight, to investigate the air-conditions in this neighbourhood.

Although it was nearly two years before the first step in this direction was made, the results were all the more startling. On March 3rd, two sailplanes succeeded without either thermal currents, thunderstorm or slope-upcurrents, in carrying out an hour's flight at a height of 2,600 to 4,600 ft. above the Hirschberg valley, almost directly above the town of Hirschberg.

Already in the year 1917, near Sofia in Bulgaria, the meteorologists discovered an upward current of air, the origin of which was probably due to the same cause. Admittedly, that was at the time purely an observation and measurement from the ground; Professor Georgii, the well-known meteorologist, discussed it in his book on soaring flight in 1922.

On the afternoon of the day mentioned, when I was supervising



Windrichtung: wind direction. Das beflogene Gebiet: regions explored. Die lange Welle: the long wave. Schneekoppe: snow-peak. Handwindgrenze: slope-wind limit. Flugplatz: aerodrome

The "Moazagotl" in the late evening of 18th March 1933.

the auto-towed flights of my pupils on the Hirschberg aerodrome, we noticed that one of our sailplanes, soaring over the grounds of the Grunau soaring school $2\frac{1}{2}$ miles away, had reached an astonishing height and was beginning to fly upwind towards the town of Hirschberg. With great haste I had our Grunau Baby II (a small sailplane of 43 ft. span) brought out and the towing aeroplane (Klemm L 25, 60 h.p. Hirth motor) started up. When, at the end of half an hour, everything was ready, there followed the most exciting towed-flight of my life!

Owing to an extraordinary eddying of the air, we could not rise much above the tree-tops, high-tension cables, and chimneys, and we had hardly struggled up to 150 ft. when a gust threw us down again to 60 ft. The aeroplane before me danced about like a mad horse. At least ten times I was on the point of releasing, but a severe crash might have resulted to the aeroplane, due to the trailing cable. So there was nothing for it but to clench one's teeth and carry on.

At last, after five trying minutes, 300 ft. of height were gained. Then followed a period of rapid climbing up to 2,600 ft., where

the other sailplane was already soaring. At this height I parted company from the aeroplane, flew nearer to my comrade, and recognised Hans Deutschmann in a Grunau Baby. Even at this height, the turbulence of the air was excessive but no longer as dangerous as it had been near the ground. I at once set about measuring the strength of the rising current, and could actually confirm the existence of a stationary upcurrent region, which began South of Hirschberg at a somewhat low altitude and stretched to a height of 4.600 ft. as far as half a mile to the North of Hirschberg. The height was sufficient to enable us to see well over the plateau of the Riesengebirge, which spread before us.

I could determine a lift of 13 ft./sec., while to the North, at a lower altitude, down-currents of 13 ft./sec. were measurable. The lost height could always be regained without difficulty in the upcurrent region lying to the South of Hirschberg.

When the sun had disappeared behind the Isergebirge, we both set about the return flight. Deutschmann, who had flown entirely without instruments, landed back at his starting-point, while I returned to the Hirschberg aerodrome after having flown for $1\frac{1}{4}$ hrs.

The secret of the "Moazagotl", beneath which we flew is still not entirely solved. In order to do that, it will be necessary to make a series of further research flights. Nevertheless, we had performed the first deliberate soaring flight in a type of upcurrent hitherto never utilised, which I might call the "long-wave", since it is undoubtedly concerned with a long wave-like motion of the air, arising from the turbulence behind the high mountain.

Lenticular Clouds

By Alan E. Slater

The "Moazagotl" under which Wolf Hirth and Herr Deutschmann soared, as described in the preceding article, is an example of a lenticular cloud. The name is given because such a cloud is commonly (though not always) lens-shaped.

The peculiarity of a typical lenticular cloud is that it stays in the same place, and does not move along with the wind. It performs this extraordinary feat by continually growing at the windward edge and melting away at the leeward edge. It may be compared to a waterfall, which always stays put, although the water of which it is

composed is continually entering it at one end and leaving at the other, or, better still, to the wave caused by the presence in a swiftly-flowing river of a boulder beneath the surface.

And here the comparison is particularly apt. For a submerged boulder does not merely produce one wave; it gives rise to a whole series of waves away down-stream, one after another. What is more, these waves remain stationary, although the water can be seen rushing at speed right through the series. If only the same phenomenon could be reproduced on a larger scale, it should be possible for a surf-rider to remain poised in one position by sliding down the front of the wave immediately over the boulder (down relatively to the water, not to the landscape), which is virtually what the slope-soaring of gliders amounts to. But our surf-rider could perform the same trick on any of the other waves further down-stream. And this is, in effect, precisely what Hirth and Deutschmann did. The water in the river sweeps up over the boulder, drops down the other side, and rebounds up again, not once but several times. Similarly, the air sweeps up over the mountain, descends beyond it, and rebounds up again. And in one of these upward rebounds the sailplanes soared. It is the fact of their being formed in this *rebounding* air that is the chief characteristic of lenticular clouds in the lee of mountains.

Many lenticular clouds are lacking in detailed structure, but others, perhaps the majority, show edges broken up into tiny cloudlets. The cloudlets are carried along with the wind, and if a close *and patient* watch be kept, they will be seen to be continually forming at the windward edge of each main cloud, subsequently moving into the cloud and getting swallowed up in it. At the leeward edge, little cloudlets will continually emerge, only to melt away before long into nothing. The cloudlets move through the stationary clouds just as ripples on water move up and over each stationary wave in a river.

Often, when lenticular clouds are unrelated to mountains or hills, they will move along, though at less speed than the wind which is blowing through them.

Since the pioneer flights of Hirth and Deutschmann in stationary air-waves, several more flights have been made in the same place under similar conditions, gradually greater heights having been achieved until such flights have actually been responsible for the last two world's height records for soaring flight.

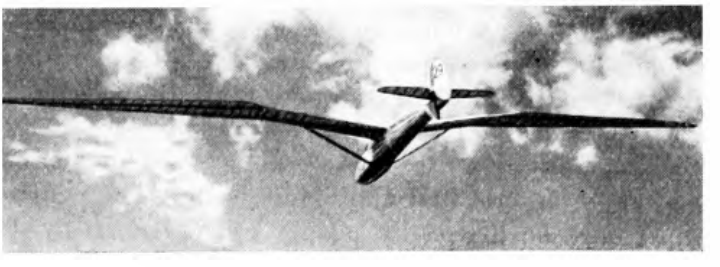
On October 1, 1935, several pupils in an aeroplane-towing course contacted with the up-current of a stationary wave and attained great heights, Dr. Ratig being able to climb to over 13,000 feet.

In the following year, Paul Steinig, an instructor at the Grunau gliding school who has taken particular interest in the "Moazagotl", explored a series of three air waves by means of a "Grunau Baby" sailplane with a small engine fitted. He found the three corresponding areas of up-current to be 2½, 6½ and 13½ miles respectively to the leeward of the mountain which was apparently causing the waves. During the flights of the previous year, however, which were believed to have been made in the "first rebound", the up-current was 9 miles to leeward of the mountain, and this is a more usual order of magnitude for the waves.

On May 21, 1937, a number of participants in a competition soared to even greater heights in the up-current of the first wave, which was found to be about 10 miles in the lee of the mountain, with a second wave at 19 miles. Herr Steinig attained a height of 18,753 feet above sea level, Herr Wolf got about 300 feet higher but was beyond what his barograph would register, while others attained 17,000 feet and lesser heights, including Herr Ziller, who took a two-seater machine with a passenger up to 16.000 feet and set up a world's record for two-seater sailplanes.

Finally, on September 14, 1937, Dr. J. Küttner soared to 22.310 feet, climbing up in front of the windward edge of the actual "Moazagotl" cloud. All these climbs were made from an aeroplane-towed start.

Dr. Küttner states that these long atmospheric waves are formed in stable air, and the length of the waves, which is independent of the height of the hill which sets up the wave train, can be calculated theoretically from the speed of the wind and the lapse rate (change of temperature with height) of the atmosphere. The "Moazagotl" is invariably formed in the so-called "Föhn" winds. The subject is of interest to pilots in other countries also, where similar waves undoubtedly form, and on September 8th, 1937, two British pilots rose about 7,000 feet above the site of the Midland Gliding Club in what is believed to have been just such a stationary wave, in the lee of the Welsh mountains.



Sailplane Moazagotl

8. Methods of Launching

The early methods of 1922 are gone! How well I can recall my flying instructors Harth and Messerschmitt standing by the ropes to the left and right of the plane, and by the sweat of their brows coupled with exhortations and benedictions despatching me from the mountain-side!

Bungy-launching, which brings out the team-spirit among pilots, later became the standard method of taking-off and it is still in force to-day; there is no need to elaborate upon this type of launching, as it is well-known and widely practised. With larger planes, such as two-seaters, it is advisable to duplicate the bungy used and correspondingly to increase the number of the launching-crew. Slope-soaring flights are usually initiated by this method of bungy-launching and will, I think, always remain the classic form of "despatching" a sailplane.

Auto-towing is most suitable for flat country, apart from training purposes. It is not often used for the start of long flights, but is sometimes the only possible method on impracticable slopes or failing a fair-sized launching-crew. In some soaring-schools, viz. Hornberg, a special track has been laid down for auto-towing, and it has proved thoroughly worth while. It is, of course, necessary to have special arrangements for the immediate release of the cable from the car in case of emergency.

Winch-launching is also chiefly used for training purposes. However, with a sufficiently long cable—and there need to be no limit to its length—considerable altitudes can be reached. It is also possible to make long flights from a winch-launch, provided the wind and thermal conditions are propitious, and the sailplane pilot is sufficiently skilled to make full use of them. The winch has also been used for short exhibition flights and when space is limited. The drum, which is usually fixed on to the back-axle of a car, attains a high number of revolutions and therefore considerably increases the initial speed of the sailplane, especially as the weight of the car, which must be taken into account, does not have to be propelled along too, as in auto-towing. A device for severing the cable, together with a secondary safety-measure in the shape of wire-cutters, are essential; consequently, besides the man working the winch, there must be two other people for telephoning, signalling and anything else that may be necessary. The winch, i. e. the motor, must only be driven by people who have received instruction and

already possess considerable experience. The greatest care must always be taken by the personnel, or the risks attendant on the manipulation of the cable will be enormously increased. The winch-driver should first slowly pull the rope taut, then accelerate quickly but steadily, so as to ensure a smooth start for the sailplane. When nearing the point of release it is advisable to decelerate slightly or the sailplane will begin "hunting". Winch-launching is more economical than auto-towing, assuming, of course, that everything is carried out correctly!

Aero-towing has now also been fully developed and is universally recognised as the best method of getting into the air for altitude and cross-country flights and thermal flying in general; while for aerobatics it is indispensable. There are various ways of connecting the cable, which is some 250—500 ft. long. Personally, I prefer the device by which the cable is fixed directly to the tail-skid: it has proved thoroughly efficient, and as no alterations have to be made to the aeroplane, it is always ready for use. The respective pilots of the aeroplane and sailplane can signal each other when they are ready to take-off; the engine will then be started up, the rope drawn taut, and they will be off! The sailplane pilot always releases the cable unless the aeroplane is compelled to make a sudden forced-landing. The aeroplane normally pulls the towing-cable away from the sailplane as quickly as possible and drops it on to the ground, usually near the next sailplane ready to take-off. The sailplane pilot must always take his cue from the power-pilot, i. e. he must watch him closely and of course at the same time duplicate intelligently the vertical motions of the aeroplane. When taking-off, the sailplane is the first to leave the ground; it is advisable then to push the stick forward a little in order not to let the drag (i. e. excessive wing-incidence) get too strong: for, owing to the severe pull on the cable, it would only impair the climb of the aeroplane. During the towed-flight, the sailplane should be slightly above the aeroplane, which postulates a good view for its pilot. The elevator must be used as gently as possible, so that pulling and slackening of the cable will not interfere with the flight of either plane. The height to which the sailplane is towed depends primarily upon the purpose of the flight: 1,000 ft. is often sufficient for thermal flights, though it naturally follows that the higher one is towed, the greater the opportunities for locating favourable thermals, should the initial thermal have proved unproductive.

9. Aerobatics

Many people are apt to think that a loop is a sign of great skill, though like so many other things this is fundamentally wrong. In my opinion it is a far greater art to be able to fly 50 miles across-country in doubtful upcurrents or spiral upwards for half an hour or so inside a thick cloud.

Soaring pilots were at one time very much opposed to aerobatics and quite rightly, as our former sailplanes were not sufficiently robust. Today it is quite different. It is highly important to practise and master all the usual "aerobatics" in order to become a skilled sailplane pilot, for any inadvertent and extreme manœuvres due to storm conditions or anything unusual can then be met calmly and confidently.

Steep spiral turns are a necessary preliminary to circling in thermals; a knowledge of spinning is essential in order to be able to get out of the spin again, should one involuntarily find oneself in such a predicament; "slipping" can make a difficult landing easy; and finally, loops are good practice for getting used to pulling the plane gently out of dives. In fact, "good hands" make safe flying.

So much for aerobatics!

10. A Short Survey of Soaring in Britain

By Alan E. Slater
Editor of "The Sailplane & Glider"

As in many other countries, gliding experiments were made in Britain both before the advent of the aeroplane and in the early days of aviation. But few of the experimenters had as their object the attainment of true soaring flight.

The first British gliding man to meet with any success was Percy Pilcher, who built and flew a series of "hang" gliders from 1895 till 1899, when he was killed as a result of structural failure in one of them. He once rose 12 feet in the up-current over a windward slope, and, according to one who knew him, believed that better up-currents existed high above the ground in which prolonged soaring could be done—in fact, it was in the hope of reaching these currents that he was preparing to put an engine in his last glider.

Although many of the early aeroplane inventors, such as Sir Alliott Verdon-Roe (then A. V. Roe), had their first inspiration from the sight of soaring birds, the problem of human soaring flight was pushed into the background when the first successful aeroplanes appeared in Europe in 1907 and the years following. In 1908 Sir

Hiram Maxim, one of the few who knew anything about vertical currents, actually prophesied: "We shall never be able to imitate the flight of the soaring birds. We cannot hope to make a sensitive apparatus that will work quickly enough to take advantage of the rising currents of air . . ."

One lone figure stands out from this period, that of José Weiss, an artist of Alsatian origin who experimented with gliders in his spare time. He attributed the success of the soaring birds to extreme aerodynamic efficiency, and he had a theory that an absolutely perfect glider—perfect in shape, stucture and smoothness of surface—should be able to fly, even in still air, on a practically horizontal path. In striving to attain this ideal Weiss constructed over 200 models, ranging in weight from a few ounces to 60 lbs., many of which were made to soar in up-currents. Finally, in 1909, he produced a man-carrying glider in which Mr. Gordon England, launched from Amberley Mount in Sussex, on one occasion climbed 100 feet in rising air over the slope and kept aloft for 58 seconds.

There is no record of any further soaring in England until the feats of the Germans in 1921 and 1922 awakened widespread interest in motorless flying. Stimulated by news of soaring flights of one, two and three hours at the Wasserkuppe in August, 1922, the *Daily Mail* arranged a meeting at Itford Hill, on the South Downs, two months later.

At this meeting the first prolonged soaring flights ever seen in England were made. The Dutch designer, Anthony Fokker, led off with a flight of 37 minutes on October 16, followed next day by Mr. Raynham with 1 hour 53 minutes. On October 21, the final day of the meeting, world's duration records were put up when Mr. Olley soared with a passenger for 49 minutes in a Fokker biplane, and M. Maneyrol, from France, remained aloft in a Peyret tandem monoplane for 3 hours 21 minutes, landing finally in the dark by the light of car head-lamps. One notable flight, performed the same afternoon, knocked the bottom out of any idea that soaring was a species of wizardry, by demonstrating that the most important requirement for keeping up was a good up-current, and not a super-efficient glider or a specially trained pilot; this was when Squadron-Leader Gray flew for 1½ hours in a glider hastily devised out of a Bristol aeroplane fuselage and the top wing of a Fokker D—VIII and costing in all 5*s* for the fuselage, 5*s* for the wing, and 8*s* 6*d* for dope.

Again there was a hiatus. In spite of pious resolutions about forming a gliding club, the Itford meeting led to nothing but the development of light aeroplanes, which would no doubt have deve-

loped in any case. Occasionally, during the succeeding years, an enthusiast here and there tried to soar, but there is no record of these efforts leading to anything of note.

When interest once more awakened in Britain, it was again the Germans who were responsible. During 1929 some remarkable cross-country flights were made in Germany, by Robert Kronfeld and others, by the use of cumulus cloud currents and cold fronts. Mr. C. G. Grey, editor of *The Aeroplane*, received so many letters on the subject that he was moved to ventilate it at length in the issue of his journal for November 6. As a result of this Mr. D. C. Culver, an old war pilot, wrote suggesting a "gliding lunch", and this famous lunch was held at the Comedy Restaurant, London, on December 4, 1929. Thirty promised to come, 56 turned up, a provisional committee was formed to start a British Gliding Association, and so the present British gliding movement was got under way.

The first thing necessary was to dispel the almost universal ignorance of how to teach people to soar. This was done to a large extent on February 19th 1930, when, at the invitation of the Royal Aeronautical Society, Professor Georgii came over from Germany to discourse on the scientific side of the subject, and Herr Stamer to explain how pupils with no previous aviation experience could be trained up to the soaring stage on gliders alone.

A further stimulus was given to the new movement in June by the holding of soaring demonstrations on the South Downs between Itford Hill and Firle Beacon, the historic site of 8 years before. Robert Kronfeld and Carli Magersuppe were brought over from Germany by the British Gliding Association and the *Daily Express* respectively, and on June 15, 1930, the first cross-country soaring flight in England was made by Herr Kronfeld, who flew 50 miles to the west in his "Wien" sailplane. Enormous crowds turned up to see these demonstrations, and the number of gliding clubs in the country, already considerable, was still further increased as a result.

During this year gliding clubs were formed in most parts of England, in southern Scotland and Northern Ireland. Much pioneering and hard work was done by disinterested enthusiasts who were determined that this time something permanent should be set on foot, in distinction to the abortive attempt of 1922. As this is not a book on the history of Gliding, but merely a chapter in a text-book on advanced soaring flight, details of their activities would be out of place here; besides, mention of some to the exclusion of others would only raise trouble for a writer who is in constant touch with those about whom he writes. Many of these early clubs still survive, others have been formed more recently; only a minority have sites

suitable for soaring, and the important thing from our point of view is the emergence of well equipped, well-run clubs which can train their members up to the stage at which they can do the kind of flying which this book describes. After all, the present renaissance of motorless flying in Britain was set going as a result of the demonstration by Germans that a sailplane pilot need no longer confine himself to the neighbourhood of hills, but can soar up to and beyond the clouds and wander freely over the countryside.

The first British pilots to reach this desired goal were members of the London Gliding Club, which had been formed in February, 1930, and began flying on March 17th with two primary instruction gliders. Like many other clubs, it was harried from one ground to another by unsympathetic landlords, but finally, at the end of that year, a permanent home was found at the foot of Dunstable Downs, 30 miles north-west of London.

Here is a range of hills, over 3 miles long and between 200 and 250 feet high, facing due west. It was thought at first that nothing but slope-soaring would be possible from such a low hill, but on August 15, 1931, a short cross-country flight was made from the site by the use of cloud currents, the pilot being Mr. G. M. Buxton. He was at that time the most talented pilot in the country—in fact, the only one who showed any real aptitude for making advances in the technique of soaring: unfortunately his duties in the Air Force hindered him from making full use of his talents, and for some time there was no one on whom his mantle could fall.

The chief credit for lifting the club out of the rut of ordinary slope-soaring must go to the late G. Eric Collins, details of whose flying career are given later. Through his example in the summer of 1933, a few of the members began going up in thermal currents; the generally increased activity brought more people into the club, including aeroplane pilots, among whom was Mr. P. A. Wills, who developed into a first-class sailplane pilot with astonishing rapidity.

The new knowledge needed to bring about this advance had been made available during the previous winter, when Herr Wolf Hirth had come over to give a series of lectures to the club on advanced soaring. It was, perhaps, these lectures which marked the real turning-point in the club's career, for they gave a new orientation to the minds of the members.

From this time onwards the club progressed in every way. An increasing number of cross-country flights were made, and soaring in thermal and cloud currents, once an event, has become since 1935 a common routine. There are now 300 members, and over 1,000 hours of soaring are done in the year — in fact, on many

days the amount of flying is only limited by the area of up-current available for flying in. The history of most other leading clubs is bound up with the series of annual soaring meetings held under the auspices of the British Gliding Association. The 1932 meeting was held on the site of the Furness Gliding Club, which uses a magnificent line of hills overlooking the Duddon Estuary in the Lake District. The club was recruited chiefly from Messrs. Vickers' works in Barrow. For some years it made little progress owing to small membership and the bleakness of the site but in the last year or two some advanced soaring has been done by a few members. One of these has particularly distinguished himself: Mr. Frank Charles, a speedway rider, who had never flown anything before, started thermal-soaring on only his seventh time of leaving the ground!

In 1933 a short but successful meeting was held at Sutton Bank in Yorkshire, a fine soaring site originally discovered by Mr. F. N. Slingsby. The next year it became the centre of a Yorkshire Gliding Club, formed by the amalgamation of gliding groups at Bradford, Ilkley, York and Scarborough which had been operating independently since 1930. This was the first British club to operate on a properly equipped soaring site, and the National meeting was held here for two further years. The first British thunderstorm flights were made from Sutton Bank on September 4, 1934, when three pilots went away in the same storm and one of them, Mr. Buxton, put up the present British height record of 8,323 feet by flying blind inside the thunder-cloud without a parachute. At the same site, on July 16, 1935, Mr. J. C. Neilan put up the present British duration record of 13 hours 7 minutes.

Another northern club, the Newcastle Gliding Club, was formed as long ago as 1930, but was hampered for many years by lack of a suitable soaring site. It has found one at last and now already possesses two pilots of cross-country standard.

In 1936 two more soaring clubs came well into prominence. The Midland Gliding Club, which started flying on Boxing Day, 1934, owes its inception chiefly to one man, Mr. C. Espin Hardwick. So determined was he to bring it to success, that when the usual trouble about permission to use a soaring site arose, he fought a legal battle on its behalf. The club, which recruits chiefly from Birmingham district, now has a most excellent soaring site which it began using in April, 1936. This is the Long Mynd, in Shropshire, which has a steep slope facing west, 700 feet high and 6 miles long.

The Derbyshire and Lancashire Gliding Club came into existence early in 1936 by the amalgamation of the Derby Gliding Club, a recent creation, with an older body whose full title is "The Gliding

Section of the Royal Aeronautical Society, Manchester Branch". It has a most useful site between Sheffield and Buxton, consisting of Bradwell Edge, facing west, and Eyam Edge, facing south. Here the national meetings of 1936 and 1937 were held, at the last of which 1,489 miles of cross-country soaring was done. The place was originally found and flown over by three energetic men, G. O. Smith, A. L. Slater and R. G. Robertson, who built themselves a "Golden Wren" sailplane in 1934 and then took it around Derbyshire trying out all the hills they could get permission to use.

The South Downs, the birthplace of soaring flight in Britain, now harbours two clubs which have survived from a large number started in 1930 and the years following. These are the Southdown Gliding Club at Brighton and the Channel Gliding Club at Folkestone. The former has a good soaring slope facing north, and a shorter one facing west from which two flights in cloud currents have so far been made.

The Ulster Gliding Club, though geographically outside Great Britain, deserve to be included in this list. They started in the usual way in 1931, but soon settled down into something in the nature of a private yachting club, with a few very enterprising members who had taught themselves to soar and owned their own sailplanes, which they took around to the various hills and mountains in Northern Ireland. Now they are once again the conventional gliding club, training numbers of new members on a permanent soaring site at Magilligan Cliffs on the north coast of Ireland. Here they soar in winds blowing in from the sea, and in view of the fact that little is known about flying in such winds, they are in a position to gather new data to enrich the science of soaring flight. Their pilots have already had some queer experiences, finding areas of lift, unconnected with the hill, which cannot be explained by any of the usual theories known to sailplane pilots.

One of the most interesting of recent developments in British soaring is that of the art of catching thermal currents from a winch-launch. The Cambridge University Gliding Club, which operates over flat country, has, up till now, relied entirely on this method to enable its pilots to soar, being able to launch the machines, raised like a kite, to heights of over a thousand feet. Now however, the Club has instituted aero-towing, which will, in future, by the standard method of teaching members thermal-soaring.

For the past two or three years there has been a Government subsidy available for clubs in a position to make good use of it, and the clubs mentioned above are those who have so far qualified to receive it.

There follows now a short biography of Eric Collins, to whom this book is in part dedicated, after which two typical British cross-country flights will be described. The first, by means of which Mr. Wills set up a British distance record of 104 miles, is certainly typical of British soaring: first, because the small size of our island compelled the pilot to land much sooner than he needs otherwise have done; and second, he was hampered by the lowness of the cloud-base, which is, on the average much lower in England than on the continents of Europe and America where most of the world's soaring is done. Mr. Fox describes a flight over England by means of a "cold front", in which he covered 24 miles, and was accompanied by two other pilots, Mr. P. B. N. Davis and Captain R. S. Rattray, who flew 48 and 14 miles respectively.

Eric Collins

By A. E. Slater

It is curious how many pilots have known how to make new advances in soaring technique—in theory—without being able to do so until some pioneer has shown the way—in practice. Eric Collins was just such a pioneer, for he had that rare combination of physical and intellectual ability and originality which fitted him for the role, and he came into British gliding just when his peculiar talents were most needed.

From Eversley preparatory school, Southwold, he proceeded in 1922 to Oundle, and during these years, like many other schoolboys, he took a particular interest in flying. Later he took up the profession of scientific instrument maker. This developed a precision of control over fine muscular movements which was commonly believed by his gliding friends to account for the quickness with which he learned to fly, and his masterly handling of diverse types of sailplanes and gliders.

It was the visit of Robert Kronfeld to England in 1930 which first aroused Eric Collins's interest in gliding and soaring in particular. At the end of 1931 a member of the London Gliding Club persuaded him to go to Dunstable Downs and join. On January 16, 1932, he had his first instruction "hop" and by February 21 had qualified for his "A" certificate and on March 19 for his "B". For the "C" soaring certificate he had to wait for a west wind; it came on May 1 and he stayed up for half an hour.

His skill with his hands brought Eric Collins another advantage: he had shown himself so competent at repair work that he was asked to join a group owning a "Kassel 20" sailplane in consideration of doing any repairs needed. He could not have afforded to buy a share in the machine, yet by becoming part-owner he could put in many more hours of practice than would have been possible in club aircraft.

This practice stood him in good stead, for when he flew the machine at the national meeting in the Furness district, on August 30, he displayed an almost uncanny knowledge of where to find the best lift, and soared to 800 feet above the hill—higher than any other pilot was able to take the "Kassel".

On November 27 came a first flight in a high performance sailplane—a "Professor". It was in a wind of such roughness that few would have cared to use it for a first "Professor" flight.

The time was now ripe for Eric Collins to progress to the more advanced kinds of soaring flight. But up till this time practically nothing of this sort had yet been done in England. The visit of Wolf Hirth to the London Gliding Club at Christmas, 1932, could not have happened at a more appropriate time. Eric Collins listened to all that Herr Hirth had to say and determined to put this new knowledge into practice at the first opportunity.

"Practise tight circles", was Wolf Hirth's advice, and Eric Collins did so for the first time on January 8, 1933—in the base of a rain cloud! But the opportunity to circle in a thermal current did not come until the summer, during a national meeting at Huish on the Wiltshire Downs.

At this meeting he had his first professional engagement as a sailplane pilot, which says much for the confidence which his short flying career had already inspired. He was engaged to give dual instruction and joy-flights to passengers in a two-seater machine. It was hard work, and not very inspiring, for the flights consisted mostly of auto-tows to 600 feet and glides down again, in calm weather. But there came a day—July 1, 1933—when the variometer showed that he was holding his height after casting off the cable. Evidently a thermal current had risen from the flat ground below, and without delay Eric Collins did the right thing: he circled, and managed to maintain his height for a short time before descending. Next day he did better, and then, on July 3, the first British cross-country flight in pure thermal currents (unconnected with clouds) was made. Starting at 1.21 p.m., Eric Collins cast off the cable at 600 feet, circled and gained height to 950 feet, set off to the south-west with a slight following wind, and landed

6 miles away, having made use of two more thermals on the way. He had his wife with him as passenger. And the next day, in similar conditions, he soared to 2,350 feet.

It was at the end of 1932 that Eric Collins had married, and soon afterwards the pair took a small cottage at Flamstead, a few miles from Dunstable. He was now devoting his whole time to gliding affairs—a precarious existence for anyone obliged to earn a living; nevertheless, the few years he lived at the Flamstead cottage must have been the happiest of his life. He spent many hours in his garden watching cumulus clouds, following their development as they moved along and trying to discern clues as to the position of the best up-currents. He would watch buzzards as they circled up in rising currents. It was this habit of gathering every possible bit of knowledge which had the slightest bearing on soaring flight, that contributed much to his later successes.

Returned from Huish, Eric Collins set to work to develop his technique at Dunstable Downs. He soon discovered that he could find, and keep in, thermal currents without the help of a variometer—hitherto considered an absolutely necessary instrument for the purpose. He did this by being able to sense slight differences of lift under his two wings, whereupon he would turn towards the side which was lifting most. On August 23 he set up a British distance record of 19⅗ miles.

At the end of the year his father generously offered to buy him a high-performance sailplane, and he chose a "Rhönadler", the most efficient type then in production. The machine was ordered from Germany, and arrived in April, 1934, but meanwhile Eric Collins had made another fine cross-country flight. On March 18 he got away from Dunstable Downs under a cloud street, flying a two-seater machine with a passenger, and landed 46 miles away in Essex. This was, at the time, only a mile or two short of the world's record for two-seaters, but on the same day he lost the British single-seater record to Mr. Wills, who went 56 miles to the coast.

When the Rhönadler arrived, things began to happen. His first cross-country flight in it took him to Rayleigh, near Southend, 52 miles. He had hoped to cross the Thames, but the only lift was under cumulus clouds, which were very sparse, and absent altogether in the direction he wanted to go.

On May 21, having joined an expedition to Prestatyn on the Welsh coast, he soared a "Falcon" seven miles into the mountainous interior and back again.

At Dunstable he frequently got up to the cloud-base, wandered round the countryside, and returned to the club ground. On July 15,

1934, he made a remarkable flight to the Thames west of London, just crossing it and returning to land at Hanworth aerodrome; this flight, which finished 31 miles from Dunstable, was in a S.S.E. direction, in spite of the fact that a W.S.W. wind of 10 to 15 miles an hour was blowing, exactly at right angles to his course. This was his second attempt to cross the Thames and get into Kent; he had attributed his previous failure to do so to the London haze cutting off the sun's heating rays as it drifted eastward. He therefore tried to get round to the west instead, but as this course took him over built-up areas he decided after all not to risk having to land in them.

The greatest flight of his career was on August 5, 1934, when he set up a new British distance record of 95 miles by soaring from Dunstable to the Norfolk coast at Holkham Bay. He made a difficult get-away from Dunstable in a S.S.W. wind, and then, by using a mixture of cloud-streets and isolated cumulus (a common phenomenon in England), arrived at the sea still 3,000 feet up after being in the air over 4½ hours and reaching 5,000 feet on the way.

The first "cold front" flight made in England was done by Eric Collins on July 29 of the same year; it took him 25 miles. On September 4, during the national meeting, he went 18 miles in a thunderstorm, the comparatively short distance being due to his flying against the wind in an attempt to find the best area of lift. During the same meeting he made a most skilful out and return flight from Sutton Bank to Osmotherly, 11 miles away.

An event in Eric Collins's flying career was a visit in June of this year to the Hornberg soaring "university" in Germany, where, under the direction of Wolf Hirth, he practised cloud-soaring and learned to do aerobatics on sailplanes. One of his climbs in clouds was to a height of 6,825 feet, which was at that time an altitude record for the Hornberg.

In June, 1935, Eric Collins was engaged to give a display at the Royal Aeronautical Society's annual garden party at Heath Row aerodrome. He was to have been towed there from Reading by an aeroplane, but on the way the cable broke. This did not worry him; he found good thermals about, soared the rest of the way, and arrived in good time according to programme.

Soon after this he was engaged to tour round in the flying display organised by Sir Alan Cobham, who had seen him performing aerobatics in a Grunau Baby when on a visit to Ireland. It was while engaged with this display that he met with the unfortunate accident which caused his death. It was at Upwood, near Ramsey in Huntingdonshire and he was attempting a "bunt", or forward loop. He was flying a "Grunau Baby", but the machine was not designed to with-

stand such a manœuvre, and a wing broke off. He had been prepared to risk such a mishap, since he had a parachute with him, but for some reason, not certainly determined, he was unable to use it to save himself.

Eric Collins earned the honour of becoming the first British pilot to acquire the international "Silver C" certificate, for which flights of 5 hours duration, 50 kilometres distance and 1,000 metres climb must be made. His number was 26 in the international list—a great achievement when it is realised that the world's "Silver C" pilots now number over six hundred.

His death was the greatest misfortune both for his club and for the whole British Gliding movement, for he had a most charming personality, and was destined to do great things for both, had he lived.

104 miles – A British Distance Record

By P. A. Wills

Conditions on the morning of July 5th, 1936, at Dunstable were so poor that there was some hesitation as to whether it was worth the trouble of rigging "Hjordis", which was in her trailer.

The sky was completely overcast, and the wind S. W., almost along the hill. However, finally I rigged and by force of habit set my barograph. At 12.15 we were winch-launched from the bottom and joined the merry party chasing each other's tails in the Bowl. The beat was only a few hundred yards, and seldom have I been more grateful for the few extra feet which Hjordis provides, which others haven't got.

About 1 o'clock I was just thinking of coming in to lunch when a minor thermal took me to 700 feet with much wriggling, and I saw a chance for a little change of scenery by making off to the Bowl at Whipsnade and the slope beyond, into which the wind was blowing rather more fairly.

As I got there the sun came out, and almost immediately the sky burst into a rash of cumulus. However, it was some ten minutes before I could get high enough to be able to circle fairly, and at no time during the whole flight were conditions more than mediocre. The biggest lift I found was only 5 ft./sec., and often I was forced to circle in a hesitant 1 to 2 ft./sec. The biggest difficulty was that the cloud-base was less than 3,000 feet at Dunstable and,

contrary to usual practice, it never lifted, so that over the flat ground I had 3,600 feet as a steady ceiling. The barograph chart shows how remarkably constant this was.

My batteries were down, so I had no blind-flying instruments and kept firmly out of clouds.

The first thermal took me to 2,900 feet, at which height the earth started to fade away, so I put her nose down and scalded at 55 m.p.h. to Luton. The clouds were in the form of short streets, a mile or two long, and staggered in relation to each other.

Some years ago, in common no doubt with other pilots, I had drawn a circle of 100 miles radius centred on Dunstable, so I knew that a flight of over 100 miles from there was rather in the nature of a goal-flight, and accordingly held a compass course north of the wind direction when not circling.

The trouble was that I could never afford to lose much height. From 3,600 feet to 2,500 feet took no time, and by then I had to be hard on the look-out for more lift, and had to dally and waste endless time circling in small patches of gently rising air. The chart shows 18 separate peaks, each of which involved numerous circles, and each successive one required increased determination.

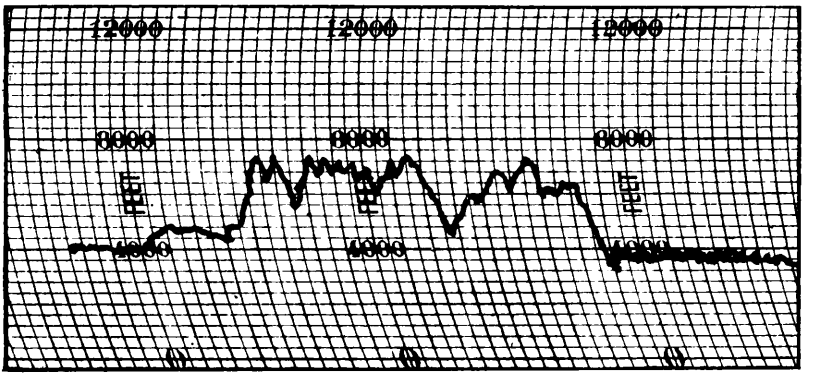
For quite soon it became apparent that designers have paid too much attention to aerodynamic form, and far too little to the shape and needs of the human frame. The sun beating into the cockpit through the small talc roof soon gave me a splitting headache. Constant circling and hard work rapidly transformed this into a sick headache. Then came a thirst like the Sahara, closely followed by cramp.

In this state considerable effort was needed to circle patiently in minute up-currents, making practically no ground; since by the cloud-shadows the wind at that height seemed almost negligible. Occasionally came blessed moments of relief when, in a cool grey haze which sheltered one from the glare of the sun, we snorted along our course, nose down, and holding our height at a brisk 55 m.p.h. But all too soon we would be out in the sun in front of the nose of the street, battering at 40 m.p.h. through a mild down-current towards the next most northerly street. Once or twice, an experience I have long hoped for, we soared along one edge of a street. It was exactly like upside-down hill-soaring: the edge of the hill above instead of beneath, the up-current blowing into it instead of up it.

Duxford aerodrome on my left gave me my position, and shortly after came the worst moment of the flight. A long glide failed to find any more lift, and the altimeter showed only 400 feet above the

launch: at the most 800 feet above the land at that point. Worse I could not see a single gilt-edged field, and was feeling far from tackling a tricky approach.

Suddenly, a miracle; lift, slight but sufficient. Headache or no headache, though paper bags should beckon, circle we must. A quarter of an hour later, feeling biliously triumphant, we had achieved 2,000 feet, and the situation was saved.



From now on little excitement. The clouds looked as if dissolving, quite inactive; from the ground I should have said there was no lift in the sky. Yet we continued to find mild lift, and about two miles from the sea, where a south-easterly sea-breeze met the south-westerly wind, was quite a bank of cumulus running parallel to the coast. Some way to the south I saw an estuary which seemed horribly familiar. Could it be the Blackwater, visited two years ago in the "Professor", and was all this sweat simply to be a repetition of a two-years'-old flight? Or were we to believe our five-bob compass?

We were, and if we were where we ought to be, by turning north along the coast, we should make about a mile further from Dunstable for every five miles we flew. (Oh, for a map!)

But this gearing was too low for my headache. We went out to sea, and at 600 feet, flying along a beautiful beach backed by a low red cliff about 60 feet high, found enough lift to keep going until a fair-sized seaside town turned up. This involved slope-soaring along the Marine Parade, or landing. I picked the latter, found a huge field at the top of the cliff, and landed at 4.25 p. m.

As I burst thickly out of "Hjordis" I got the best moment of the whole trip: the fresh cool smell of the sea.

A Thunderstorm Flight

By J. S. Fox

In normal cross-country flying among clouds, one knows that if one follows the shadows of those clouds one must be going in the right direction. This time, however, it was the *wrong* direction. The direction of the ground-wind causing the front was towards London; this I followed until well over St. Albans, gaining height fairly steadily up to an occasional 15 feet per second. From 300 feet to 3,300 I timed at roughly 7½ minutes, an average of 7 ft./sec., but I was not in such a good section of the front as the other two planes. I had curved away from the London direction by the time I was past St. Albans, and the 4,000 feet cloud shadows (somewhere near the point "C") were heading straight for Bishop's Stortford. It was in this direction that all three planes eventually flew. If, on the other hand, any of us had been clever enough to follow the correct direction of the front we should have had a wonderful flight right over the centre of London.*

I followed the snow wall for a long time, turning into it once to see if any of the snow was going up, only to be bombarded by some enormous hail stones, and then to have the "Kite" nearly shaken to pieces after a rope of lightning shot down at very frightening proximity.

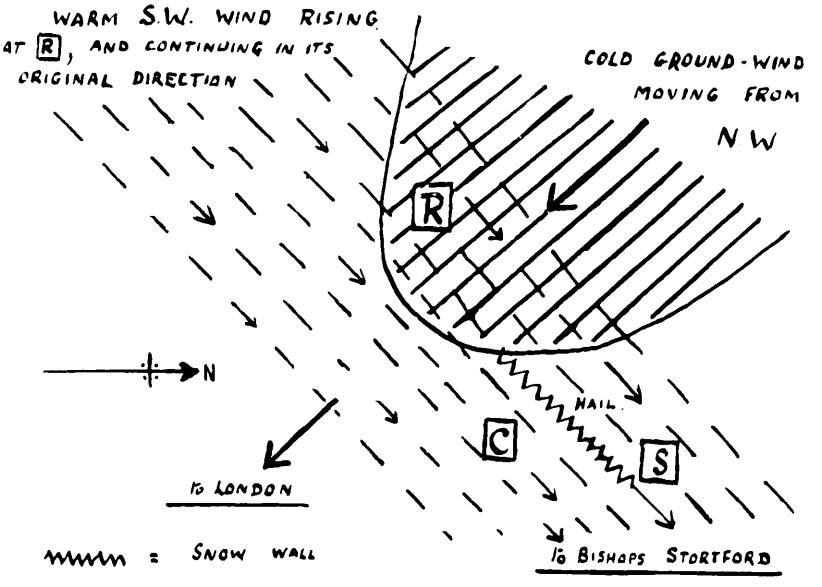
Captain Rattray was on ahead of me along the snow wall, and he turned away to the right in order to land at Hatfield, which he succeeded in doing. I went on in the Bishop's Stortford direction, landing at Puckeridge (24 miles from start).

Peter Davis, in his "Scud", did a magnificent flight with no instruments at all. He was right out at the Whipsnade end of the hill and got the lift there early, with Captain Rattray not far behind him. He then flew straight out towards Ivinghoe Beacon, and he must have been at about 3,000 feet before I reached the lift at all. When I had risen to 3,000 feet he was still a long way above me. He eventually got into cloud and came out in a spin. He then must have flown through part of the snow and hail region "S", because he came over well to the left of me at Puckeridge with still 2,000 to 3,000 feet to spare, and landed gloriously a good 48 miles from Dunstable.

* Since writing this article I have discussed this question with Kronfeld, and he says that in doing cloud-front flights it is always necessary to fly at roughly 45° to the upper wind directions.

It was a great day; but we shall all do much better next time.

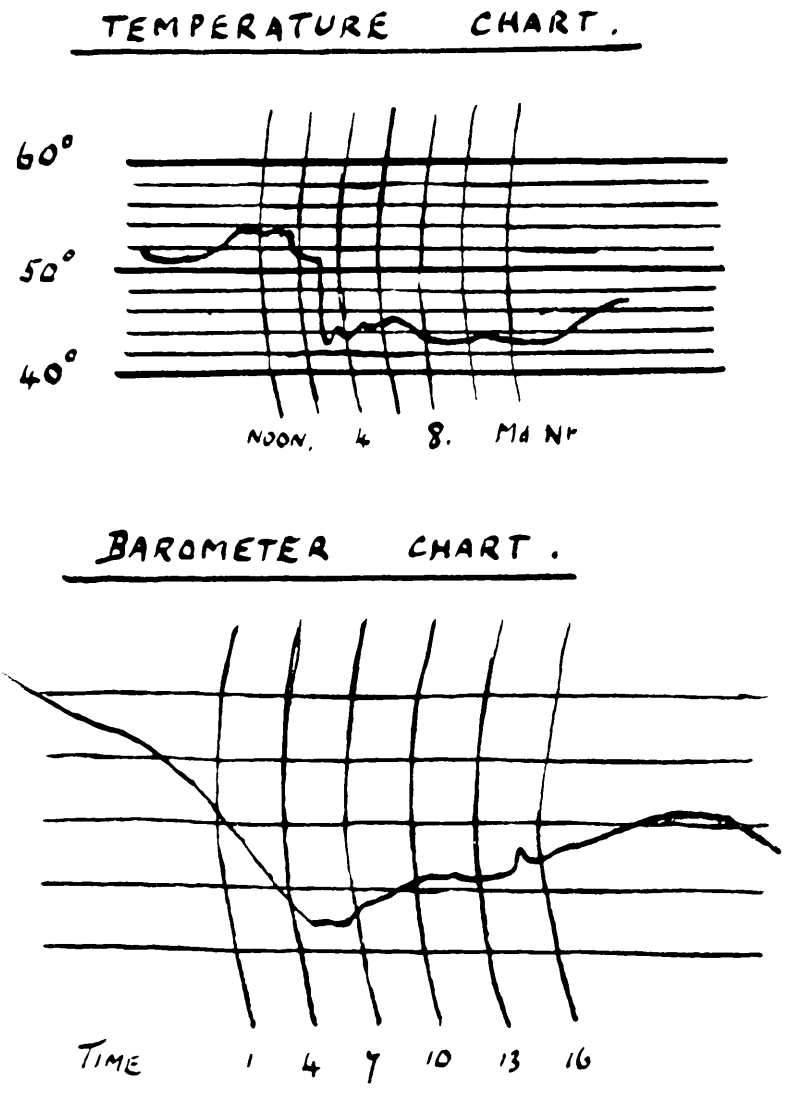
The storm reached London soon after three o'clock and created quite remarkable disturbances on the weather charts at Kingsway. There was a sudden burst of pressure which was partly due to the convergence of the two air-streams, and partly, they said, due to the sudden arrival of the heavier colder air. The temperature chart was the more phenomenal of the two. It showed a sudden drop, as



the cold-front arrived, of about 10 degrees F., and I traced a copy of both these charts to show what really did happen.

Our storm was actually only a very secondary affair, as the daily weather report showed an extensive cold-front which passed over about 7 a.m. as shown by the trough of pressure at that time on the chart. It was travelling at 36 m.p.h., which is probably the speed at which the whole system, including our little storm, was still moving in the afternoon.

One most unfortunate fact was that the relative humidity, which I measured at Dunstable before going up, was in the neighbourhood of 73 per cent. Air as moist as this, I calculated, could easily give cloud on this day down to 3,000 feet. There seemed to be a tremendous lot of dirty grey-looking cloud connected with the storm, and if only the air had been in a drier condition a nice clear-cut thunder-cloud would have been formed, in front of which a real joy ride could have been made.



The best part of this story is, I think, its conclusion, in which I would like to translate Kronfeld's advice. He says: "The best way for a young pilot to learn to understand storm fronts is for him to take every possible opportunity of studying them, even when he is not sitting in a sailplane."

A Climb in a Cloud

How the British Height Record was raised to 10,080 feet

By P. A. Wills

(Reproduced by permission from "The Times")

High flying in sailplanes is perhaps the final development of the art of motorless flight, and requires a training and technique additional to all that the pilot has learnt before in achieving, first, duration, then thermal and distance flying. This is because above a certain height most climbs must be made flying blind in unstable clouds, and it is unfortunate that blind-flying training, which is done in aeroplanes, as well as the special instruments and parachute necessary to reduce the hazards inseparable from the rough conditions likely to be encountered, are expensive. This is the reason why so few high flights have hitherto been made in this country.

The main difficulty of flying blind is that the pilot is subject to attacks of extreme vertigo, brought on either by very rough conditions or, in the case of sailplane pilots, by the need to fly blind in constant circles in order to remain within the areas of rising air which are found inside the right kinds of clouds. The uninitiated may easily get a very exact idea of this difficulty by trying the old parlour joke with a walking stick. Plant this on the floor, clasp the hands on the crook, then bend down and put your forehead on your hands, so that you are gazing at the floor. In this position shuffle five or six times round the tsick, keeping its point stationary on the floor. Now stand upright, drop the stick, and walk in a straight line across the room. The sensations you feel while doing this are precisely those experienced by the blind-flying pilot after doing a spin, or a number of circles, in his machine.

Like an Octopus

The pilot, however, is faced with the relatively more intricate task of controlling his machine in three dimensions, while his judgment is over-shadowed by the rather nerve-racking possibilities which can arise from failure. A specially strong machine is desirable; the strength factors of the Minimoa are much greater than those of a fighting aeroplane. To assist him the pilot has certain instruments, and he must learn to obey these while his senses are peremptorily telling him to do the very reverse; and fortunately, after a few lessons under a hood in a two-seater aeroplane, one does in fact learn to divorce one's actions from one's instincts, though this

partial immunity is temporary and has to be renewed regularly every year, or more often if necessary. But there is a great deal to be learnt about the internal gust-structure of unstable clouds, so that flying to great heights is still something of an adventure.

On Sunday (June 5th) I took off from the site of the London Gliding Club on Dunstable Downs at 3 p.m. The conditions were good, but not extremely so, and I had no idea of going for a height record. At about 4.30, however, I struck a strong upcurrent, and, in company with a friend in another machine, circled rapidly up to near the base of a small cloud over Luton, at about 4,500 feet. From here I could see a rather large storm-cloud building up over Leighton Buzzard, some eight miles to the west, so flew towards this. As I got nearer it became clear that there was a very active current of air ascending into it. The base looked quite flat, as is the case with nearly all active cumulus clouds, except that along the far edge there seemed to be a darker slate-grey area, denoting a greater depth of cloud-vapour above, bordered by a hangig ragged fringe which could be seen to form constantly and to be constantly ascending into the cloud above. As I approached this my rate-of-climb indicator showed increasing lift, until it moved up to a climb of 10 feet a second. I put the machine into a circle and spiralled rapidly upwards. At this point the rapid upcurrent of air had lifted the seemingly flat ceiling of cloud somewhat, so that I spiralled up into a kind of diving bell, the walls formed of blue-grey cloud, with below a reducing circle of sunlit green fields. The base of this bell sank slowly down. We approached the ceiling, and everything vanished. The time when I went into the cloud was 5.10 p.m., the height about 4,900 feet.

Entering a big cloud in a sailplane is a very different experience from doing the same thing in an aeroplane, for in the powered craft the general noise and vibration overshadow the subtler flavours of flight. I had the feeling that we had been silently absorbed by a large and immensely powerful octopus. The rush of air over the wings and body of the machine took on a different key and became smoother and quieter. One felt as though entrapped in a envelope of sticky power. The hue of the surrounding vapour, a bluish black, was octopus-like too. This, of course, was due to the great thickness of the cloud at this point, for I subsequently discovered it was more than a mile high. It is only the shallower clouds or the fringes of the big ones which assume the friendly hues of white or light grey.

Ten Thousand Feet

The rate of climb now gradually increased to 15 feet a second,

the only sound being the comforting buzz of the little electric motor of my turn indicator. For a while the air rose smoothly and swiftly, then we struck a rough area, and the machine started to lurch. Simultaneously I began to feel marked vertigo, my head started to swim, and my senses to convey impressions quite different from those recorded by my instruments. Before going into the cloud I had noticed that the edge nearest to my point of entry lay to the north, so I now straightened the machine from its right-hand circles (which operation gave me the most violent, but false, impression of doing a steep left-hand climbing turn), and held her rather grimly on a northerly compass course, which about five minutes later brought us out of the towering wall of dazzling cloud into the sunlight at 7,500 feet. I flew around, losing height, for a few minutes until the vertigo had subsided, then headed back into the cloud. My intention was to fly straight through it and out the other side, but after first negotiating a very violent down-current, which shot me down at nearly 20 feet a second, I struck a smooth patch of air rising nearly as fast, so again put my machine into a circle and climbed very fast indeed.

Now ice started to form on all protuberances, on the front of the cockpit cover and the leading edge of the wings. However, I did not meet any rain or hail, which is usual in such clouds, and I knew that Minimoas had emerged successfully from much more severe conditions after cloud flights in Germany, and was not worried. But the nervous strain is considerable for the amateur, and it was with some relief that I saw the needle of my altimeter at last top 10,000 feet, which was the height I had set myself to reach. I straightened up again and steered a southerly course. The surrounding cloud gradually lightened, then a gap appeared ahead. With joy I anticipated seeing the earth again, and the long quiet glide down and back to tea at the clubhouse. But I was disappointed. I came out of my cloud to find far beneath me apparently stretching in all directions the bulging tops of an unbroken sea of cumulus. Behind me, a mountain of white rising out of the white plain beneath, my stormcloud towered yet another 1,500 feet up into the blue sky. It was a sight to dazzle the gods, but to me it was a pain in the neck. I wanted tea, not ambrosia.

It was 5.45. I had been 35 minutes inside the cloud. As I slowly descended towards the cloudsheet beneath I searched for a gap through which I might descend without having to do further blind flying with the possibility of encountering more unwanted lift inside the clouds beneath, and at length I did in fact find a small gap through which I could see, an incredible distance below, a vista

of green and brown fields and a road. I circled steeply down through this, occasionally penetrating the surrounding clouds, and emerged a short while later just to the north of Luton, my cloud having drifted about eight miles while I was inside it.

I set the nose of the Minimoa back west for Dunstable and had a good look round. Along the leading edge of the wings, 58 feet in span, ran a three-quarter-inch ribbon of jagged ice-crystals. Similar crystals had formed on the front of my transparent cockpit cover and on various protuberances on the outside of the machine. In absolute silence we planed down to 4,000 feet, when a sharp crack made me jump in my seat. I looked anxiously round. Then a spark of watery lieght flew by, and a lump of ice melted from the nose, flew back and hit the wing with a crack like splintering wood. Next similar sounds started from the tail, and it was quite a relief when, at about 2,000 feet, the last withe fragments had gone and all was again quiet.

The landing was at 6.15, and the height recorded on my barographs, subject to official correction, was rather over 10,000 feet.

Going West

By P. A. Wills

I

The newpapers always call it Buchan's third cold spell, though I don't know what Professor Brunt would say about that. Be that as it may, I have personally noticed that in each of the past four years we have had, between March 20th and April 30th, a spell of highly unstable north-east winds. In past years I have made desperate plans to get a launch from the South Downs during the period, which have always come to nothing, but this year the advent of aero-towing at Heston, specially organised to be ready in time, made it easy; and to celebrate the event, Buchan's third this year turned out at least twins. In fact, unstable north-easterlies blew steadily for practically the whole period, to the great confusion of farmers but the great profit of sailplane pilots.

Soing to the office on Friday, the 29th, I looked wistfully up from the crowded city streets at the activity of a different sort going on overhead. It seemed too much to expect yet another such day to follow, but that evening the Weather Bureau said: "Same

again." That meant north-east wind, cloud streets starting as early as 9 a.m. with a tendency (in London anyway) for the sky to cloud over completely later in the day. I asked, however, whether this was not due to the influence of the North Sea, and if so, as one went cross-wind to the west, one would shortly get out of the danger area, i.e., the area down-wind of the North Sea. They agreed that this was likely, and that I would probably be safe from Salisbury onwards. It looked, therefore, as if part of the problem would be to get to Salisbury (65 miles) before, say, noon. This meant early breakfast at Berkhampstead, to be rigged and away from Heston if possible by 10.30 a.m.

We spent a busy evening getting everything teed up for an early start, I ruled out the necessary line of flight on the mag, and studied the course as closely as possible. The conditions looked as if they might be very similar to those of my flight, earlier in the month, from Huish to Plympton, so I hoped I might find the same sea-breeze effect which I had then found so useful from Lyme Regis onwards. The course I mapped out, therefore, took me to Lyme Regis, thence out to sea and along the coast to Exmouth, then on towards Plymouth. As a matter of fact on the actual flight I was seldom five miles off this course at any point.

On Saturday morning, however, it did not look very hopeful. The instability was there all right, but the wind was strong and far too northerly. We left consequently rather later than to plan, and without luggage or even money, except for the housekeeping money, it being luckily pay day at home We said we would be back to tea.

Arrived at Heston the sky looked marvellous. Tremendous streets ran up and down wind as far as the eye could see, and although the surface wind was almost due north, the upper wind, judged from the line of the cloud streets, was north-east. The actual direction, from 1,000 feet upwards, was officially confirmed as 50^0, whereas my course, to get me round Sidmouth Bay, had to be 70^0 (or rather, 250^0). Across a 20 m.p.h. wind this was better than I had feared, but quite bad enough. However, I hoped, in my favour, first, for the favourable sea-breeze effect already mentioned, and, second, that the wind might drop with the combination of oncoming evening and conflicting sea-breezes that might be found from Bridport—if I got as far to Plymouth, which I formally declared as my goal. Now, as it happened, both these preconceived possibilities came true. Let us therefore be optimists always.

A last point was that, with the big veer in the wind, it was clear if I got into difficulties anywhere, as I got lower these would be

increased by the northerly surface wind taking me ever more seriously off my course.

I make no apology for this long preliminary argument, because I am sure that the previous planning of a long flight is of the utmost importance, particularly in England, where every really long flight must of necessity be in the nature of a goal flight.

II

With the various delays and uncertainties it was 11.05 by the time we actually took the air. I had asked to be towed up-wind towards a cloud street over Harrow, but we had barely crossed the aerodrome boundary, only 600 feet up just east of the gasometer, when the aeroplane ahead jumped as if it had been shot. Instinctively I released, then cursed myself for being so hasty.

However, there undoubtedly was lift somewhere near by, and after a little searching she took it fairly in the seat of the pants. The variometer jumped from six to nine, and a bit later to 12 feet per second climb. We circled up, back over one corner of the aerodrome, into the base of a cloud at 3,600 feet near the Staines reservoir. I turned her nose north-west, put it well down, and struck off at 65 m.p.h. The battle was on.

North of Staines was another cumulus. I found the up-current beneath at 2,500 feet showing 3 feet per second, but this was not enough. I now declared as a rule of the day when over 3,000 feet. I would not be content with 3 feet per second. If after a search round I could not bring it up to at least 5 feet per second. I would go on. But I would never just circle in bovine content unless I got up to 9 feet per second. Until that I watched every circle and manœuvred restlessly about searching for the meatiest bits. Time was the essence of the flight, and to save it meant constant hard work. Lesser lift I used by flying as slowly as possible through it, putting the nose down again when it was past.

I worked this second thermal up to 6 feet per second, and set off again. But this time further lift was hard to find. Virginia Water and Fort Belvedere slid beneath, and I was getting dangerously low. I abandoned the cross-wind struggle and went straight down-wind towards a large common short of Farnborough (Chobham Ridge). I was miserably reflecting that there was not a safe landing-spot in sight, what a lot of luck there was in putting a sailplane down in one piece, and what a lot of work had been wasted on this effort, when we struck lift, 700 feet above the start, perhaps 500 above the common below. A last-minute save.

My pride over rates of climb quite gone, we struggled round and round . . . A while later we were up again at 3,900 feet just north of Farnborough, well off the course, and rather depressed.

However, this was the last shock for a long way. We got back to our course at Basingstoke, flew along south of the road to Whitchurch, where we worked a thermal up to over 15 feet per second climb, along to Andover, with Southampton Water and the Isle of Wight in sight to the south, then Salisbury. The rolling country of Salisbury Plain was, as expected, stiff with thermals.

Over Salisbury we had some fun. We found ourselves climbing at 6 feet per second up beside a large and dense-looking cumulus. The best lift seemed in a circle of which the nearest point was perhaps 25 yards south of the wall of cloud. At 5,100 feet the lift declined, so I decided to go inside and try for more. We charged at the solid wall of cloud, hit it—and burst out on the other side, as if through a pane of frosted glass. It could not have been more than 25 yards thick, then we were in clear air again—in the most violent down-current of the day, over 51 feet per second.

"You nibble a bit off this side," said Alice, "and you grow taller; off the other side, and you grow shorter. Curioser and curioser." I went back and nibbled some more on the other side.

I had been carefully checking my average speed, and found we had made 32 miles for each of the first two hours. This would get us to the proposed junction with the coast at Lyme Regis about 3 o'clock, and after that I expected to be able to increase speed. I reckoned on being safe to at least 3.30, so it might be a near thing to catch Brer Fox, which would take place, if at all, at Exmouth.

But I was wrong in my calculations; the big speed-up of the day was now at hand. After Salisbury we flew along the line of hill used at Easter by the Cambridge Club, past White Sheet Hill to Shaftesbury, and in this third hour covered 44 miles.

Now came Blackmore Vale, which I had previously found, on the flight to Plympton, rather cold to strangers. It was again. Again near Yeovil I gave up and turned north to make for the aerodrome. Again I spotted the same little sloping wood; again it came to my aid. The conditions were extraordinarily the same from now on to Exmouth.

We climbed thankfully to 3,800 feet, then made no bones about it but fairly bolted down-wind for the sea. Between Bridport and Lyme Regis was the same belt of coastal lift, formed from one to three miles out to sea by a south-easterly sea-breeze undercutting the north-easter. In this we flew fast along the coast, over the blue

sea. past Seaton, Babbacombe, Sidmouth, to Exmouth. Here the same strong thermal took us up to 5,500 feet, and after my last experience at this spot a new caution informed me. Our ground speed had increased greatly since reaching the coast, as I had expected. but the struggle at Yeovil had brought the fourth hour's kill down to 32 miles again. We put our first bird, Exmouth, in the bag, and concentrated on the second, Plymout. The wind was now dropping, the clouds dissolving.

From Exmouth we flew to a cloud beyond Newton Abbott. where I found an unexpected aerodrome, circle and all, beneath. Weak lift from a seedy-looking cumulus took us hesitatingly to 4,000 feet again—and then a long glide found us heading down a river ending in an estuary and a cardboard conical island planted in its mouth, Bigbury. The fifth hour again saw 32 miles go by.

The prospect of getting enough height to cross the high land north of me and make Plymouth aerodrome seemed remote, though as we crossed one or two of the brown rocky spurs of Dartmoor with perhaps 500 feet to spare I found weak lift over each. With a prevailing dearth of landing grounds I was thinking of making a bid for the beach at Bigbury. so recently furrowed by the skid of the Sperber, when we came to the end of Dartmoor.

Just to the north I saw the text-book spot for a wind-shadow thermal. Dartmoor billowed down from about 1.600 feet in a series of rounded slopes, facing the westering sun. The bulk of the moor to the north-east provided obvious protection againt the north-east wind, so the quiet air over the slopes should have had every opportunitm to warm up. I gave up my safety-first plan of Bigbury sands and reached the hopeful spot at 1,900 feet. Immediately I found lift; in no time Plymouth aerodrome was in the bag: a bit later I began to be torn between completing a 178-mile goal flight, or going on while the going was good. and brying for 200 miles, a nice round figure. Then I remembered the "Golden C" requirement—300 kms. or 186 miles. By this time I was at cloud base, 6,000 feet over Plymouth. Inside the cloud lift was strong but patchy, and at 6,900 feet. I gave up the mental struggle and went on west. I came out of the side of the cloud and saw the irregular coastline of Cornwall ahead, the numeros inlets an rivers silver against the declining sun. the colours of the landscape darkening by silhouette.

I flew along the coast. finding dying lift here and there. The land an sea breezes both seemed to have gone; smoke below was rising gently and vertically. Six hours. yet again 32 miles clocked on.

Over the river running down to Fowey was gentle lift; farther on

I could see St. Austell, a surprisingly large town, the hills behind it dotted with huge white pyramids of china clay. I remembered that this was the home town of Capt. Phillips, where he used to land his "Avro 504." How bucked he would have been with all this! I reached St. Austell at about 1,500 feet, saw a sloping field behind a garage on a by-pass, and circled down to a landing at 5.15 p.m.

I had caught a heavy cold and felt extremely ill. In Addition I had had nothing to eat since 8 a.m. But the task of keeping at bam the ravening hordes of small children until the Minimoa was safely packed away took another two hours, before I could get any food.

The official distance (by Great Circle course) was eventually given as 209 miles. The distance covered by my wife with the trailer, retrieving me in the two days, was 581 miles. Who won the greater virtue? No prize is offered for the answer.

11. Soaring Flight in America

By A. E. Slater

The history of soaring flight in the United States of America begins with Octave Chanute, a remarkable man who, having retired after an energetic life as a railway engineer, took up active gliding when he was over 60 years of age. His first practical experiments were undertaken in the summer of 1896, on the sand-dunes bordering Lake Michigan near Chicago. He engaged younger men to do the flying, though he took an occasional hop himself, and after trying out many arrangements of wing surfaces found the trussed biplane type, fitted with rudder and elevator, to be the most satisfactory. His assistants flew off hills up to 90 feet in height, in winds of up to 31 miles an hour, and often soared for several seconds on end after rising from 10 to 20 feet.

Some of Chanute's prophecies have proved astonishingly accurate. Here is one of particular interest to us; writing in 1894 he said:—

"To the possible inquiry as to the probable character of a successful flying machine, the writer would answer that in his judgment two types of such machines may eventually be evolved: one, which may be termed the soaring type, and which will carry but a single operator, and another, likely to be developed somewhat later, which may be termed the journeying type, to carry several passengers, and to be provided with a motor."

The aeroplane beat the sailplane after all in the race for priority, but it is a curious fact that the first man to fly a successful aeroplane was also the first to make a prolonged soaring flight on a glider. This was Orville Wright, who, with his brother Wilbur, began gliding experiments on the sandhills at Kitty Hawk in North Carolina in October, 1900. Chanute joined them in 1901, to help with advice. During September and October, 1902, on their third expedition to the site, nearly a thousand glides were made in winds of up to 36 miles an hour; and in the autumn of 1903 several flights exceeded one minute and included short periods of soaring. At the end of that year the Wrights had added a motor to their machine and achieved powered flight, and all attempts to carry out prolonged soaring, one of their original ambitions, were put aside for many years.

But in 1911, on October 24, Orville Wright succeeded in hovering above the take-off point for 9¾ minutes in one of his gliders, during a flight which lasted 11 minutes in all. This was at Cape Cod, in

North Carolina, and the machine was, like all previous Wright gliders, a biplane. For years this remained not only a world's record, but the only prolonged soaring flight that had ever been done, and it was unbeaten till 1921, when the Germans had started their intensive experiments and Herr Harth succeeded in staying up for 21 minutes.

The success of the Germans in the years following gradually re-awakened interest in soaring in America, as in other countries, and in April, 1928, a delegation of three German enthusiasts brought a few sailplanes and gliders over to give demonstrations. On July 26 one of the three, Herr Hesselbach, became the first pilot to exceed Wright's record in the New World, when he soared for 57 minutes at the historic site of Cape Cod. Shortly afterwards he flew for over 4 hours.

The organisation which had invited the Germans over was the American Motorless Aviation Club, formed in New York at the end of 1927. It now attempted to work up a movement for the encouragement of motorless flight, helped by several former Germans who had taken part in the early soaring meetings at the Wasserkuppe and since emigrated to the United States. These men, by the way, still form a very active nucleus in the American gliding movement.

Not much success was achieved at first in popularising the sport. Few people were able to visualise soaring flight as an end in itself, and there were several accidents due to the use of unsuitable machines for stunt flying. Further, there was no unified authority in control. However, things gradually righted themselves, and a visit by Wolf Hirth, with his "Musterle" sailplane, during the winter of 1930—31 helped to direct enthusiasm along the right lines by showing what the modern sailplane can be made to do in expert hands. From this time onwards American soaring has never looked back, and since February, 1932, there has been a well-run organisation, the Soaring Society of America, in charge to ensure that progress is maintained.

The Americans have their national soaring centre on the hills overlooking Elmira, 180 miles inland from New York. The site was discovered in 1930 by Dr. Wolfgang Klemperer, holder of German "C" soaring badge No. 1 and now an American citizen. First to soar there was Jack O'Meara, subsequently to become the first American "Silver C" pilot.

Starting in 1930, eight national soaring contests have now been held at Elmira, and the results in successive years show a steady improvement in the numbers and skill of America's soaring pilots.

At the 1937 meeting, for instance, 147 pilots entered with 54 machines; 669 launches were made, and a total of 2,224 miles were flown across country.

Another fine soaring site where successful meetings have been held in the last few years is Blue Ridge in the Shenandoah National Park, Virginia. And yet another is at Empire, Michigan, where pilots soar over sand-dunes on the shores of Lake Michigan, just as Octave Chanute had attempted to do 40 years before.

It may be said that the American and British gliding movements are very similar, with the Americans slightly ahead. They have not only the advantage of an earlier start, but their thermal currents are more vigorous and their cumulus clouds higher than in England, while their country certainly allows more room for distance flights!

There follows a short biography of the late Warren Eaton, and then an account of a cross-country flight of unusual type by Mr. Lewin Barringer, now Manager of the Soaring Society of America. He achieved the sailplane pilot's dream of ridge-soaring nearly all day long, on and on across country, without once retracing his course. Examples of other kinds of cross-country flight in the United States are given elsewhere in this book, where Wolf Hirth describes how he did the world's first "pure thermal" flight from Elmira, and Martin Schempp relates an exciting experience in a thunderstorm.

It should be mentioned that the account of Mr. Barringer's flight is taken from *The Sportsman Pilot,* and those of Mr. Wills and Mr. Fox in England from *The Sailplane and Glider.*

Warren Eaton

By A. E. Slater

Mr. Warren Eaton, to whom, with Eric Collins, this book is dedicated, took up soaring when he was over 40 years of age, and became one of the most enthusiastic sailplane pilots in America. In his working hours he was partner in a big chemical works at Norwich, N.Y., but once he had tasted the joys of soaring flight all his spare time and energy were devoted to it, and to assisting its development in America.

His first two soaring flights, which were carried out at the 1930 Elmira meeting, were of 5 and 7 hours duration (he was already an

aeroplane pilot). At the end of 1931 he became the first private sailplane owner in the United States, and at the same time founded a gliding school in his home town, where primary instruction was given by means of auto-towing. He adapted a Ford chassis most ingeniously for this purpose, the instructor having a seat facing backwards, from which he could not only watch his pupil, but also work the gears, brakes, throttle and cable release hook, leaving the driver to do nothing but steer a straight course.

When the Soaring Society of America was formed Warren Eaton became its first President. He not only organised the meetings run by the Society, but took part in them himself, and made many flights of interest, including one from Blue Ridge, Virginia, in September, 1934, when he and Mr. Barringer flew together across country and both landed in the same field 30 miles away after being in the air about 5 hours.

Warren Eaton met his death in an unfortunate accident in December the same year, when his cockpit cover blew off and rendered him unconscious during a sailplane flight in tow of an aeroplane at Miami, Florida.

The present writer had met him only five months before this at the Wasserkuppe in Germany, and can well remember his geniality and friendliness. He had just arrived from America by way of England, to cap his European tour by a pilgrimage to the spot where soaring flight was natured to full growth.

Warren Eaton's widow still does all she can to carry on his good work for American soaring, and is one of the Directors of the Soaring Society.

The Longest Ridge-Soaring Flight

By Lewin B. Barringer

For several years I had thought of making a soaring flight down the Blue Mountain ridge in Pennsylvania. Many power flights across this long continuous "hog-back" mountain had convinced me that here, right close to home, we had distance soaring possibilities perhaps second to none in the entire country.

Although I had so often thought of soaring along the Blue Mountain ridge, for a long time I could locate no cleared place on top of the ridge where a take-off could be made. Early in March, 1935, while I was flying on a reconnaissance mission with one of

the National Guard "Douglas 0—38's" my course took me past the town of Ellenville, N. Y. Above Ellenville is a good sized mountain which forms the end of the ridge. There, at the one place where it could do me the most good, I sighted a small field high on the mountain side, overlooking the valley and the town.

As soon as I was able I drove the 150 miles up there from Philadelphia and found that a good road led to the small field, and that it was in nearly every respect an ideal take-off site. From then on I began to make my plans. I had gathered data about wind directions and velocities which had been recorded for that locality over a period of 22 years. From these I determined that March and April seemed to have the most days of strong N. W. winds. I then dug up the records of those months and found the hourly direction and velocities for March and April of the preceding year.

It was, however, a combination of circumstances other than meteorological that finally decided the date for the soaring expedition to Ellenville. The Joint Persian Expeditions invited me to head their newly formed aviation department. My acceptance of the position necessitated my sailing April 30th for a two-year sojourn in Persia doing aerial survey work. Hence, if the soaring flight was to come off at all, it had to come off more or less immediately.

Arriving in Ellenville Saturday, March 31st, I met Earl Southee, who was to supervise any attempt at setting a record, and the three other members of the crew. We spent the next two days of "dud" weather preparing the shock-cord, making trial launches into the valley, and in other ways getting all set for the first flight off Mt. Mongola, 1,400 feet above the valley and 1,720 feet above sea-level.

Two of the greatest meteorologists in America, Dr. Karl O. Lange, of M. I. T. in Boston, and Dr. James H. Scarr, of the U. S. Weather Bureau in New York, were to wire me when the most propitious weather conditions were on the way. As we ate lunch on Tuesday, the 2nd, two telegrams from these gentlemen arrived simultaneously, and we made ready to take-off next day at dawn. The sailplane was towed up the mountain on its trailer and stored in a barn near the small take-off field.

Up at 3.30 a. m., we had a bite of breakfast and drove up the mountain. The sailplane was hauled to the field, assembled, checked, and all ready to take off by the time it was light enough to fly. It was cold up there, and the fire we built served both to warm us and to show the wind direction and velocity. The direction was perfect, due N.W., but the velocity, not over 5 m. p. h., was too slight for take-off. Gradually, though, it picked up, and by shortly after eight we were all set to take-off.

I strapped on my 'chute, climbed in the narrow little cockpit, and had the hood fastened down over my head. With the tail of the Albatross II. held by a rope, one end of which was tied to a car and the other end held by three men, the shock-cord was stretched out by my Ford roadster. The four strands of $^5/_8$ inch rubber rope were stretched to nearly double their length; the ship quivered with the strain. As Earl Southee gave the signal "Let go!" there was a snap and the ship stayed right where it was as the shock-cord let go and crashed against the rumble seat of the Ford. The metal ring on the tow hook had snapped in two!

Substituting another ring we made ready to try again. This time Earl Southee's cry of "Let go!" brought immediate and powerful results. With terrific yet smooth acceleration the big sailplane shot forward. Almost before I could think I was making more than sixty miles an hour and was well out over the edge of the mountain. I immediately felt the lift and began climbing steadily as I made several "figure eights" along the face of the mountain. Here, although unknown to me, a remarkable thing happened. The many spectators saw a small hawk go after me, and, apparently infuriated at having his soaring domain invaded by a strange new bird, he actually attacked my right wing tip!

In no time, it seemed, I caught a thermal and spiralled up 2,000 feet on it before heading down the ridge.

The first thirty miles were slow—taking me nearly two hours, for the wind was quite variable. I kept going on slope-winds most of the way, being helped a bit now and then by weak thermals.

Passing the fire tower beyond Port Jervis, I was only about a hundred feet higher than the lookout, and when I shouted at him, he almost fell out of his perch. Thermal lift carried me past the bad wooded stretch between there and the Delaware Water Gap. I soon found myself flying along the ridge overlooking the Delaware and the Shawnee Golf Course. The Gap itself looked very wide and formidable, and I wondered how I should get across it.

Just about then I caught a thermal that took me up at ten feet per second as I spiralled steeply to stay within it. From 3,000 feet the Gap looked insignificant, and I sailed over it, in fact miles past it, before I was down to slope-soaring again.

The next twenty miles were the best part of the trip. The ridge was unusually even and a strong cross-wind blew all along it. Putting the nose down, I watched the air speed go up to 55 as I kept the rate-of-climb at zero, and sailed along in the steady slope-wind about 500 feet above the ridge. It gave me a chance to relax a bit and eat a bite of lunch. Ted Bellak, my crew chief, had wired over

my head a thermos full of hot coffee with a rubber tube leading down, and all I had to do when I wanted a drink was to put the tube in my mouth and press a valve.

Along about mid-day, four and a half hours out and 90 miles on the way, things began to look bad. The wind died down and I had to drop well below the ridge. It was all wooded below, and I had a few very anxious moments as I glided across some foothills and well down into the valley. It looked as if I was all through, but I decided to hang on to a slope on a low foothill as long as I could.

Then, thank Heaven, the wind picked up again. Carefully I worked my way up to the top of the ridge once more, soon caught a strong thermal which boosted me first at ten feet per second and then *seventeen feet per second!* I climbed in it to cloud-level, over 5,000 feet, and continued on my way. The temperature (a record of which I kept on a pad strapped to my right knee) was 39 degrees along the ridge and 30 degrees at the top of my climb. They call them "thermals", but there was certainly nothing warm about them that day!

So the hours passed rapidly as I continued on slope winds and thermals. Although I was cramped in that tight little cockpit, I was far too interested and excited really to get tired. I know nothing quite so thrilling as a soaring flight such as this. The thought that I was well past the 136-mile mark which stood three years as a world's record was encouragement enough.

Six hours and ten minutes out, at 2.40, I passed Manada Gap. It reminded me of the time during the last summer's National Guard encampment when I flew one ship of a three-plane formation which made a surprise attack at dawn on the infantry at Indiantown. We had flown through this very gap, west down the valley, skimming the tree tops, and then through Indiantown Gap completely to surprise the ground troops who had neither seen nor heard us coming. What a nice surprise attack I could have made this time, sailing down on Indiantown on silent wings!

After a thermal had carried me across this gap, my mind was quickly brought back to present realities when I began steadily to lose out as the wind shifted gradually to the west. I stretched it as far as I could, my heart in my throat, as I skimmed the tree tops. Then came the landing—quite suddenly. I had decided to land in a field half a mile away when a down-draft off a low hill caught me, and I put the nose down and dived at the up-slope. The air-speed showed close on sixty as I put her on the ground, pushed the wheel full forward and jammed on the brake. I came to a dead stop in 40 feet.

I had made an arrangement with Earl Southee and Ted Bellak whereby they started after me as soon as I was out of sight. They were to "check in" at the Western Union offices of five principal towns along the route. I was to telephone the one nearest to my landing place and leave a message directing them where to come. This worked so well that when I called from a farmhouse near Piketown, Pa., seven hours after taking off from Ellenville, now 220 miles distant by road, Earl and Sully arrived within an hour, and Ted, with my car and the trailer, half an hour after them.

Measuring on my map the air line distance from Ellenville I found it to be approximately 160 miles. Allowing for the inevitable error there was a bare chance that I had the necessary 5% over Dick duPont's National Record of 158 miles. Unfortunately the Press immediately announced a new record although I told them I would not know for sure until my barograph had been calibrated by the Bureau of Standards a week or more later. The Bureau finally announced my distance as 154.54 miles.

I look on every carefully recorded soaring flight as a contribution to the science of aeronautics and meteorology. As such the conclusions obtained from it are important. The chief conclusions of this flight which, as far as I know, was the longest ever made along a continuous ridge, are as follows:—

1. It established the Ellenville site, which I discovered, as one of the most promising in America.

2. It proved the value of careful study and preparation beforehand.

3. It showed that very strong thermals exist in sub-freezing temperatures. (Some were stronger than any I have ever encountered in the summer-time.)

4. Although thermal soaring played an important part in this flight, it can truly be called a ridge-soaring flight as most of the distance was made in pure slope-wind and the thermals utilised developed because of the ridge.

5. Due to the fact that I was often bucking a cross headwind, I would undoubtedly have made much greater distance in a sailplane of cleaner design and higher cruising speed such as we have to-day.

I am hopeful that someone else will follow me down that route. If not, perhaps I'll have to try it again myself.

Distance over the Plains

How the new American record was made by L. B. Barringer

On the morning of Tuesday, April nineteenth, I picked up the boys at the National Guard Armory in Wichita Falls, Texas, a quarter of seven as usual. We drove the six miles north to the airport and had our breakfast. By eight o'clock the winch was set up, the rope laid out and the Minimoa checked over, all according to our daily routine.

It was a clear, cool morning with no indication of good convection and, as it was obvious that we could do nothing early, I busied myself with barographs, maps, lunch and notebook, as on every preceding morning. I did not have any great hopes, but just wanted to be ready—in case.

About nine o'clock I noticed Ted Bellak talking with Rufford Manning, weather observer and station man for Braniff Airways. Ted was studying the barometer and making notes. Then he walked out to the slatted box, lifted the lid, and noted the temperature. Spinning the little fan, he also took a wet bulb reading of relative humidity. Then, walking toward me with an excited look in his eye, he said, "I think it's going to be good!" I laughed and bet him a quarter I wouldn't get over three thousand. At ten fifteen I strapped on my chute, climbed into the Minimoa's cockpit at the northwest corner of the field, turned on the two barographs and strapped myself in. As I tied a handkerchief over my head to ward off the sun's rays, intensified through the new plexiglas cockpit cover, and put on dark glasses, I noticed small cumuli beginning to form to the southwest. Snapping the cover shut I shouted "All set" to Pete Bonotaux at my left wingtip. Picking up his large flag, Pete waved it from side to side. The field had a slight crown to it so I could not see th winch four thousand feet distant, but I could see Ken Findiesen waving another flag about half way to it. Almost immediately the slack was taken out of the rope. As the ship began to move, Pete dropped his flag, Ken lowered his, and Ted gave the winch full power. There was only a slight breeze blowing but the Minimoa soon had flying speed and I lifted her off through the oat tops.

Climbing gradually at first and then very steeply, I could feel the pull on the rope slow up the winch. With an indicated airspeed of 45, I climbed very rapidly. The manila rope absorbed shock and strain so well that there was no feeling of roughness or overstres-

sing the wings. The hand of the Kollsman altimeter rose rapidly and, when steeply over the winch, I nosed sharply down and pulled the release; it read 850 feet. Pulling up with the reserve speed I gained another hundred before levelling off and hunting for thermals. When down to 800, I caught a weak one southwest of the field and just held altitude fo a bit before losing it. Soon I was down low, so turned into the field and landed downwind at the starting point. With a minimum of delay I was off again and this time turned west after releasing. A few hundred feet beyond the hangars I glided into a thermal that showed 1 to 4 feet per second climb as I spiralled in it with wide, slightly banked turns, which a week's experience with Texas thermals had taught me was the best technique. This time I climbed to 1,500 feet before I lost it. Gliding back over usual thermal areas, I found nothing more and landed after 16 minutes in the air. As I made ready fo the third try, I noticed the cumuli were growing rapidly all over the south and west of the airport. My meteorological notes showed: Wind SW 4. Barometric Pressure 29.85, Temperature 82° F, Relative Humidity 65. Altitude of airport, 1026 feet. On this take-off, at 10:45, I again reached 950 feet, but seemed to have less luck than before, until I was down to 500 feet over the south end of the field. There I caught a good one and spiralled in it up to 2,000 feet. From this height I could see really sizeable cumuli a few miles east along the Wichita River. Heading cross wind in that direction, I caught several weakish thermals which kept me going until I reached the line of large clouds. Under one I climbed to 2,800 feet and jotted down on my log that I was over the Wichita River—Temperature 70°—Humidity 90—Time 11:20. The cloud shadow paralleling the river in a northeast direction seemed to indicate a cloud street, but this was not the case. The clouds were so close as to be practically touching, yet as I proceeded along under them I encountered upcurrents beneath the center of each and downdrafts between them.

As I passed over the junction of the Wichita and the Red River which forms the Texas-Oklahoma line, I began to lose out. Even the most promising looking clouds seemed to offer no lift, so down I came. Approaching the U-shape bend of the Red River, west of Waurika, Oklahoma, I was down to 800 feet and things looked bad. Below me were enormous level fields, but it was a mile or two to a road and I saw my chances dwindling fast. If I were forced down now it would be too late to start again that day. Staking everything on past experience, I headed for a half mile square field at the bend of the river. The dust blowing from three teams plowing it showed the soil to be dry. Down I came to 500 feet over the center of the

field, and there I caught a thermal lifting me at 2 feet per second. Spiralling carefully, as the sweat ran down my face, I climbed slowly upward. At 1,500 feet the lift increased to 3½ feet and I spiralled a bit tighter, keeping the airspeed at 38 and the ball bank carefully centered.

This time I reached the cloud base at an altitude of 3,800 feet. It was now 11:46, one hour out and 20 miles on my way, as I passed Waurika. Pulling the atomizer bulb out of the map pocket with my left hand, I started pumping it. The gyro soon responded and I spiralled slowly up into the cloud. The air was fairly turbulent and the lift weak. I soon came out into the clear above an edge of the cloud at 4,000—and continued on a compass course of 10^0 east for Oklahoma City. I had announced my intention of a goal flight to Tulsa but decided that conditions were not exceptionally good and I might as well try for the lesser goal of 106 miles and prize of $100.00 first, as it was not far off the longer route.

At 12:05 p.m. I passed over Addington—like most towns in Oklahoma—conspicuously marked by a large roof sign in yellow letters.

From here on the clouds were more evenly spaced and, although the strongest thermal showed no more than 6 feet per second, I had no difficulty in staying over 3,000 feet. As I passed over Wildhorse Creek near the village of Velma, I noticed that the cloud shadows were now moving almost due north parallel to the section line roads. In thies part of the country practically all the roads run north-south or east-west, which makes navigation very easy on a cross-country flight.

As the conditions improved I began to relax somewhat and take things a bit easier. By this I mean that the first hour or so had been a struggle to stay up and keep going, during which I had to bring into play all my past experience, flying ability, and judgment of cloud formations. I was on edge because I wanted so much to succeed, not because I was ever worried from a safety point of view. The country was now becoming more wooded and crisscrossed with more streams, yet never was there a moment when I would not have had a choice of at least two large, level fields to land in, if forced down as low as 500 feet.

At 12:55 I crossed the Washita River west of Landsay, seventy miles on my way. I began to get hungry and thirsty so munched some cookies and sucked an orange. Planning to keep my energy up as evenly as possible, I ate and drank something every hour for the rest of the flight. My diet also included bananes, apples, nut cookies, and chocolate. In carried no water, relying on the oranges as efficient thirst quenchers. Spiralling up under the cumulus clouds

and flying downwind between them, I flew due north for the next thirty miles. The cloud bases were rising and the cumuli became smaller and flatter. The thermals soon became more and more turbulent and spiralling in them was not easy. As I approached the town of Newcastle, I could se Oklahoma City in the distance and determined to make for the Airport southwest of the city, as the cumuli began to break up. Flying over a bend in the Canadian River at 1:30, I was down to 1,500 feet when I caught the strongest thermal of the day, which carried me up at 10-13 feet per second, as I fought to make even turns in its turbulent interior.

Up and up I went and entered the cloud base at 6,100 feet. Overhead was the largest cumulus I had seen for some time, so I went into it. Spiralling carefully with a 20-30 degree bank, I climbed to 6,500. This was my highest altitude of the flight and was 7,500 above sea level, which made the press claim a new altitude record, which, of course, it could not be. The reason that I didn't go higher was that the interior of the cloud became so turbulent that it was impossible to continue flying on instruments with any degree of safety. One second the airspeed showed a normal 45, then without warning it went up to 60, and the next moment a gust hit the ship and she was quivering in a stall with the needle at 32. Pushing the stick forward and holding the compass due north, I dived out of the cloud to find myself fife miles south of the skyscrapers of Oklahoma City and east of the aiport.

With such a great boost I was encouraged to push on for more distance. Passing over a large oil field south-east of the city at 1:50, I saw several fires with smoke streaking along the ground duee north. I estimated the wind at my altitude as being at least 35-40 miles per hour, also blowing due north. The clouds looked equally promising, north and east, and here I had a real decision to make.

Best chances for greatest distance obviously lay to the north, flying with the wind. Yet I had announced my destination als Tulsa and there is much personal satisfaction and credit from the soaring fraternity, if not the official bodies, for a successful goal flight. In addition, there was the Fiduciary Counsel price of $1,000.00 for a goal flight between two cities over 200 miles apart. Although Mr. Jackson Martindell, who first proposed the prize, had been in Europe when we announced in February that we would have this as an alternate course to the previous one of New York—Washington, we had every reason to believe that he would approve it. I had used it as an inducement for other pilots to join me in Texas for a real test of level country conditions. Unfortunately, none of them could

get away because of business pressure during the "recession", but still i saw no reason why I should not go after the prize myself. So it was that I threw away chances of what would probably have been a 300 mile flight, and pushed on cross wind to the northeast.

Passing over the North Canadian River near Jones, Oklahoma, I hit another 10 feet per second thermal and a most interesting fact, substantiated by several airplane pilots, was forcibly brought to my attention. The strongest thermals—in fact the only strong thermals on this flight—are found over the rivers! This I can try to explain only by the fact that most of the rivers in this part of the country have wide sand flats, due to the spring floods, and these must heat up more rapidly than the soil of the fields on either side. As the flight progressed, I saw more evidence of the strongest thermals as well as the largest clouds over the rivers.

About 2:30, I passed north of Chandler and turned north toward the most promising cumuli I had seen for several hours. Southwest of Cushing I was under another line like that encountered early in the flight, and again it proved to be individual thermals and not a cloud street. The air became increasingly turbulent as I passed south of Cushing at 3:00. A glance at my map showed that I was about 165 miles airline from Wichita Falls and, as I was 4,000 feet high, I knew that I had at last exceedet the American distance record, which I had been trying to do for four years, only narrowly missing it three years ago.

Curiously enough, I had no feeling of great elation, probably because far in the distance I could see the sun-lit skyscrapers ot Tulsa. I bent every energy on reaching that goal and prayed that the conditions would hold out to enable me to do it. As I passed Drumright at 3:15 and jotted down: altitude 5,300′—temparature 65°—humidity 77, I realized that my ground speed had slowed up as I was forced to fly more and more cross wind.

The last thirty miles I was frequently headed southeast to keep from being carried too far north. As I neared the junction of the Cimarron and the Arkansas Rivers, the clouds and the thermals again thinned out. As I crossed the Arkansas, I was down to 1,500 feet when another good "river boost" caught me up. I crabbed along just north of the river, making very slow headway but finding sufficient lift to maintain comfortable altitude.

Passing over the town of Sand Springs west of Tulsa, I again lost out and was faced with the possibility of having to land in a park, when a particularly turbulent upcurrent carried me up to 3,500 feet, at which altitude I flew over the city of Tulsa at 4:15. Tulsa is a really impressive American city, prosperous, clean, and modern. To

me, with the late afternoon sun lighting the tall buildings, it seemed a city of rare beauty, for I was seeing a dream come true.

The Municipal Airport is six miles northeast of the city, so I continued with the help of three good thermals and arrived over the field at 2,500 feet at 4:25, having covered 212.45 miles at an average ground speed, measured for the airline distance, of 37 miles per hour. The clouds were now small and widely scattered, although the thermals were still fairly frequent and strong. As I pushed my way down through them to land, I estimated that I could probably have continued on at least another twenty miles to Claremore, birthplace of Will Rogers.

I had been flying over the airport for at least fifteen minutes before anyone saw me. Then someone, in the beautiful administration building, announced over the public address system that a glider was coming in to land. The Spartan School of Aeronautics promptly stopped work and a score of white-coverall clad students rushed out as I landed gently into a 22 mile south wind on the runway at 4:35, after having been in the air for 5 hours, 50 minutes.

With the help of the students, I was rolled into one of the big hangars, where I climbed out and the ship was put up for the night. I asked for the airport manager to witness the removal of the sealed barographs and, when he arrived, he turned out to be Charles S. Short, Jr., one of the best known airport administrators in der country, as well as a member of the Contest Board of the N.A.A.

What followed is more or less of a confused haze in my memory—long distance calls, telegrams, newspaper interviews, talking over the radio, being airplane towed back next day behind a Waco F-3 flown by Red Kimbrell, landing at Oklahoma City and being met by a contingent of honor flown up from Wichita Falls by Ray Schifflett in his trimotor Stinson, and the ovation-like reception at Wichita Falls. However, despite all this, I soon arrived at some definite conclusions about the flight.

Of course, I am delighted to have been able to set a new record and give soaring a boost, but I realize that we still have a long way to go to beat the Russians—and beat them we will, I am sure, because I am convinced that this was not an exceptional soaring day for this part of the country and that, although it was the best we had during our visit there, many better days with really great distance possibilities exist in June and July. As I said, it is a real satisfaction to have set a record and proved my contention of the suitability of our level plains for high performance soaring from every point of view, but there is an even more significant conclusion to be drawn from this flight. It was the first lang distance soaring

flight ever made in America from winch tow on an airport in level country. This makes me feel sure that real performances can be made anywhere in the country and I hope that it may prove an incentive to soaring pilots the country over to get out and do some real soaring during the summer months over airports or large fields in their home localities.

12. Soaring Expedition to South Africa Oct./Nov. 1936

By P. A. Wills

When the writer had to make a business trip to Johannesburg in October 1936. Mr. Slingsby of Slingsby Sailplanes generously offered to send out one of his Kirby Kite sailplanes for demonstrations to the South African gliding movement.

Conditions for soaring on the high veldt. 6000 ft. above sea-level. were practically unexplored, and many local pilots. ignoring the thousands of vultures daily indulging in thermal soaring above their heads, considered soaring impossible at that height.

In view of the increased stalling speeds to be expected owing to the altitude, I decided not to take a high efficiency and high speed sailplane like my Hjordis. and the Kirby Kite seemed a reasonable compromise.

Arriving at Quaggapoort, the Rand Gliding Club's site near Pretoria, 35 miles north of Johannesburg, in October we soon decided that an attempt at a really ambitious cross-country flight would be undesirable; partly because the numerous ant-heaps scattered over the high veldt made minor damages on landing probable. and these would have been very difficult to repair in Johannesburg—and partly because my firm might have had something to say if I had gone off on a long cross-country flight on a Sunday and in the absence of communications failed to get back to work before the following Wednesday.

So it was decided to attempt a goal-flight to the main Johannesburg airport at Germiston, 33 miles away. This flight I carried out successfully on the following day. The Quaggapoort site is a low and broken hill facing the north wind which prevails steadily at Johannesburg for the six summer months of the year. It varies from 200 to 500 ft. in height and the beat is perhaps 3/4 mile long. I was launched in the morning in a fair 20 m. p. h. wind, and for 3 hours beat up and down, encountering many small but fierce thermals up to 2000 ft., where an inversion evidently occurred. The sinking and flying speeds of my machine seemed more adversely affected than could be accounted for by the altitude alone, while the surface heat of the ground evidently made matters worse. My sinking-speed seemed quite doubled. and the flying-speed rose from a normal 30 on the A. S. I. to 36 m. p. h. The thermals rattled me up smartly at

from 10 to 20 ft./sec., then one sank briskly back to the hill at anything up to 10 ft. per sec.

I landed for lunch and took-off again at about 3.0 p.m. By then the inversion had no doubt been partially broken down by the increased heat at ground-level. There was not a cloud in the sky, but in a short time I met a thermal which took me to 5,400 ft. at from 15 to 20 ft./sec., a total altitude of approximately 11,200 ft. above sea-level.

The subsequent flight was carried out in the normal way, further thermals being met on the way.

Later a number of thermal flights were done from aero-tows, the aeroplane being an American Rearwin 2-seater machine with a radial engine of only 85 h.p., which nevertheless did the job operating from an aerodrome at 6,000 ft. There is no doubt that on five out of six summer days on the high veldt thermal flights are possible. The cloudless days seemed the best, on other days shallow streets of strato-cumulus formed at only 2,000 ft. above the ground, and the lift inside was slight. In the evening fierce thunderstorms would commonly occur, and hailstones weighing up to a pound a piece are not unusual, requiring for their formation upcurrents exceeding 200 m.p.h. Needless to say I did not go near anything of this sort.

The vultures I found exceedingly useful as thermal indicators, and I was surprised to find they also appreciated me in the same role. If ever I found a thermal on my own I would in half a minute or so be joined by one or more large brown birds with nasty looking faces, and we would all circle up together, though around 2,500 ft. the birds would usually leave me. Evidently this is about their useful range of vision for spotting carrion on the ground. Their sinking and flying speeds seemed about the same as my own.

It is clear that their method is to fly singly, quartering a strip of ground within vision of their neighbours on each side. When one bird starts circling in a thermal or diving to a kill, its neighbours see it and fly inwards, and their neighbours in turn follow suit. Thus arises the well-known spectacle of a kill occurring under an apparently empty sky which a few minutes later is full of wheeling vultures.

13. Some Young German Sailplane Pilots

By Georg Brütting

Ludwig Hofmann

Ludwig Hofmann's parents were simple peasant-folk, who took no interest in the scientific developments of the century. How then did young Ludwig come to be one of Germany's best known sailplane pilots while still a youth? Perhaps it was his grandmother who first fired his childish imagination by recounting stories of the famous Parsifal, who used to fly over the village in his airship waving his cap! Later a balloon drifted over the peaceful countryside near his home, and another time a military aeroplane made a forced-landing on a field not far away. From then on, young as he was, Ludwig Hofmann was determined to become an airman.

He showed considerable ingenuity as a boy by building without any previous experience or guidance a model aeroplane, and although this never flew, he found solace in making and flying kites so creditably that he eventually became champion of his village.

His parents sent him to school in Aschaffenburg, where, in an old bookshop, he came across a pamphlet entitled "How can I build myself a model aeroplane?" He at once began to save his pocket money, and buying the pamphlet and the necessary materials he spent his evenings, which should have been devoted to study, building one model aeroplane after another: each one an improvement on the last. This, of course, did not fall in with the wishes of his worthy parents, who threw his precious models one by one into the fire. But it was no good! Ludwig would not be dissuaded from his passion, and his parents were distrait at noticing his even greater enthusiasm after an Air Meeting in Aschaffenburg. As a good pupil of a country school, there were, of course, only two professions open to him, either clerical or scholastic. His well-meaning relatives decided on the latter, and in order to take his mind right off flying he was even promised a motorcycle.

He first became acquainted with gliding in Würzburg, where, joining the local Gliding Club, he made his initial ground hops. But to his astonishment he was absolutely hopeless, every time breaking some part of his glider, which he had so carefully put together. In spite of this he was allowed to take part in the Junior Competitions on the Wasserkuppe, where, surprisingly enough, he very soon passed the "A" test with a glide of over one minute. At last he

seemed to have got the hang of it! But on his very next flight in Würzburg, he stalled, and surrendering to the urges of his flying instructors, became a non-flying member. But no! In spite of his parents' protestations and his own inability to fly, he remained undaunted and once again saving up every penny took a course on the Wasserkuppe in the Easter of 1930. He again distinguished himself by crashing at his very first attempt, and besides smashing the Zögling sustained multiple injuries to his right leg. This brought things to a crisis between himself and his parents, who insisted on him completing his studies. Then one day he packed his things, and appearing at his home announced that he wished to become an airman and not a school-teacher. His parents, seeing that Hoffmann's heart was clearly set on flying, then sent him to Weimar to become an aeroplane designer. Being inexperienced, he took an initial course of flying; but he was again so hopeless that each time he flew, his instructor feared he would have to bury him the next day! In spite of this, Hofmann was deadly serious about learning to fly and even spent his spare time watching others in the air and learning from them, until one day he astonished everybody by carrying out a perfect flight! All of a sudden—as is so often the case—he had got the hang of it: his grit and determination had triumphed!

In the Spring of 1933, he returned to motorless flight. After passing the "C" test, he took a course of aero-towing in Darmstadt as a pupil of Heini Dittmar and Peter Riedel. In his spare time he studied "Die Hohe Schule des Segelfluges" (The Art of Soaring Flight), to which, he attributes much of his success. In the Competitions he made a number of duration flights in an old "Professor" and in the Autumn of 1933 was engaged as a gliding instructor and also temporarily as a power-flying instructor in Mannheim.

His quick rise to fame commenced in the Spring of 1934. In a fortnight he had flown a total distance of 625 miles, his flight to France and Nürnberg being particularly meritorious. While the former represented his first flight abroad and brought him invitations to numerous Air Meetings, the latter was characterised by an unparalleled energy. The previous day he had made a cross-country flight and travelled back over-night. Without having had a wink of sleep he climbed into the plane again and in spite of a bad chill flew first Northwards to Karlsruhe, then Eastwards to Nürnberg. On the way, he was often overtaken by sleep, so that several times he went into a spin, woke up, righted his plane again, and resumed circling. Over Nürnberg he still had 2,000 ft. of height, but as he was too tired to continue the flight came in to land. In an exhausted condition he had covered 140 miles, and as he still had 2,000 ft. in

hand over Nürnberg, it can be asserted without exaggeration, that if he had been in top form, he would have broken the world's record which at that time, in the Spring of 1934 was only 150 miles.

In the 1934 Jubilee Contests, Ludwig Hofmann lived up to his reputation by winning the prize awarded for the greatest total distance flown with the extraordinarily high aggregate of 725 miles, the second altitude-prize and the second total duration-prize, thus becoming "Victor Ludorum" of the Competitions. Stress of weather never prevented him from embarking on cross-countries, and he invariably covered at least 40 miles and only twice less than 60, his longest distance being 194 miles to Czechoslovakia. His systematic flight through four local thunderstorms was also carried out on a day when there was no other flying.

An unfortunate accident, which occurred outside his flying activities, put him "hors de combat" during the Autumn of 1934. The Winter he spent on the Eibsee lake as personal adviser on soaring problems to Ernst Udet, the flying ace, who was producing the film entitled "The Wonders of Flying"!

In the Spring of 1935, Hofmann succeeded in making some excellent flights as test-pilot of Jacob's brand-new "Rhönsperber". In a few weeks he had covered a total distance of 625 miles, including his magnificent flight from the Hornberg to Zürich, which made him the first pilot to complete a motorless flight to Switzerland.

In the Rhön Competitions of the same year, he again created a sensation by establishing on the very first day a new world's long-distance record of 296 miles to Olesnice in Czechoslovakia. Barely had he returned from this flight than he was off again, this time landing in Belgium near Arlon after a nine (!!) hour flight, having covered 200 miles. Thus, he also became the first sailplane pilot to fly to Belgium.

In the Autumn of 1935, he was a member of the German Expedition to the International Soaring Competitions on the Jungfraujoch in Switzerland (which was sent out there for the purpose of exploring soaring possibilities in the Alps) where he won the long-distance prize. Shortly afterwards, he returned to Germany, and the very next day was 5th in a field of 68 in the Alpine Flight: this being his greatest success in power-flying up-to-date.

His life's longings have now crystallised into his profession, and as before soaring flight remains the main theme of his life.

Heini Dittmar

Heini Dittmar, one-time holder of two world's records and winner of the 1934 Hindenburg Cup for Soaring, also sprung from comparative obscurity. However, his interest in soaring was early stimulated by his elder brother, who in 1928, held the world's height record of 2,530 ft. While still a schoolboy he was already at home in the workshop. Then he went to the Wasserkuppe and in the years 1929/31 was engaged as a constructor of model aeroplanes in the workshop of the Rhön-Rossitten Co. as it then was, where, profiting by studious attention to all around him, he helped to build the unforgettable world's record-breaking sailplane "Fafnir".

But he was not content with spending all his time in the workshop or always just envying others in the air. He wanted to break records and win prizes too, and having made his first ground-hop in a Zögling, he was anxious to fly a real sailplane. Stamer, his instructor, could not, of course, allow him to do this so soon, and suggested that he should build one himself. Heini did not need telling twice, and when in 1931, he had to spend four weeks in hospital as the result of an accident, he worked out the preliminary plans for a plane of his own. In it were to be combined the manœuvrability of the "Fafnir" and the soaring qualities of the "Wien", Kronfeld's record-breaking sailplane. After all kinds of innumerable sacrifices had been made and 2,000 hours had been devoted to its construction, the new sailplane at last stood ready in the hangars on the Wasserkuppe, bearing the proud name of "Condor". With it Heini participated in the 13th Rhön Competitions and won the Junior Class.

In February 1933, he took a course of blind-flying in Darmstadt with his "Condor" and obtained "Silver C" No. 9. His prowess attracted the attention of Professor Georgii, and only a month later he was engaged by the German Research Institute for the purpose of making scientific soaring flights: a position which he still holds today.

The Spring of 1933 started him off on his great career. In Griesheim he carried out many notable night-flights, and from the Wasserkuppe made his first long cross-country flights. On 7th June, he soared from Griesheim to Saarbrücken in 5 hrs 40 mins., having covered a distance of 82 miles.

Besides attending various Air Meetings, he was also present at the 14th Rhön Competitions, where among other flights he made one to the Kissinger Hut and back. In the Autumn, he undertook research flights over the outskirts of Berlin together with Hirth and Riedel.

In the beginning of 1934, the young expert was among those selected to join the Research Expedition to South America with Professor Georgii. For a long time, the Expedition was wrapped in silence, until Heini Dittmar startled everyone by creating a new world's altitude record of 14.100 ft. above releasing-point. He had climbed vertically through three superimposed cumulus clouds. (See p. 92.) In Buenos Aires, their third port of call, he increased the number of his 100 km. flights to six, with two flights of 100 and 140 kms. respectively.

In May, his companions returned to Germany, but he stayed on as Flying Instructor in São Paulo, where he founded a Gliding Club complete with workshop, and in a few weeks he had turned out many Brazilian "A" and "B" pilots as well as four "C's".

On 10th July, he arrived back in Germany and exactly one week later, won the prize, which the Opel Firm had for years offered to the first person to land on the Opel test track after a flight of at least 100 kms. On 27th July, at the 15th Rhön Meeting, he made a 235 mile flight occupying 5 hrs. from the Wasserkuppe to Liban in Czechoslovakia in the new "São Paulo—Fafnir II", thereby breaking Wolf Hirth's record of 220 miles, which he had established only 24 hrs. previously. This record-flight was largely instrumental in enabling him to win the prize awarded for team-flying in the Senior Class. For these magnificent flights in the year 1934, he was awarded the Hindenburg Cup for Soaring.

In the Winter of 1934/35, he made many notable flights in Winter thermals in his capacity of pilot to the Research Institute, and in May he created a new world's height record for two-seaters of 8,800 ft.

In the 1935 Rhön Competitions, he appeared with the "Condor II", which was a modified edition of his original sailplane and had, in particular, a much higher flying-speed. With this plane he flew 262 miles to the South-East of Prague, thereby breaking his previous record. Later he was to be eclipsed by the triumphant flights of the four Brünner pilots, who established the magnificent record of 314 miles.* In September 1935, he took the "Condor II" to the International Meeting on the Jungfraujoch in Switzerland, where, besides winning the altitude-prize, he also won the greatest number of points.

* The present long-distance record of 388 miles is held by Russia. (Victor Rastorgueff.)

Hanna Reitsch

Hanna Reitsch, who started gliding in Grunau in 1932, as a pupil of Wolf Hirth, first made a name for herself by a somewhat hazardous cloud-flight. "It wasn't exactly pleasant in there," she admitted laughingly, "but as I had never been inside a cloud, I wanted to see what it was like! After about an hour, I fell out upside-down and was astonished to find the sky below and the ground above. But I righted the plane again and landed safely."

In the Winter of 1932-33, she accompanied Wolf Hirth to the Hornberg in Württemberg, where she stayed as a Gliding Instructress until the Rhön Meeting. During and after the Competitions, she assisted with others in the making of a film for the "Ufa" Co. called "Rivals of the Air", which was taken mainly on the Wasserkuppe and in Rossitten. There she established a new world's duration record for women of 10 hrs., which was later broken first by Frl. Mendel, who stayed 11½ hrs. in the air, and Frl. Zangemeister, who flew for 12½ hrs. Then her ambition carried her further to the more difficult realms of cross-country and altitude flying.

In January 1935, Hanna took part in the Soaring Expedition to South America, where she became the first woman to gain the "Silver C", and also established a new world's height-record for women of 7,150 ft. on the same day as Dittmar created his sensational height record previously described.

In May, she returned to Germany, where, after making a few more cross-country flights, she set up her 3rd world's record by flying 100 miles in the veteran "Fafnir" from Darmstadt to Reutlingen in Württemberg. Once again the only woman to compete in the Jubilee Contests, she made several fine cross-country flights and won, together with Heini Dittmar and Peter Riedel, the prize for team-flying in the Senior Class, with a total combined distance of 363 miles. In the Autumn of 1934, she was a member of an Expedition sent to Finland, where her magnificent flying attracted many new soaring enthusiasts among the Finns.

This time she spent the winter in Stettin where, at the invitation of the Air Ministry, she took a course in power-flying. Next she made several interesting research flights as a test-pilot in Darmstadt with the two-seater "Obs". With the advent of a new soaring season, she joined an Expedition to Portugal, and in the Autumn, led yet another expedition to Finland, where, in the meantime, gliding and soaring had been taken up in earnest.

One might say in conclusion that Hanna Reitsch has done as much for soaring as Amelia Earheart, Amy Johnson, or Elli Beinhorn have for power-flying.

My Beginnings as a Soaring-Pilot

By Martin Schempp

My soaring "adventures" (for soaring is still an adventure to me, even though it has become my profession) had its inception not in Germany but strangely enough in France in the Summer of 1928 at the Vauville Competitions, which I visited chiefly out of curiosity. But when I saw the feats of Nehring, Kegel, and Wolf Hirth, I was, as they say in America, "sold to soaring."

After a short course of power-flying in a Klemm, I made my first ground-hop at Mühlhausen in the Black Forest, as a pupil of Wolf Hirth, who later also taught me how to soar. It consisted of a straight glide in a Zögling lasting exactly 30 seconds, and for which I received my "A" Certificate. The thrill of that day will always be fresh in my mind.

In America in the Summer of 1929, I spent all my spare time perfecting my knowledge of soaring and for a long time had to confine myself to pure theory. I was an omnivorous reader and collected all possible literature on sailplanes and soaring ranging from the manuscripts of Lilienthal to the latest reports on the Rhön Meetings by Lippisch.

However, I was only properly initiated into the secrets of soaring flight, when Wolf Hirth came to America in 1930. By his participation in the American Soaring Competitions in Elmira, N.Y., he demonstrated the amazing forces present in the air, and showed how they could be utilised. His 33 mile cross-country flight from Elmira to Alpachin, which as far as I know, was the first to be carried out in pure thermals by means of wheeling in upcurrents after the manner of birds was a revelation to all sailplane pilots, but especially to me, as I witnessed a part of this flight and also had the advantage of having the lessons of it personally expounded to me.

From the time Kronfeld and Wolf Hirth were awarded "Silver C" No. 1, in February 1931, it was my ambition also to earn this mark of distinction for soaring ability. But two years were to pass before I received a "Silver C."

The following year I was employed by the newly founded "Haller-Hirth Sailplane Corporation" in Pittsburgh, Pa., the first firm in the U.S.A. to build high-performance sailplanes.

Saturated with theory, yet without any practical experience of soaring, I had to attend the second American Soaring Competitions as representative of the Haller-Hirth Corporation, and as a pupil of Wolf Hirth it was up to me to uphold his traditions.

My first flight brought me the longed-for "C" Certificate, and my enthusiasm was so great that on the same day I soared for four hours. With a total flying-time of 18 hours, I gained a great deal of valuable experience, which, however, was largely limited to slope-soaring. Four times I set out across-country, covering a total distance of 50 miles, but my best single flight did not exceed 15 miles. True, I was once carried up to 3,000 ft. by a thermal, but my technique was not yet such that I could take full advantage of the conditions. Nevertheless, I won first prize for distance and altitude and recorded the best total flying-time. Besides a third of the prize money and a great deal of experience I brought home something more: permission to do aero-towing. What I had seen the Franklin brothers do in Elmira proved to me that the quickest way of gaining experience in thermal soaring was by means of aero-towing. A few days later, following an invitation to the National Air Races in Cleveland, Ohio, I had the opportunity of doing my first aero-tow.

Further towed-flights near Pittsburgh followed, and once after one of them I soared for an hour above the skyscrapers of that town at a height of 2,500 ft., and then, flying beneath an arched bridge, landed successfully in the Monongahela River. This was my first water-landing in a sailplane.

In the course of my travels through Germany in the Winter of 1931, I made a point of visiting Wolf Hirth at Grunau, where I discussed my experiences with him and thanks to him returned to the United States a great deal more enlightened. Two months later, I had to undergo a severe test in the shape of my first thunderstorm flight. Being unable to reach the front, I was confined to a struggle with the air-rollers mostly in blind conditions. With a lift of up to 30 ft./sec., my Haller-Hawk was whisked up to a height of 8,000 ft. in hail, thunder and lightning, and it seemed incredible that she could withstand such a terrific strain. The wings flexed under the severe stresses, but remained intact. The moral to be drawn from this flight was obvious: I needed more practice in blind-flying, as I had already made one abortive attempt to make an altitude flight in a cumulus cloud.

In my capacity of Chief Instructor of the Haller School of Soaring

Flight at Pittsburgh, I instituted auto-towing, and it is now recognised as the quickest and safest method of training in America.

In the 1932 Competitions in Elmira, New York, I at last succeeded not only in breaking Wolf Hirth's long-distance record, but also in doubling it, at the same time earning "Silver C" No. 8.

The first time that I ever made an exclusively thermal flight, it resulted in being also my best cross-country. After being catapulted into the air, I did, it is true, use the slope-wind with which to gain height, but after 45 minutes of this I discovered a strong lift column in which, by circling steadily, I rose to 4,000 ft. As there was a good cloud-street ahead of me in the direction of the wind, it was possible to pass rapidly from one cloud to another, and at the same time climb to a height of 5,000 ft. In this way, I covered 65 miles in 2 hrs.: undoubtedly one of the fastest cross-country flights ever made in a sailplane. My flight finally came to a premature end owing to the wooded slopes and valleys of the Pennsylvanian range of mountains, which lay at right angles to my course, and though I turned parallel to them, I was soon forced to land.

In the course of a later flight, I came across an astonishingly potent thermal over the small town of Elmira, which is enclosed on three sides by hills. After 2 hours of slope-soaring $7\frac{1}{2}$ miles from Elmira, I flew at a height of 3,000 ft. over the town, and cruised there for a good four hours without much difficulty. A strong bubble was liberated at regular intervals over the opening of the valley. This flight was made late in the evening, and was quite one of the most enjoyable I had ever made, easily compensating me for all the hard work of the last two years.

Unfortunately, as the fuselage of my sailplane had been damaged, I was unable to make more than four flights in all during the Competitions, so that I could only win first prize for altitude, second prize for distance, and third prize for duration.

Shortly afterwards, I was again invited to the National Air Races in Cleveland, Ohio. After being towed-up to 2,000 ft., I soared for 50 mins. over the dead flat country near the aerodrome before a crowd of 300,000. It was a difficult flight, for I had to compromise between remaining within sight and utilizing infrequent thermals, which, when they did occur, were being blown rapidly away by the stiff breeze; and of course, my main object was to stay aloft! My success was largely due to the fact that I was thoroughly familiar with my plane and to the general excellence of my instruments, particularly that of the Askania variometer.

Though altitude and cross-country flights in a sailplane transcend all other pleasures to be derived from flying, to me it was an even

greater joy when, as happened only the other day, one of my pupils climbed to 3,000 ft. on his first soaring flight, and despite the bitter cold, remained in the air a good two hours.

In tracing the careers of young sailplane pilots, we find that unlike the early pioneers they owe their success largely to a sound theoretical knowledge and good planes rather than to accumulated experience, and it is on this note of study and untiring observation that I would wish to conclude my remarks.

14. More Soaring Flights

By Georg Brütting

Increased knowledge and improved technique coupled with a greater appreciation of meteorology have gradually brought soaring to a fine art.

Great was the joy in those early days of August 1920 when Klemperer covered the first mile in a sailplane; again, in May 1929 there was a considerable stir when Kronfeld was the first to exceed 60 miles; while the brilliance of Grönhoff's 170 miles from Munich to Czechoslovakia is given added lustre, when we remember that this record stood for three years. However, the feats of 1934/35 far excelled the dreams of even the greatest optimists. In the 1934 Competitions, Wolf Hirth covered nearly 200 miles; the very next day Heini Dittmar established a new world's record by flying 235 miles to Lisban; while the 1935 Competitions proved a landmark in the history of soaring, and showed us that present-day sailplane pilots can cope with almost all types of flying weather.

From the abundance of cross-country flights can be taken three 250 mile flights, each one fundamentally different from the other. Ludwig Hofmann was the first to fly more than 250 miles, and in fact completed a distance of 296 miles to Olesnice in Czechoslovakia in 7 hours. Even though his flight was a combination of slope-currents, wind-thermals, and finally front-upcurrents, the wind-thermals, which gave him such a high flying-speed, were easily the most predominant feature. It is an interesting fact that towards evening he could not gain much more height and only made very flat turns. Still more remarkable was his next flight, which took him 200 miles to Arlon in Belgium. In the most unfavourable conditions, he took-off with a cross-wind—almost downwind—on the

West Slope shortly after 9.0 a. m., i. e. at an hour which had always been considered too early for cross-country flights; and he seemed on the point of having to abandon the flight when he discovered a weak bubble in the "Goldloch", which slowly brought him up to 1,300 ft. He then flew over the towns of Fulda and Schlüchtern, over the Taunus Mountains and finally across the Rhine. After passing over the Hunsrück Mountains and the Moselle Valley, extremely difficult flying conditions prevailed, and only by exerting all his skill was he able, after crossing and re-crossing the Moselle Valley to retrieve his height, which, however, he lost again when nearing the frontier. But Hofmann knew that every mile was valuable, if he were to gain a formidable number of points, so he struggled on for another 12 miles into Belgium, where he landed shortly after 6.0 p. m., having spent 9 hours in the air. The prodigious duration of the flight alone—up-to-date the longest in thermals—tells us how often it must have been necessary for him to resort to circling and at times even go back on his course, in order to scour every possible region of upcurrents. Wolf Hirth considers this flight to be the most outstanding feat of the whole Meeting.

When Wolf Hirth carried out his 262 mile flight in his latest design the "Minimoa" to Zlabings in Czechoslovakia, entirely different weather conditions prevailed. Whereas Hofmann and the "Brünner" pilots were favoured with a very strong wind, Hirth had only a light breeze but at the same time very strong thermals. Over the Wasserkuppe itself he circled up to 3,000 ft., a height which he maintained closely during the major part of the flight. Throughout, he had to circle a great deal, but once he had sufficient height, he ignored any potential lift that may have existed in the locality and set off on his journey proper. Today, it is generally recognised that for cross-country flying it is far more important to cover ground rapidly, once a reasonable height has been gained, than to waste time endeavouring to extract every ounce of lift out of a thermal. The striking part about Hirth's flight on this occasion was that his maximum height of 5,300 ft. was reached late in the afternoon, for at 4.30 p.m. his variometer was still recording lift at the rate of 16 ft./sec. However, it was not long after this that he found himself at his lowest altitude; then once again at 5.30 p. m. he rose rapidly with a lift of 10 ft./sec. Even though this thermal was not potent enough to enable him to exceed his previous highest level of 5,000 ft. it sufficed to enable him to continue flying for another hour, until he eventually landed near Zlabings. The success of this flight—which was 56 miles longer than the next best flight of the day—was largely due to the excellence of the "Minimoa", a fast, cantilever sailplane,

smaller than the Moazagotl but with an equally good gliding-ratio and exceptional manœuvrability.

The fact that Bräutigam took less time to cover 314 miles than Wolf Hirth did to cover 250, shows how one's ground-speed may be materially improved by favourable wind-thermals, for Bräutigam created a world's long-distance record to Brünner Aerodrome in only 5½ hours. At the beginning of the flight he took advantage of the upcurrents far more often than towards the end, and it is significant that he attained his greatest height of 3,800 ft. in the latter half of the flight. In his own words, he flew, from the Eger onwards, beneath the clouds as a power-pilot would have done, i.e. instead of circling to gain height, he flew straight down a cloud-street, and by pushing the stick forward increased still further his already high ground-speed.

After the Competitions many other notable flights were made, such as Ziegler's new world's record for two-seaters of 112 miles from Hannover to Cuxhaven.

The advent of goal-flights in 1935 imbued soaring with a still greater interest; and even the uninitiated were amazed by the number of landings made near important towns and on aerodromes. The idea behind these flights was, of course, to facilitate the transport of the plane, which instead of having to be dismantled could then be towed back by air. At the same time, some of these flights were carefully planned, such as Späte's 135 mile flight to his home in Chemnitz and Hirth's return goal-flight from Hamburg to Hannover. The latter is the only time in the history of soaring that a return goal-flight has ever been made within two days.

In the course of the year the records for goal-flights were broken almost as soon as they were made. Thus, in May, Ludwig Hofmann flew 112 miles from the Hornberg to Zürich; shortly before the Competitions Peter Riedel created a sensation with his 164 mile goal-flight from Berlin to Hamburg; on 21st August, Erwin Kraft, who during the Competitions had already made several notable flights, carried out the magnificent world's record goal-flight of 206 miles from the Hornberg to Cologne. This flight had been carefully planned and was carried out in difficult conditions and partly with a cross-wind; but perhaps we should let him describe it himself.

My Goal-Flight: Hornberg-Cologne (206 miles)

By Erwin Kraft

The choice of Cologne for my goal-flight was determined by the fact that long cross-country flights of over 180 miles are only possible from the Hornberg in three directions, if one does not want to land in a foreign country: i. e. the courses indicated by a S. E., S. and S.W. wind.

As the thermal conditions had greatly improved in the third week in August, it was only a question of taking advantage of a day with a relatively favourable wind.

On the morning of 29th August, 1935, the sky was clear with a steady East wind of 18 m.p.h., and at 10.0 a.m. it was already obvious that excellent thermal conditions would obtain. Between 10.30 and 11.0 a.m. the first typical lift-clouds could be seen forming, and I went to report my intention of making a goal-flight to Cologne with a Rhönsperber. My proposal met with a great deal of scepticism, as the wind conditions could certainly have been better. For the greater part of the way I would be flying with a cross-wind, which would undoubtedly impede the success of my goal-flight, if not frustrate it altogether. But I had carefully planned the flight and was determined to attempt it. In the meantime, the clouds had become well-developed, and the sky was covered with the most promising looking cumuli.

At 11.45 a.m. I was towed up to 650 ft., where I released and rose with a very slight lift to 1,000 ft. However, losing this, I soon found myself forced to search for new upcurrents, which I found after losing a little height in very turbulent air conditions on the lee-side of the Hornberg.

Circling steadily, the Sperber now rose to 3,000 ft. above the Hornberg, and the moment came to set off across-country. Flying in a North-Westerly direction, I pushed the stick slightly forward till the A.S.I. registered 60 m.p.h. and the variometer indicated a fall of 7—8 ft./sec. After flying straight for about 6 miles, the variometer again moved towards "Rise". I at once began circling while the needle of my variometer rose to + 10 ft./sec. and I soon found myself at the cloud-base, which lay at 7,000 ft. above sea-level. In order to gain as much height as possible I allowed myself to be drawn into the cloud at the rate of 8—9 ft./sec. After 8 minutes' blind-flying, the light filtered through above and soon the

cloud lay in gleaming white below. Through the cabin-windows could be seen the blueness of the heavens; but I had no time to enjoy the splendour of the scene. My altimeter registered 8,000 ft. above sea-level and it was now a matter of converting this height into distance. So once more on a North-Westerly course, I pushed the stick slightly forward and speedily covered ground, for as I had only 6 hours in hand and a cross-wind with which to contend, it was necessary for me to maintain a high ground-speed.

After ¾ hr., I found myself over Heilbronn, where a strong lift again brought me to the cloud-base. As before, I rose rapidly by flying blind inside the cloud, and reached my greatest height of 8,600 ft. above sea-level, i. e. 5,200 ft. above releasing-point. Once again I flew along at high speed, while below me the River Neckar wound its way through the country-side, and Heidelberg came into view. In order not to waste time, I flew straight through small belts of upcurrents (N. B. The modern technique of cross-country flying attaches great importance to the question of saving time whenever possible). At 1.0 p. m. I caught my first glimpse of the Rhine and at 1.20 p. m. flew over Mannheim. Up till now my average speed had been highly satisfactory, for in 1½ hrs. I had covered 80 miles.

While flying high over the Rhine in the direction of Worms, I saw ahead of me a towering cumulus, which appeared a likely source of lift. But I was to be disappointed, for when the Sperber arrived beneath it, it was in process of dissolution and I found myself in a belt of strong downcurrents.

So once again I slowly lost the height, which I had struggled so hard to gain; but in the meantime I had crossed the Rhine and the country over which I was now flying was unknown to me. My altimeter registered 3,000 ft. above sea-level, and for the first time I began to doubt whether I should "make" Cologne. It was certainly a blow to see the last cloud dissolve before my eyes. I seemed to be in a wide belt of downcurrents, and the chances of finding further thermals were growing very thin. I kept glancing hopefully at the variometer, but it remained maliciously below zero, until the altimeter registered only 2,300 ft. Suddenly the air became turbulent; the needle of the variometer quivered a few times, then slowly crept up to zero. I drew a deep breath for I knew that for the moment I was safe. Very cautiously I began circling, while the needle of the variometer slowly moved to + 3 ft./sec. The strain of the last quarter of an hour was over, and once again I felt that everything might turn out well after all. In spite of the cloudless blue sky, my altimeter soon registered as much as 6,500 ft., and as soon as the lift ceased I stopped circling and set off across-country

again. I had now become more cautious than before, and endeavoured to draw lift from every possible source.

At 3.15 p. m. I once more looked down upon the deeply incised valley of the Rhine, and neither to the right nor to the left was there a landing-ground to be seen! In view of the high landing-speed of my plane, conditions were somewhat dangerous, and I knew that if I should be forced to land, no amount of skill would prevent me from crashing. In order to reach Cologne, a certain amount of risk would have to be taken, even though the prospects of finding lift continued to grow more remote. Latterly, my cruising speed had deteriorated, for in the last 2 hrs. I had covered only 45 miles and a good 80 miles still lay ahead of me.

Without heeding the country below, I flew on, losing height steadily, but right over the Rhine a fresh belt of upcurrents came to my rescue and drew me upwards at the rate of 6 ft./sec. However, the terrors of a forced-landing on the declivitous slopes of the Rhine Valley were again impressed upon me, as I once more lost the height, which I had only recently gained after a fierce struggle. The variometer recorded a fall of 10 ft./sec. Boppard, a small town on the Rhine, drew closer, and in despair I realised that I was only 1,500 ft. above the Rhine and still falling at the rate of 13 ft./sec. A landing at this juncture would mean either coming down on the waters of the Rhine or landing in the vineyards on its banks.

Behind Boppard the Rhine curves sharply to the right. With the wind blowing as it was, it should be possible to find slope-upcurrents at the corner. It looked like my last chance, and I was only 650 ft. up when I made towards it in a desperate attempt not to be forced down. Suddenly it became extraordinarily turbulent, and I was thrown about violently, the wings shuddering under the vicious bumps. At last, the variometer again moved up to zero, hesitated, and—Great Scott!—fell back to —3! In my despair, I could do nothing but gaze at the dial hopefully. Another bump! The needle flickered, then travelled surely and steadily to +3! I at once began circling to the left, my Sperber dancing about madly; but after gaining 1,300 ft. my variometer registered a lift of 6 ft./sec. and I could once more breathe freely. The last quarter of an hour had been a terrible nervous strain. In the meantime I had again reached 6,500 ft. and once more set off across-country. It was already 4.15 p. m., and it was debatable, to say the least of it, whether I should have time to reach Cologne. I had passed Koblenz and could see Bonn in the distance. The upcurrents now became more frequent, and several times I was able to climb to 6,000 ft. above sea-level, eventually leaving Bonn behind me at a height of 4,000 ft.

Only 20 miles to go! But I was gradually losing all my height. On the dusky horizon, I could already see the house-tops of Cologne; but I was lower than ever! Should I be forced down so near to my goal? But luck was with me, and there was still a slight rising of warm air.

In despair I made use of even the weakest lift, and by dint of struggling for every inch of height once more rose to 3.000 ft. But then it was all over!

In a long glide, my Sperber carried me to Cologne, and I soon fell to 1.300 ft. In wide circles, I searched for the aerodrome, but could not find it anywhere. The situation was becoming critical and I was only 700 ft. above the house-tops, when literally at the last moment a power-plane came to my rescue. As it was climbing towards me still at a very low altitude, it could not have taken-off so very long ago. So, pushing the stick forward, I flew rapidly in the direction from which it had come. At last the aerodrome appeared in sight, and clearing the last obstacles with 6 ft. to spare, I landed right in front of the hangars at 5.35 p.m. completely exhausted after a 6 hr. flight. I was almost too tired to climb out of the cockpit; but I was in high spirits, for I had flown 206 miles: the longest goal-flight ever made in a sailplane.

15. A Glimpse into the future

From Glider to Powered-Sailplane*

By Wolf Hirth

It is an age-old truth that new ideas and inventions, particularly of the scientific order, not having found support, often disappear again for a long time. Again, a movement is apt to be dropped, either because the masses are not yet ready for it or because the general trend of development is not yet correspondingly advanced.

So it was with the single strut landing-gear, designed for the Parnall Pixie as early as 1923; with the retractable undercarriage, which has been in existence for a very long time now, though at first it was not taken too seriously; with the single wheel landing-gear, which Esnault Pelterie employed in very early days; with the

* Excerpt from "Flugsport", annual 1935, No. 10.

streamline car; and with Wenk's gull-wing tailless glider, which made its first successful flight in Germany in 1920.

Though the gull-wing did not become really popular until Lippisch resuscitated it some ten years later, like the modern streamline car it has now come to stay. In both cases, their predicted "arrival" had only to await a general advance in relative technical developments.

The powered-sailplane was predicted in the same way and has been given a good deal of practical attention. Perhaps the reason why it has not yet become popular is because the lines of development have diverged from the original ideal of a lightly powered true sailplane and too closely approach those of the ordinary aeroplane.

I would like to take this opportunity of making public the main part of a proposition, which has been shelved in my mind for many years and which I made known to a small circle of soaring experts in Darmstadt in 1923.

There are today three distinct groups of low-powered planes. F. Kramer has written fully on the subject in his Article "The Maikäfer: a powered-sailplane" in the magazine "Luftwissen" 1934, No. 10. They may be enumerated as follows:—

Group I. Prior to the great war, ultra-light aeroplanes in Europe could be represented by the following selection: Grade monoplanes, Ellehammer's machine, Santos Dumont's Demoiselle, and A. V. Roe's triplane; while after the war (and in no way to be considered in the same light, as the only available horse-power was then used as distinct from the special engine designs now being produced to meed the demands of a growing need) we have notably the Aeronca from the U.S.A., and in Germany machines like the Käfer, Hummeln and others. The Flying Flea, which enjoyed a shorst burst of popularity, must be considered apart, its object being to make "home-construction" possible and also to provide a machine of low running costs.

Group II. We have here machines with small engines built into the fuselage, in appearance similar to sailplanes. Experiments with this type have been made continuously ever since 1923. Typical examples: Bäumer's Roter Vogel, Lowe Wylde's B.A.C. (now controlled by Kronfeld), the Motorbaby, Kormoran, Maikäfer, Motorcondor, and many others. The intention in this instance was to produce a sailplane that could take-off under its own power, search for thermals over flat country, and on occasion be used just as an ordinary aeroplane, speed remaining a comparatively unimportant factor.

Group III. Powered-Sailplanes: a high-performance sailplane either with an engine built into the fuselage or a power-plant creating but little or no drag when not running. (It is well-known that Carden-Baines was the first to build a powered-sailplane.) Though small flapping wings may, in the distant future, solve the problem, at the present time, a retractable propeller seems to be a more practicable proposition. But I will return to that later.

Two questions arise: firstly, what is the best way of graduating from a glider to a powered-sailplane, and secondly, what path should be followed to give practical effect to the demand for a people's aeroplane?

Though much has lately been written on the subject, it seems that the responsible authors possess but an imperfect knowledge of auto-towing and winch-launching. Thus, for example, under a picture of a two-seater glider, I once read:—

"We consider dual-control an excellent method of teaching a pupil how to fly, because it is the quickest and safest method in existence. But this particular two-seater seems to us less suitable for this purpose, because it has no engine, and training is dependent on an expensive towing-car and a large aerodrome. It seems to us impossible that a pupil can learn to feel at home in a machine, which can only make circuits of 3 to 4 minutes each. In order to learn how to make turns, this is much too short a time in the air. The fact that this plane has made over 2,600 flights with a total flying time of only 150 hours (an average of 3½ mins. per flight) alone proves its extravagance."

At that I must protest strongly. Perfect turns and landings can only be achieved by constant practice and not merely by spending a long time in the air. Far better than anything I could say would be a three week's stay at a first-class Gliding School, such as the Hornberg: those who have seen 15 to 20 pupils make clean 1½ min. circuits and spot-landings inside circles 160 ft. in diameter after this period of training, would no longer doubt that it is possible to learn to fly by means of auto-towing and winch-launching, though not necessarily in a two-seater, which is usually reserved only for "difficult cases".

I would like to go a little further into the question of winch-launching. In the course of 6,000 starts, I have proved that it is easily the cheapest form of flying in existence. It is also self-evident, for the heavy engine remains stationary and does not have to pull either its own weight or that of the car: only the light towing-cable and the sailplane. There is no wearing out of tyres, while as for the "expensive towing-car", second-hand cars and very old

ones at that are cheaper than correspondingly strong and reliable aero-engines, and they are likely to remain so for some time to come. Last of all, in the few seconds of launching, an infinitesimal amount of fuel will be used, and what is more important still, an absolutely safe start assured. Those who have actually flown ultra-light aeroplanes (and it has certainly been the case with me) must have found that taking-off is often touch and go especially on ploughed land and soft fields, which can at times be the cause of a bad crash. That is why I recommend winch-launching as a means of getting into the air, either for an ultra-light aeroplane or a powered-sailplane.

It is not by any means possible to find at every small town an aerodrome from which ultra-light aeroplanes can safely take-off, whereas winch-launching with an auto or electro-winch is feasible almost anywhere: on heather and sand, swampy ground and soft fields, ploughed land and stubble fields, over brushwood, ponds and hedges, and also on snow and ice. Consequently, it seems only sensible to train pupils, whether ab-initio or otherwise, by the use of a winch. In this way, almost every small club could rapidly acquire an active flying membership.

After an average of 50 winch-launches, a pupil will be so safe that further winch-launches will bore him. As soon as he can make clean spot-landings and is absolutely safe, the instructor can put him into a small plane, in appearance exactly similar to the one he has been used to; only at the centre of gravity it will have a tiny engine. This machine is a powered-glider. After making a few winch-launches in it without the engine running to convince him that there is nothing radically different, he will then try it with the engine ticking over, and finding no difference will feel absolutely confident, which is, after all, the main thing.

Now comes the last step. The release-trigger, with which the cable will be dropped, besides resembling the throttle and being situated at the same place, will also be inter-connected with it, so that the moment the pupil releases the cable at a safe height, say 500 ft., he also automatically opens up the throttle and proceeds with his flight. Now, for the first time, he will be able to fly leisurely round the church-spire of his home-town, with a feeling of the utmost safety, for he knows that directly he closes the throttle everything will be exactly the same as the 60 or 70 other times when he was winch-launched into the air! He can land on the smallest field, whether he has a skid only or a single wheel landing-gear, consisting of a skid and "braked" wheel. Of course, later, provided the field is big enough, or in summer, when there are large stubble-fields,

he can also try taking-off in the usual manner. This is certainly neither as pleasant nor as safe as the gentle winch-launch, but it is quite practicable given sufficient space and a good surface. However, this practice should not become a habit, because it is far more strain on the tiny engine when pulling on a climb than when flying horizontally; and undue strains shorten the life of an engine. Supposing that an engine taking-off constantly under its own power lasts 80—100 hrs., then with help from winch-launching it should last at least 200 hrs. And it is no strain on the winch, which will stand a great deal of hard-wear, because its engine does not have to be excessively light and can easily weigh its 12 lb. h.p. and more.

And now to continue, for our pupil, having thoroughly assimilated the theoretical side of soaring, will, when a suitable opportunity occurs, want to put his knowledge into practice. This will not surprise sailplane pilots, who know that words are quite inadequate to describe the wonders of soaring flight.

The soaring aspirations of our now advanced pupil will have to be met either by aero-towing (which for lack of towing-machines is unfortunately not possible on all aerodromes) or by a visit to the mountains: it is not easy for a beginner to locate thermals from a winch-launch.

The best solution to the problem seems, therefore, a powered-sailplane with a wholly retractable power-plant. When the engine is built or stowed into the machine and the propellor and shaft retracted, the machine is indistinguishable from a high-performance sailplane, except for its weight. It must by now be well-known that in this case the gliding-ratio remains unaffected and only a small difference is apparent in the sinking-speed, while the forward-speed can be augmented if desired.

We therefore take-off in our powered-sailplane, either with a winch or from a slope, and begin to soar, until such time as the lift weakens. We then bring out our propeller, and directly this reaches T.D.C. (whereby electric contact is established) the engine will automatically fire, and the fins regulating the passage of cool air round the engine will simultaneously open. We can then continue flying with our engine on until we find further natural lift or conversely arrive at an aerodrome.

By means of a powered-sailplane, we can, with a little imagination, see ourselves as true birds of passage.—In the 1934 Rhön Competitions, Ludwig Hofmann covered over 600 miles in 14 days in a sailplane. With a powered-sailplane and 12 gallons of petrol, one could well cover 12,000 miles in a summer holiday—and that not in a mad rush, but by soaring most of the time and by only resorting

to the engine for taking-off and perhaps for the last few miles in weak evening thermals.

And when it rains three days running? Then one can read a good book or have a look round the town, or visit friends. In any case, one has plenty of time, as one does not fly because time is money, but purely for pleasure.

The time will come when there will appear such articles as: "How I power-soared to Finland" or adventure books like: "Soaring to the sources of the Nile"; and no doubt there will also be competitions for powered-sailplanes, viz. the greatest distance covered in 14 days with 12 gallons of petrol in a sealed tank.

Amateur pilots, having learnt to fly at home, can then practise cross-country flying in a powered-sailplane. At the age of 20, they understand something of engines and of navigation; they are at home in their own country and half Europe.

Anyone who gives this subject more than a passing thought will readily appreciate the value, not only to the individual but also to the whole nation, of the knowledge simply but thoroughly acquired of gliding and powered-sailplaning, which covers far more ground than I have here touched upon. Powered-sailplanes themselves can, of course, be put to more uses than those I have mentioned.

Many will not read this at all! Some readers will laugh! A few, to whom I have spoken on the subject of retractable power-plants, have already laughed, or more politely merely secretly thought me a fool. They have smiled and jeered like others, who ten years ago were told quietly but positively of gull-wings, tailless aeroplanes, single wheel landing-gears, and retractable undercarriages. They have smiled indulgently; but today they no longer smile, and some have even forgotten that they ever smiled.

How far can the Standard of Soaring be Raised by Man's Skill alone?

By Wolf Hirth

This question is of interest to all sailplane pilots, whether ab-initio or otherwise who hope one day to accomplish great feats. My own experience in training pilots is as follows: –

1. Some of our best sailplane pilots were slow to learn.
2. Those pilots, who seem to have an innate flying-sense and con-

sequently do not take long to cover the rudimentary stages, are often not among the future "aces". Perhaps the reason for this is because they have not had to struggle and have had no opportunity to build up courage and perseverance

3. Sailplane pilots, possessing all the qualities necessary to accomplish great feats, are extraordinarily rare.

Grit is often the chief, though not of course the only, quality that enables a pilot to rise above the average. This fighting spirit, which the beginner possesses is often lost in the struggle to gain experience. He who still possesses it when half-way on the road to becoming an expert and has at the same time accumulated much valuable experience, stands a good chance of one day becoming an "ace". However, great feats cannot, of course, be accomplished without a certain amount of skill: in fact, an expert pilot must these days possess a many-sided ability.

It is most essential to be able to fly instinctively: and a little trick of my own, which consists of flying with two hands, may be of assistance: the right hand is the controlling influence, while the left is used as a shock-absorber. This very important resilience will be enhanced by resting the right elbow on one's thigh. This results in the lever-arm having a better action and giving finer control-movements.

Only when one has learnt to make the correct movements automatically, can one be free to concentrate on such factors as instruments, maps, the country-side below, weather-conditions, clues to upcurrents and wind-indicators.

It is also necessary to go into systematic training against fatigue Nowadays, every long cross-country flight is at the same time a duration-flight, and will become more so as further records are established. Furthermore, cross-country flights demand powers of quick decision, and this is far more evident in the case of soaring than in power-flying. It follows "ipso facto" that a thorough understanding of meteorology will enable one to make such decisions correctly.

Nowadays, a study of blind-flying is also desirable, and when brought to a high pitch of efficiency obviously increases one's chances of making record-flights. Night-flying, too, plays its part in the breaking of cross-country records, and must also be practised. Again, we have the question of morse-signalling, which it may be necessary to use in place of wireless, should the latter remain insufficiently developed for use in sailplanes.

Finally, sailplanes will, in future, have charts, showing, for

example, the speeds at which it is best to fly the plane in different conditions.

The record cross-country flight of the future might perhaps be carried out in the following manner:—Let us presume that we have taken-off from the Wasserkuppe. Towards evening, a mountainous region (say that of Zittau some 212 miles from the Rhön) will be reached by means of wind-thermals. When the thermals subside, the flight can be extended a few more miles in daylight by using pure slope-upcurrents (helped possibly by evening thermals) over the mountains as far as the West slope of the Riesengebirge Ridge. Good landing-grounds are to be found here, so that as long as flares have been lit in case of a forced-landing, slope-soaring would be possible until the following morning. Should the night pass without incident, one could then set off again across-country with the first thermals and possibly reach Warsaw on the second day.

In any case, one could exceed the 400 mile mark in this way, and with a two-seater it should even be possible to fly 600 miles, provided favourable weather-conditions prevailed. One could also fly three days running! Wireless connection with ground stations, which are at the service of the Air Ministry for balloon races, could undoubtedly be extremely helpful.

It is certain that we have not yet reached a dead-end. Skilled and experienced sailplane pilots with sufficient determination can easily improve upon the existing records in all categories: duration, altitude and distance, and at the same time add a wealth of knowledge to the science of soaring flight.

Conclusion

The foregoing chapters do not by any means form a comprehensive text-book on soaring. The aim of this book has not been to replace other works that have already appeared by well-known soaring experts but to supplement them. The views of my various collaborators are not always identical; but by careful and repeated study and by comparing the different accounts, the reader can pick out the most important points.

There is still any amount of research to be done in the realm of soaring flight. Its technique can undoubtedly be advanced, and to this end all sailplane pilots must collaborate. The following equipment is essential:—

1. *Good Sailplanes:* i. e. they must not only have good soaring qualities, but must also possess marked stability. Planes which are slow to respond to the movements of the stick are not suitable. The man who is capable of feeling afraid—and we cannot blame him for it—must have full confidence in his plane.

2. *Flying Ability:* the pilot must be able to fly automatically in order to give his undivided attention to such tasks as looking at his instruments, watching the weather conditions, and so on. In this art of instinctive flying, one can never have too much practice. It is fundamentally wrong for a young competitor at a Meeting to say:—"What is the use of my slope-soaring, when the weather-conditions are not good enough for a cross-country flight anyway?" It is not for nothing that Kronfeld wanders around the Kuppe for six hours on end or I fly three times from the South Slope to the Eube and back without a hope of material rewards in the shape of prizes. Yes, even "showing off" for the benefit of the spectators inspires one with a feeling of safety and confidence both in oneself and in one's plane.

3. *Instruments:* I will take only one example, namely, that a good variometer is more important that 12 ft. extra wing-span. If one can have both, all the better!

4. *Knowledge:* a certain knowledge of weather conditions and the general principles of motorless flight is essential, but there in no necessity to be a meteorological or aeronautical expert. It is also advisable to read what our forerunners have accomplished. Kronfeld, Grönhoff, Mayer, and I have all learnt from Nehring, Schulz, Kegel, Martens, and others; and I myself never tire of reading the accounts of the Rhön Soaring Flights published by Professor Georgii. I have followed Kronfeld's cross-country flights, remembered the good advice of "Bubi" Nehrung, and learned from the experiences of Fuchs. However, second-hand knowledge is not sufficient. In order to become an expert soaring pilot, one must first know the rudiments of the subject and subsequently explore the matter for oneself.

List of British Gliding Clubs and their Secretaries

This list is intended as a guide to those who wish to join a gliding club, or to see gliders and sailplanes in action. Not all the clubs mentioned are active.

For information as to the running of a gliding club, apply to The British Gliding Association, 119, Piccadilly, London, W.1. Tel.: Grosvenor 1246-7-8.)

England.

Beacon Hill (Essex).—W. P. Harris, 22, Hamlet Road, Southend, Essex. Primary training ground at Canewdon, Essex. Workshop at Southend. Subscription, 10s. 6d. p.a.

Bristol.—M. H. Maufe, Hambrook House, Hambrook, near Bristol.

Cambridge University.—J. W. S. Pringle, Club rooms at 1, Benet Street, Cambridge. Flying ground at Caxton Gibbett: winch-launching and aero-towing. Subscription, 3 guineas p.a. (non-flying 1 guinea). Country membership, 2 guineas p.a. No entrance fee. Flying charges: 1s. to 1s. 6d per winch-launch, 8s. to 9s. per aero-tow. Fulltime instructor. Limited number of non-University members admitted.

Channel.—F. G. Whitnall, 16, High Street, Cheriton, Folkestone. Auto-towing at Hawkinge Air Station; soaring at Arpinge, 2 miles N.W. of Folkestone. Hangar at Arpinge.

Cornwall.—J. W. Graham, Red House, Tywardreath. Flying ground at Rosenannon Downs. Primary training; soaring possible.

Cotswold.—J. D. Pether, Culver's Close, Burford, Oxon. Primary training at Minster Lovell, near Witney, or Pewit Farm, Wantage.

Croydon.— N. V. Marshall, Hollydene, West Hill, Epsom.

Derbyshire and Lancashire.—C. Kaye, 63, Clarkhouse Road, Sheffield. (Tel.: 62463.) Primary training and soaring. Headquarters at Camphill, Great Hucklow, Derbyshire (between Buxton and Sheffield), adjoining flying grounds at Bradwell Edge and Eyam Edge. Clubhouse (Tel., Tideswell 207) and hangar. Subscription 3 guineas p.a.; non-flying £1 1s. (both include 5s. subscription to Royal Aeronautical Society, Manchester Branch); no entrance fee. Flying charges: from 6d. per flight; soaring flights from 2s. 6d. Resident instructor-manager.

Devon.—S. G. Tolman, Journal Office, Exmouth. (Tel.: 76.)

Dorset.—L. A. Lansdown, The Portman Arms Hotel, East Chinnock, Yeovil, Somerset. (Tel.: West Coker 01 Y4.) Primary training and soaring at Maiden Newton; soaring also at Kimmeridge, Isle of Purbeck.

East Grinstead.—G. J. Smith. "Tolskity". Sackville Lane, East Grinstead, Sussex.

Essex.—W. Webster. 113, Coombes Road, Dagenham. Primary training.

Furness.—J. S. Redshaw. 18, Fairfield Lane, Barrow-in-Furness. Lancs. (Tel.: 803.) Training sites at Hawcoat, Birkrigg and Gleaston. Soaring sites at Moorside (near Ireleth) and Bootle Fell, Cumb. Hangar at Moorside. Subscription, £2 p.a. and flying fees.

Harrogate.—E. T. W. Addyman. The White House, Starbeck, Harrogate.

Hereford.—See Midland Gliding Club.

Hull.—R. E. Havercroft, 216, Park Avenue, Hull. Flying ground, Hedon aerodrome (auto-towing).

Imperial College.—Secretary, Imperial College of Science, South Kensington, S.W.7. Members use London Gliding Club's machines and flying ground at Dunstable Downs; also a sailplane for club's exclusive use.

Kent.—Miss R. H. Sinclair, Lade Place, Sutton Courtenay, Berks. (Tel.: Sutton Courtenay 46.) Primary training ground at Lenham, near Maidstone, Kent.

London.—Tring Road, Dunstable, Beds. (Tel.: Dunstable 419.) Flying ground, Dunstable Downs (1¼ miles S.W. of Dunstable). Primary training and soaring. Clubhouse and hangar; sleeping accommodation; 13 gliders and sailplanes for members' use. Subscription, 3 guineas p.a. (non-flying, 1 guinea); entrance fee, 2 guineas; flying charges, from 3s. per day. Resident full-time instructor; flying on Sundays and every week-day except Thursday.

Midland.—M. F. Barnes, 100, Holly Road, Birmingham 20. (Tel.: Smethwick 1181.) Resident Manager: J. B. Keeble, Whitcott, near Norbury, Bishops Castle, Shropshire. Primary training grounds at Handsworth (Vernon Avenue), Northfields and Hereford. Soaring site at Long Mynd, 3 miles W.S.W. of Church Stretton, Salop. Clubhouse and hangars; 10 gliders and sailplanes for members' use. Subscription, 3 guineas p.a. (10s. 6d. junior membership); entrance fee, 1 guinea; flying charges, 3s. per week-end for primary or secondary training; 6s. per hour for soaring.

Newcastle.—A. P. Miller, 25, Holme Avenue, Walkerville, Newcastle-on-Tyne, 6. (Tel.: Wallsend 63320.) Soaring sites at Chillingham. Auto-towing at Cramlington Aerodrome. Workshop in Newcastle.

Norfolk and Norwich Aero Club.—Gliding Section: J. F. Taunton, Municipal Aerodrome, Norwich. North Walsham aerodrome. One sailplane; auto-towed launches.

Oxford University and City.—Mrs. H. Aspell, 5, Holywell, Oxford. (Tel.: 3448.) Subscription, 2½ guineas p. a.; entrance fee, 1 guinea.

Portsmouth and South Hants.—R. G. H. Parnell, 128, New Road, Portsmouth. Flying ground: Portsdown Hill.

Southdown.—A. York Bramble, 7a, First Avenue, Hove 3, Sussex. (Tel.: Hove 4335.) Primary training and soaring grounds at Devil's Dyke, Brighton. Clubhouse and hangar, ½ mile S.S.W. of Devil's Dyke Station.

Yorkshire.—L. A. Alderson, 32, Wensley Green, Chapel Allerton, Leeds 7. Primary training and soaring. Flying ground, Sutton Bank, between Thirsk and Helmsley. Clubhouse and hangar. (Tel.: Sutton under Whitestone Cliff 19.) Resident Steward; full residential facilities. Full range of machines for members' use.

Scotland.

Dumbartonshire.—J. V. Campbell, Kirklea, Cardross Rd, Dumbarton.

Inverness.—F. Oliver, 13, Leys Drive, Inverness.

Perth.—R. Mackelvie, View Cottage, Union Road, Scone, Perthshire.

Scottish Gliding Union.—J. W. Gardner, Journal Office, Alloa.

Soaring site: Lomond Hills, Fifeshire.

Northern Ireland.

Ulster.—N. P. Metcalfe, c/o Ulster Spinning Co., Ltd., Belfast. Flying centre and hangar at Downhill, Magilligan Strand, Co. Londonderry. Auto-towing and soaring.

Channel Islands.

Jersey.—A. J. Scriven, Quainton, Samares, Jersey. Primary training and soaring at Les Landes, at north end of St. Quen's Bay. Subscription, £3 p. a. Flying on Sundays and Thursdays.

Wales.

Swansea and District.—A. H. Knott, 209a, High Street, Swansea.

Handbuch des Segelfliegens

(Manual of Soaring Flight)

By Wolf Hirth

The best known German soaring pilot Wolf Hirth collected many reports on outstanding soaring flights by his fellow pilots, often urging them to write down all their experiences and adding his own to.

The result is an unusual complete manual which is going to give a new impetus to young soaring pilots.

One of the numerous reviews is as follows: "Every soaring pilot will read this book with pleasure. The various co-operators have written down all they could give and the ingenious combination gives as a manual telling the very latest experiences in soaring flight. Be it a beginner or already a master in motorless flight, every one will find a gain in this book."

(Schweizer Aero Revue, Bern.)

Pages 250 with 156 illustrations. RM 8.50.

FRANCKH'SCHE VERLAGSHANDLUNG / STUTTGART

Bibliography

Compiled by Alan E. Slater

English Books

Gliding and Sailplaning: A Beginner's Handbook. By F. Stamer and A. Lippisch. Authorized translation by G. E. Startup and Frances Kinnear. With 84 illustrations and diagrams. John Lane, The Bodley Head Ltd., London, 1930. Price 5s.

(The authors were pioneers in the art of teaching people without previous aviation experience to fly on gliders: the book is particularly useful for those who are learning to fly gliders without the help of an experienced instructor.)

Gliding and Motorless Flight. By L. Howard-Flanders and C. F. Carr. Sir Isaac Pitman & Sons, Ldt., London. Revised Edition. 1931. Price 7s. 6d.

(Mr. Howard-Flanders, a pioneer of aviation, is a former secretary of the British Gliding Association and was on its Technical Committee. The book gives advice needed by the inexperienced, and gives particular attention to the running of a gliding club and the choice of a flying ground.)

Kronfeld on Gliding and Soaring: The Story of Motorless Human Flight. By Robert Kronfeld. Translated by J. Manchot. John Hamilton, Ltd., London, 1932. Price 21s.

(The author was the first pilot in the world to make deliberate use of clouds for soaring, and has more than once held the world's distance and height records for motorless flight. The book deals with the whole subject of soaring flight very thoroughly, including the history of its development, descriptions of well-known sailplanes, personal accounts of cross-country flights, and much advice on the art of soaring.)

Sailplanes: Their Design, Construction and Pilotage. By C. H. Latimer Needham. Chapman and Hall, Ltd., London. Cheap Edition. 1937. Price 6s.

(The author was for several years Chairman of the Technical Committee of the British Gliding Association, and was the first British pilot to obtain the "C" soaring certificate. The book, which originally appeared in 1932, is the only work published in Britain which deals fully with the technical side of motorless flying.)

Motorless Flight. Edited by J. R. Ashwell-Cooke. John Hamilton, Ltd., London, 1932. Price 7s. 6d.

(The book is by eight different authors, each specially qualified to write on his subject. It has chapters on instruction, elementrary and advanced, construction and maintenance, mechanical towing, aerodynamics and meteorology.)

Gliding and Soaring. By C. H. Latimer-Needham. The Sportman's Library. Philip Allan, London, 1935. Price 5s.

(The subject of motorless flying is comprehensively dealt with, including elementary training and advanced soaring, the construction, repair and erection of gliders, and choice of a site, and the technical regulations of the British Gliding Association are given in full.)

Mechanics of Flight by A. C. Kermode.

A short Course in Elementary Meteorology by W. H. Pick.

Aerodynamics by Lanchester.

American Books

Henley's A.B.C. of Gliding and Sailflying. Edited by Victor W. Pagé. The Norman W. Henley Publishing Co., New York. 1930.

(Gives all-round useful information, including instructions for building a training glider.)

Gliders and Gliding. By Ralph Stanton Barnaby. The Ronald Press Co., New York, 1930.

(The author is now President of the Soaring Society of America. His book gives good information on every aspect of gliding and soaring, including construction.)

Sailing the Skies: Gliding and Soaring. By Malcolm Ross. The Macmillan Company, New York, 1931. Price $2.50.

(All-round general information is given, including a long historical section.)

Gliding and Soaring: An Introduction to Motorless Flight. By Percival White and Mat White. McGraw-Hill Book Company, Inc., New York, 1931.

(Like the previous books, this work gives general useful information and instruction.)

The Book of Gliders. By Edwin W. Teale. E. P. Dutton & Co. New York. 1930. (Includes much about gliding history.)

Books in German

Handbuch des Segelfliegens. Edited by Wolf Hirth. Franckh'sche Verlagshandlung, Stuttgart. 1938. Price RM. 8.50.

(This, the very latest look on soaring, is written entirely by experts, and should be in the hands of every aspiring sailplane pilot who can read German.)

Die Praxis des Leistungs-Segelfliegens. By Dipl.-Ing. Erich Bachem. C. J. E. Volckmann Nachf., Berlin-Charlottenburg. Second edition, 1936. Price RM. 7.50.

(This very useful text-book on the practise of high-performance soaring flight is intended, on the whole, for pilots at an earlier stage of progress than those for whom the present book by Wolf Hirth is written.)

Gleit- und Segelflugschulung. By Fritz Stamer. C. J. E. Volckmann Nachf., Berlin-Charlottenburg, 1931. Price RM. 2.—.

(A text-book specially written for gliding instructors. The author was director of the Wasserkuppe Gliding School for many years.)

Werkstattpraxis: für den Bau von Gleit- und Segelflugzeugen. By Hans Jacobs. Verlag Otto Maier, Ravensburg, 1932. Price RM. 2.75.

Segelflugzeug: Anleitung zum Selbstbau. By H. Jacobs. Spiel und Arbeit, Bd. 138. Verlag Otto Maier, Ravensburg. 1935. Price RM. 3.50.

(These two books, by the designer of the famous "Rhönadler", "Rhönbussard" and "Rhönsperber" sailplanes, give fully detailed instructions for building gliders. To some extent they overlap, the first contains more reading matter, while the second includes detail drawings for building a machine of "nacelle" type. In working from these books it should be remembered that German woods have not necessarily the same strength properties as the corresponding varieties in other countries.)

Der Segelflug und seine Kraftquellen im Luftmeer. By Professor Dr. Walter Georgii. Third edition revised by Dr. F. Höhndorf. Verlag Klasing & Co., Berlin, 1935. Price RM. 1.80.

(Dr. Georgii is the world's expert on the meteorology of soaring flight, with which this book deals. Dr. Höhndorf is on the staff of the German Research Institute for soaring flight, of which Dr. Georgii is Director. This is the only text-book of its kind in existence.)

Periodicals

The Sailplane and Glider. Official Organ of the British Gliding Association. Founded by Thurstan James on Sept. 6. 1930. Editor. A. E. Slater. Published monthly by H. O. Davies. 13 Victoria Street. London. S.W. 1 Subscription (post free): 1s per copy; 5s. 6d. for 6 months; 10s. for 1 year.

Soaring. Official Organ of the Soaring Society of America. Founded in January. 1937. Editor, Lewin B. Barringer. Published by The Soaring Society of America. Room 502. 1500 Locust Street. Philadelphia. Pennsylvania. Subscription in the United Staates: $ 2.00 per year. which includes associate Membership of the S.S.A. Subscription in other countries. $ 3.00 per year.

(The above are the only two periodicals in the world solely devoted to gliding and soaring. The following foreign journals. however. give space to motorless flying activities in each issue.)

Flugsport. Edited by Oskar Ursinus. Frankfurt am Main. Hindenburg-Platz 8. Fortnightly; price 80 Pfg. Subscription (inland and abroad) RM. 4.50 per 3 months.

The editor started the German gliding movement which has led to the development of soaring flight throughout the world. Technical articles. and descriptions of new sailplane types. both German and foreign; also short items of news.)

Luftwelt. Deutsche Luftwacht. Verlag E. S. Mittler & Sohn. Berlin. Monthly: price RM. 0.50 in Germany. RM. 1.— abroad.

Der Deutsche Sportflieger. Leipzig C 1. Petersteinweg 19. Monthly: price 50 Pfg.

(Both these journals give general news and often include first-hand accounts of notable soaring flights.)

L'Air pour les Jeunes. Ligue Aéronautique de la France. 40. Rue de Colisée. Paris VIIIe. Monthly: Price 2 fr.

(Scope similar to that of *Luftsport und Jugend.*)

Skrzydlata Polska. Warsaw. Monthly. price 1 Zloty.

Samolet. Moscow. Monthly. Subscription 9 R. per year: 2 R. 25 k. for 3 months.

(Both in Poland and in Russia gliding and soaring has been intensively developed in recent years. These two journals give news and frequent technical articles.)

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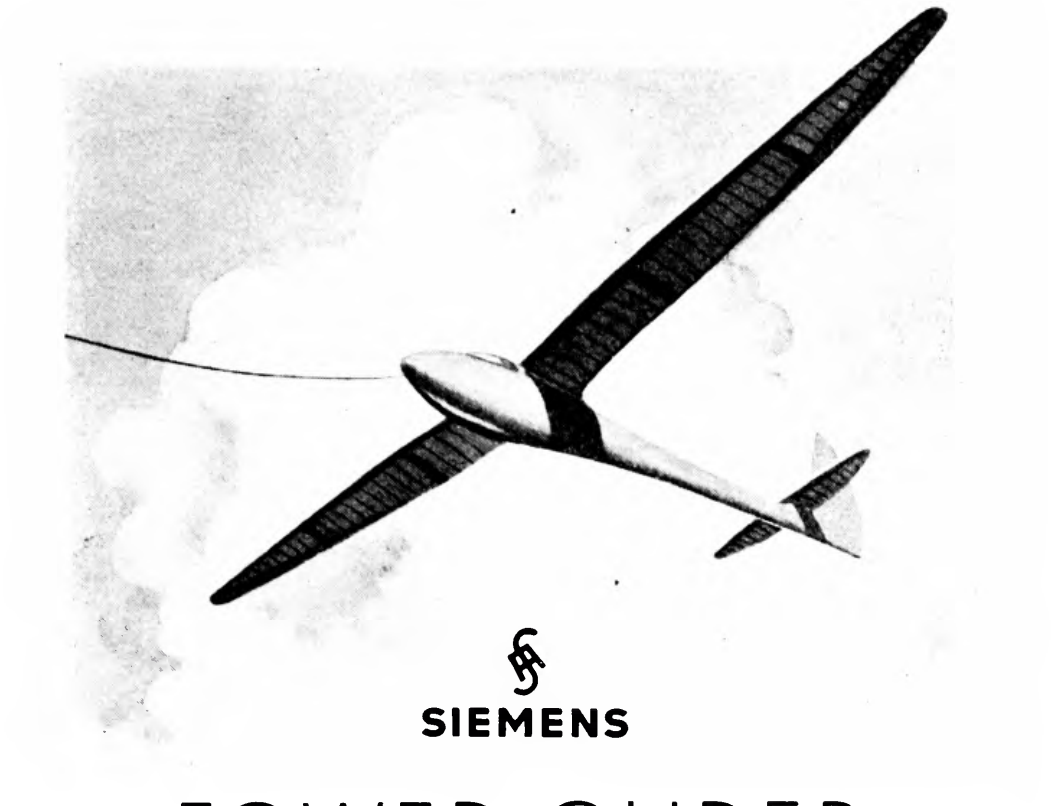

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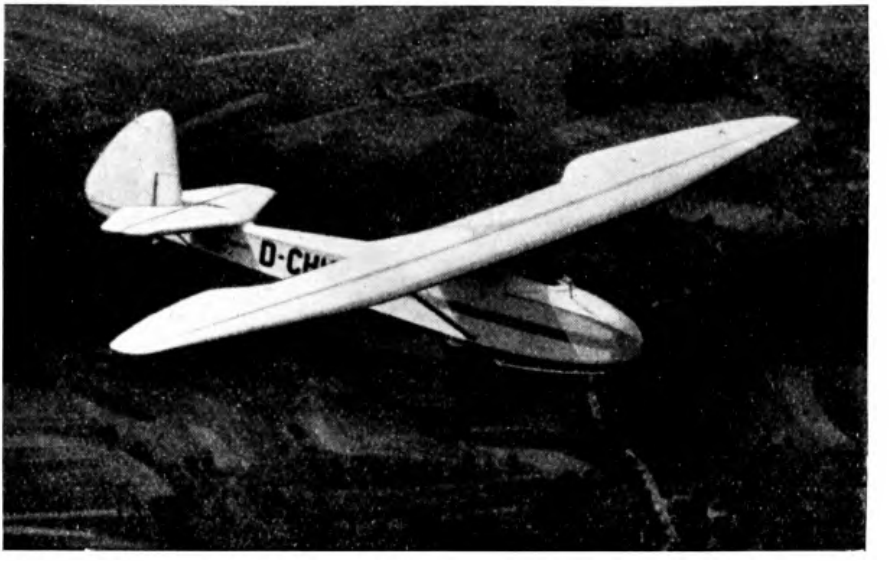

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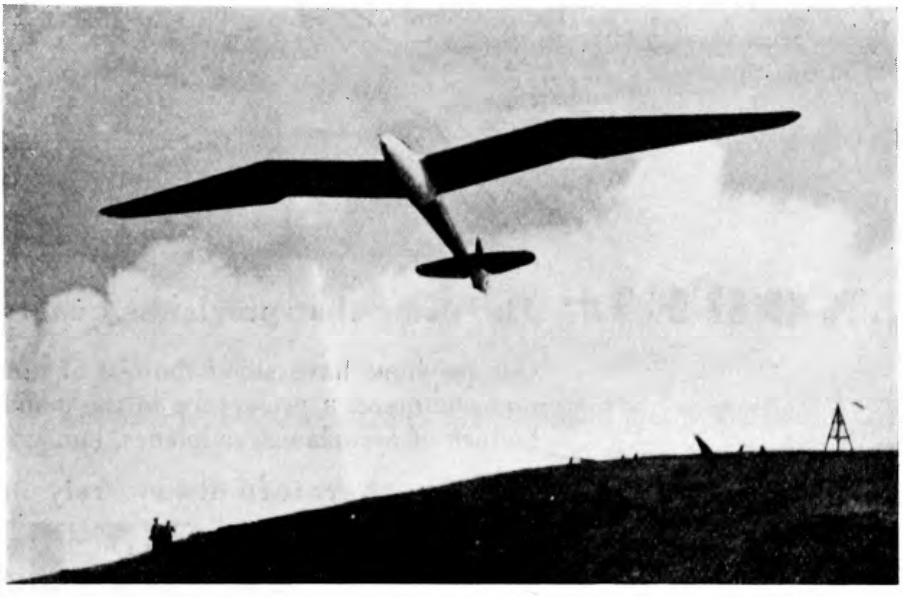

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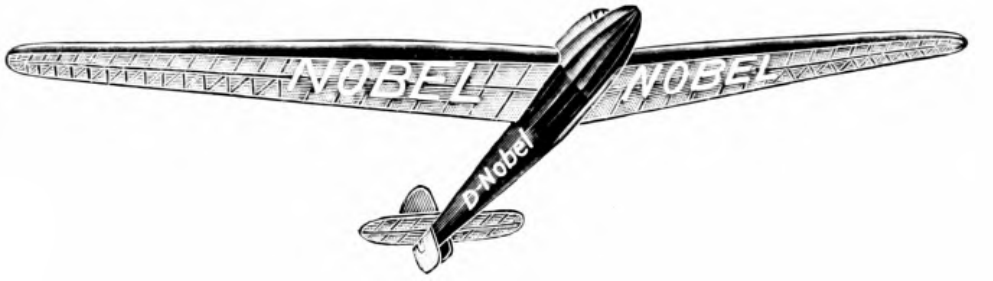

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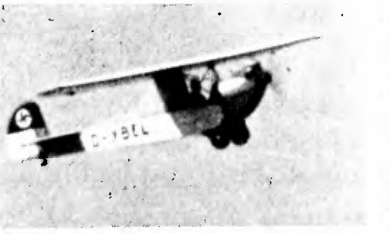

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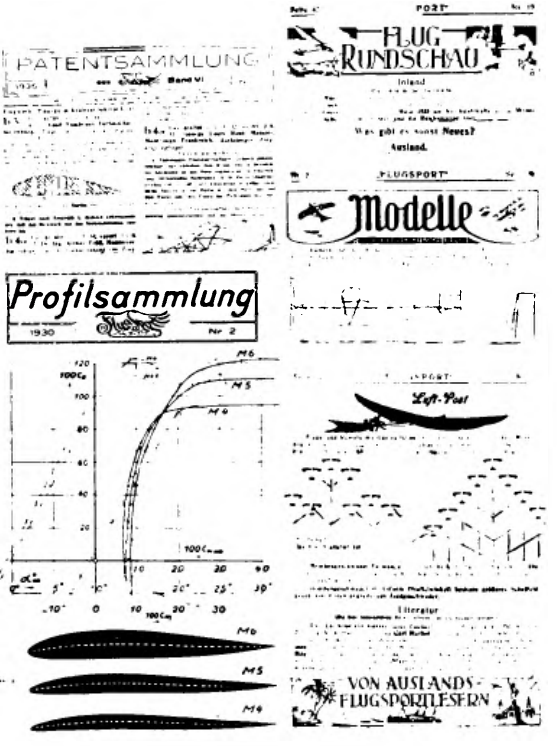

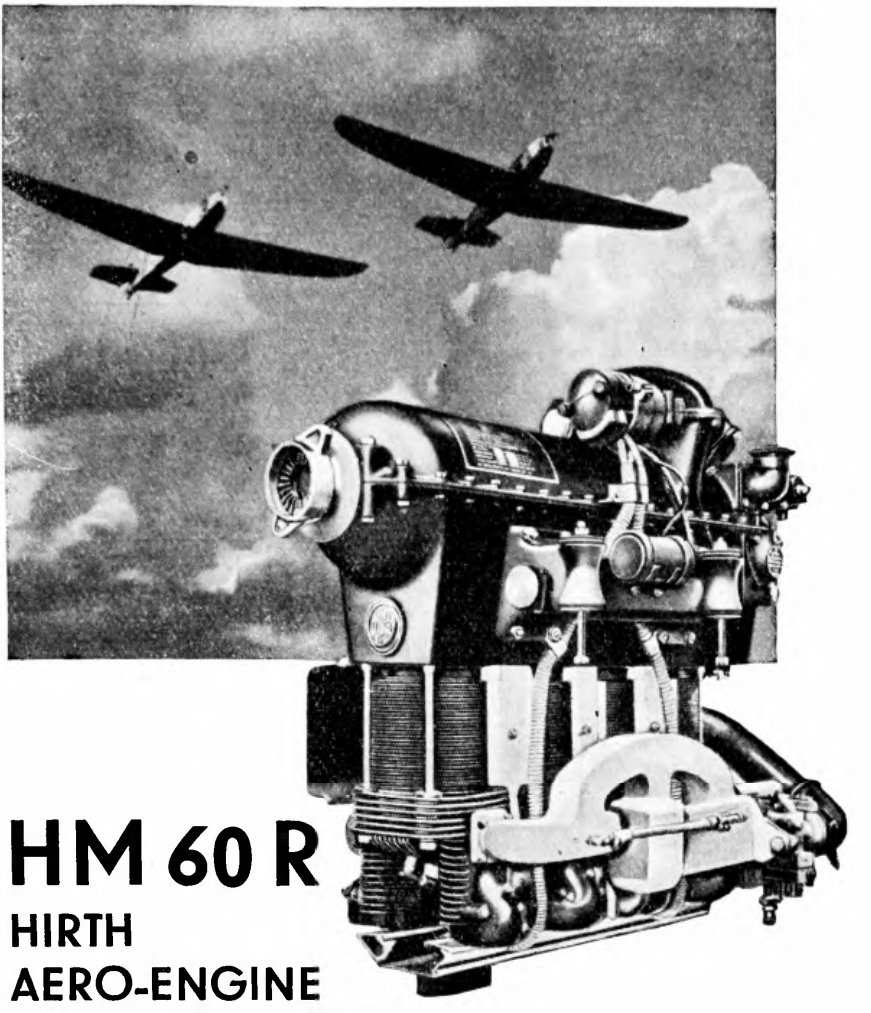

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