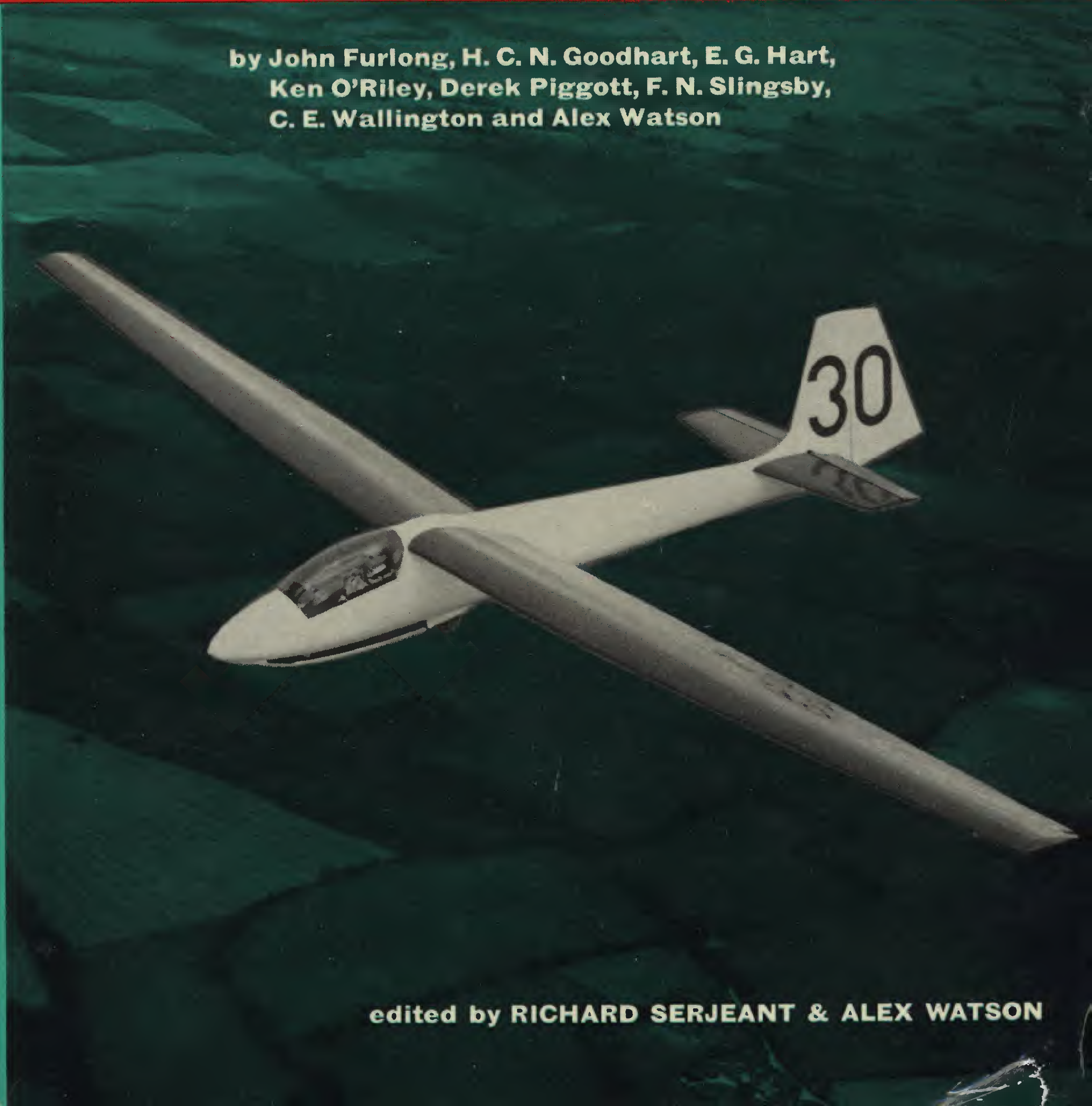
THE GLIDING BOOK

by John Furlong, H. C. N. Goodhart, E. G. Hart,
Ken O'Riley, Derek Piggott, F. N. Slingsby,
C. E. Wallington and Alex Watson



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With contributions by

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Edited by

Richard Serjeant and Alex Watson

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The photograph on the wrapper of this book shows a SKYLARK 4 *and was taken by Alex Watson*

DRAWINGS

Introduction

by Richard Serjeant

EACH chapter in this book is an extremely personal one, written by its author to cover the title suggested by us but without direct reference to the contributions of others. Some overlap is therefore inevitable, but the feeling of deep interest and identity of aim seems to run through every word. Although independent the chapters have been planned to form a logical sequence. Each contributor is certainly an expert in his particular field, and a wide variety of interests is represented from teaching youngsters the elements of gliding to the ultimate in achievement. We also hope that there is a reasonable balance between the Civil and the Services viewpoints, which are fundamentally similar though differently administered.

To me it has indeed proved a pleasure to be associated with this book, to meet and talk with the people who have written it and to absorb some of their enthusiasm. I have been particularly impressed by the spirit of unity within the movement and by the manner in which its members seem to place the movement itself before any interests of their own.

Gliding is a unique pursuit in which anyone can take part, yet at its limits calling for the highest qualities of judgment, skill and physical fitness. There is a complete absence of the greed, jealousy and cruelty that characterize so many so-called sports. Although the subtleties of its development have undoubtedly led to considerable progress in aerodynamics and in meteorology there is a pleasing lack of any direct practical applications.

There is also another aspect, and this has been described as the sheer poetry of soaring flight. This would be impossible to define, but we think that more than a hint of it will be conveyed to readers.

1 The Gliding Movement

by John Furlong

John Furlong is chairman of a firm of mechanical engineers, among other business activities in London. He learned to fly in 1915, and served in the RFC in the First World War.

He now has his own light powered aircraft for private purposes and to help with his activities in the gliding world.

He took up gliding in 1933 at Dunstable with the London Gliding Club, of which he is now president. He has taken part in many national championships.

He is a member of the British Gliding Association Council and chairman of the Flying Committee, the Safety Panel and the Master Committee for international championships.

During the last war he helped to form the ATC Gliding Organization, established the first gliding school in the south of England, and became District Gliding Officer and finally Gliding Adviser to Home Command RAF.

NOBODY knows when men first tried to become airborne or how many were injured or killed. Gliding, as we know it today, was the outcome of the prohibition of power flying by the Germans laid down by the Treaty of Versailles after the First World War. In about 1929 people in England began to be aware of these flying activities in Germany, where they were said to be remaining in the air without an engine. Very gradually details came through, and one or two gliders were built over here. The original machines were very simple open jobs—it was like sitting on a broomstick! Fred Slingsby was in this right from the start—before I was—and he built several copies of the German Kronfeld. These early machines were known as Daglings.

My own first flight in a glider was at Biggin Hill somewhere in 1932. I paid 10s. for this, and then won a height judging competition and got another flight. At this time a few interested people began to group together and form gliding clubs, most of which only lasted a short while; however, some survive to this day, notably the London Gliding Club, which began at Ivinghoe very near its present site at Dunstable. I learned gliding at this club, of which I am now president.

THE BUNJIE LAUNCH

At the start machines were primitive and inefficient and not very safe, but it was comparatively easy to be pushed off a hillside and slide down the air to the bottom learning how to control height, direction and speed by means of the now familiar controls. We developed the bunjie launch—a huge elastic rope with four people at each end and the glider hooked in the middle like a stone in a catapult (E. G. Hart describes this at greater length on page 30). All the machines were single-seaters and they had to be dragged back to the launching point by hand—no retrieving cars in those days. As a matter of fact it worked very well, and still does. Exactly the same thing is being done at a number of boys' schools today—they build their own gliders and have short hops along their biggest field with a bunjie launch. This is usually run in association with the Air Training Corps in the hope of getting the youngsters air-minded.

A little later the winch system was developed, using a car with a wire round a pulley, and we also used cars to tow the gliders back. The winch system enabled us to get considerably more height to start with, and so more time in the air, but before long people began to realize that there were other ways of staying airborne and even of gaining height, especially near hills. As soon as reasonable proficiency in control was attained, pilots wanted to learn the mysterious art of soaring, almost unknown outside Germany at the time. It seemed almost like magic then, and still does today to the uninitiated.

The behaviour of air currents passing over hills and in unstable meteorological conditions soon began to capture the imagination and before long great strides were made in performance, not only on the home site but also further and further afield. This was real *flying*, as opposed to being dragged into the air by an engine. Captain Rattray once described it as seduction compared with rape; after all, he said, if you put a big enough engine on a barn door it will fly.

THE START OF BGA

It was about this time that the British Gliding Association started, and they adopted the official classification of certificates that was being used in Germany—the A, B and C certificates, and also the Silver C which they now call the D. Our modern Silver, Gold and Diamond C certificates are of course international, and the overall controlling authority for this and other gliding activities is OSTIV (Organization Scientifique et Technique Internationale du vol à Voile) with headquarters in Switzerland.

It took me twelve months to get my C certificate, flying very intermittently. The rules were just the same as they are now, with a thirty-second flight for the A, and two forty-five-second hops and one of one minute with right and left turns for the B, the C being a five-minute flight above the point of release, or fifteen minutes between take-off and touch down. This C rating was originally adopted for the ATC because they usually operate from flat sites, and with a winch launch it is possible to get five minutes without lift with a bit of luck. I devised the fifteen-minute rule just for this reason: a flight of this duration off a winch *must* have some lift; in other words you have to spend some of the time going *up* after release.

MY EARLY FLIGHTS

My first flight at Dunstable was in a two-seater; it was a Falcon 2 and was so valuable that they were very careful who they allowed to fly it. Some time later John Simpson and I were allowed to fly it together, and we both thought we could fly it better than the other. All went fairly well until we came in to land—we both landed it! He was going to land it there, and I decided to land it here. The result was that we landed it in the middle.

One of the better machines in those days was the Cambridge, a copy of the Grunau made in this country by two German pilots who fought against us in the First World War—Zander and Wyle. Wyle was a very clever aeronautical engineer. With another enthusiast—Captain Rattray, a white hunter from South Africa—I bought a Cambridge for £120 (there were only two of them altogether) and it was a very strong machine, luckily for me. Rattray reached 7,000 feet in it at Long Mynd, but I was very green at the time; I wanted to try for my 'five hours' and got into a snowstorm at Derby. The idea was to use the up-currents produced by the wind rushing into the horseshoe-shaped range of hills headed by Mam Tor, in the Hope Valley. We only had three instruments—an ASI, an altimeter that worked and a variometer that didn't. This variometer relied on a little piece of wire or tape that was always broken; we used to look at the needle and kid ourselves that it had moved.

I was shot off on a bunjie launch and the whole team went racing off down the hillside and disappeared. A few minutes later and there were eight or nine of us all floating about in the air at the same time. Having heard about cloud-lift and that sort of thing I went over to have a look at a large mushroom-shaped cloud and then flew straight under it at about 2,000 feet. I was sucked straight upwards; I put the nose down hard and the speed built up, but I was still roaring upwards, and ages later when I suddenly came out I couldn't recognize a thing, everything seemed to have changed. The ground had been green when I went in but it was white when I came out—it must have been snowing quite heavily behind me. There was a row of black specks, but I didn't realize that these were people on top of the hill. My wife was there, and my partner without thinking said to her, 'He's had it!' There was just nothing to land on and the only way out was a kind of gorge just a bit wider than the glider. I got through this somehow and sat down in the biggest field I could see. This day was quite a disaster for the meeting because I was the only one who got down in one piece.

Actually thermal flying was being practised in Germany in 1936 and Eric Collins had already flown eighty or ninety miles. He was No. 1; Philip Wills was No. 2 over here and following him closely, flying a Hjordis which he had helped to design. Fred Slingsby was by then improving on the German designs, and produced a two-seater which made them laugh, but it won the duration record and was the first two-seater in this country. Competitions started all over the place with the BGA doing the administration, and records began to fall; minutes, miles, and hundreds of feet became hours, hundreds of miles and thousands of feet.

GLIDERS AND RADAR

This sort of thing went on until the Second World War and well into it. All private powered flying stopped abruptly, but we went on flying gliders for the best part of a year before the Government noticed anything. The war did not stop all gliding however; Philip Wills and a few others were in fact using gliders for war purposes—testing radar. They were being towed high up and out to sea and then trying to get back undetected, using special gliders with all the metal taken out and no wires longer than three feet anywhere. The idea was to see if there was any way by which the Germans could beat the radar, but these gliders were detected all right.

A little later—about 1941—the people in high places got the idea of using gliders for elementary flying training, and the Royal Air Force collared all the gliders in the country. I was approached and asked to talk to them about the subject of gliding and so were several others with similar experience. The Air Training Corps was formed with the idea of getting boys air-minded. Eventually, under the leadership of Air Commodore Chamier, we took over all existing gliders and formed various schools, but there was very little co-ordination to start with; everyone ran his particular school in his own way and heard vaguely about others being formed elsewhere. Later the Air Force took more direct control, but as District Gliding Officer I had a free hand forming the school at Kidbrooke. It was the first school in the south of England, and we ran courses for potential air crew.

Before the war I had seen Frank Charles killed. He was a dirt-track rider and had bought a glider of his own. He went up on a winch launch and pulled the wrong knob to release the cable, so the thing was dragged down and crashed. I devised a new kind of hook at Kidbrooke after Charles was killed, and Leonard Ottley made it; we called it the Ottfur hook and, following ARB testing, it is the only approved hook in the country. All our own gliders have this release now.

RECONSTRUCTION

After the war, as soon as the Air Force got the hang of gliding, they decided to run the whole thing themselves and threw all us old boys out. They did promote me to Command Gliding Adviser, but they never asked for any advice; in fact they sat me on the shelf for a year and a half and then said I was too old.

I went back to my old club and started flying there again. In 1952 I bought a SKY, which was made by Fred Slingsby at York—the letters stand for Slingsby Kirbymoorside York. All the clubs were trying to find their feet, and the BGA started up again. Gliding really got going as a united movement when we got Lady Kinlock as secretary of the BGA; she was a glider pilot and a really first-class secretary and organizer. Under the general leadership of Philip Wills the movement made great strides, in fact the international meetings were started quite soon after the war. This close unity is a very strong feature of the gliding world, and it owes a great deal to people like Philip Wills, and also to Ann Welch, who is probably one of the best organizers of championships in the world.

One big difficulty immediately after the war was to get anything built, but the BGA managed to get a fair amount of stuff over from Germany, and the ATC had a lot of it. Before long Slingsby started up again and then we got some gliders—my SKY was one of them. I was put on the BGA Flying Committee, and was elected chairman in 1954.

I believe the British Gliding Association is the best organization of its kind in the world. Although every gliding body is under the general control of OSTIV it does seem that the BGA has enormous respect everywhere for the part it plays. International rules are built up on what the British have laid down, and nearly all the new ideas come from this country. Although obvious pioneers in this field the Germans have stepped right down; they have one or two individual experts but their organization is nothing like as good as ours. Our nearest competitors are probably the French, but their administration seems to me too tight, not allowing the individual freedom that we get. The Americans are completely the reverse—intensely individualistic; they have lots of money and are very scattered so the necessary unity is not easy. Also conditions vary greatly from place to place, and gliding on the whole does not suit the American temperament, mainly because it needs patience and team work. Of course their private flying is much more closely organized than ours; in fact, in its very unity it resembles our gliding movement.

The liaison between the British Gliding Association and the Air Training Corps is a strong one. All the rules of gliding so far as competitive flying is concerned are devised by the BGA and we have no interference from any government department at all. One of my jobs was chairman of the BGA Accident Panel, and I met the Ministry of Aviation representative from time to time for discussions. We take a great deal of trouble investigating accidents and trying to see that the same kind of thing does not happen again. The Ministry rather wish that private flying was as well organized, and speaking as a private pilot so do I.

Over the years the BGA and the Air Training Corps have developed considerable mutual respect. We started by giving them all our knowledge, then we got a good deal of money from them, and are now giving it back in the form of services and information.

In spite of all that, I believe that the British Gliding Association and the Air Training Corps could co-operate even more closely than they do, and I think perhaps this little book may help to achieve that.

2 The Elements of Gliding Flight

by E. G. Hart

Flight Lieutenant E. G. Hart, thirty-six, is at present chief flying instructor at No. 2 Gliding Centre, Royal Air Force, Kirton-in-Lindsey. He first started gliding in 1949 when, as an instructor with an ATC squadron, he was accepted at a week-end gliding school for training. Eventually, he became Adjutant and CFI of the school.

In 1958, he resigned his post as a school teacher to become an instructor with the newly-formed No. 2 Gliding Centre, becoming CFI in 1962. In this, he is responsible for the training of ATC cadets and RAF personnel to solo standard and for the running of instructor courses for members of Air Cadet gliding schools.

His experience is not limited to Air Cadet work since he has been a member of the Derby and Lancs Gliding Club and at one time was a part-owner of a Skylark 3. He holds a Silver C and has over 17,000 launches to his credit, having flown twenty-four different types of gliders. Despite this experience, he says that he is still learning about gliding and gliding instruction and hopes that he will never stop doing so.

The illustrations for this chapter were drawn by another instructor of No. 2 Gliding Centre, Flying Officer P. J. Bullivant.

BECAUSE of the limitations of space, this chapter cannot be considered an exhaustive treatise on the principles of flight involved in gliding. Selections have had to be made, some things glossed over, many ignored. But it is hoped that what is left will be of use both to the prospective glider pilot, in that it will give him some idea of what he will encounter when he starts learning to glide, and to the practising glider pilot in that it might help to clarify some of his ideas.

Judging by the lectures of many flight instructors, it all began in the draughty Bernoulli household when the wind whistled through the gap left by a slightly-open door. Instead of blowing further open, the door slammed shut. This story is, of course, as untrue as James Watt's steaming kettle, but it is a fact that Bernoulli did determine the relationship between the speed and the pressure of an air-stream, and a commonly found proof is the slamming door. If an airstream speeds up, then its pressure decreases, and if the breeze happens to be rushing through a doorway, then the door is drawn inwards by the reduction of pressure and—slam! When this principle is applied to aviation and the door replaced by an aeroplane's wing we can see how lift is produced.

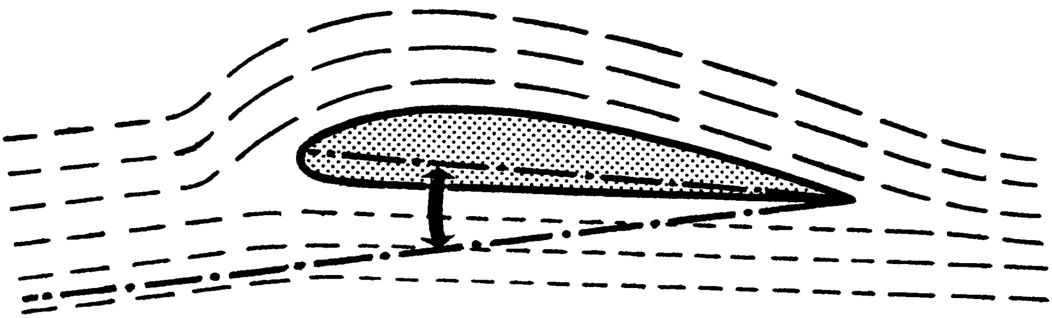


Fig. 1. The airflow over a typical wing section, showing the angle of attack

LIFT AND DRAG

The flow of air above the wing is increased in speed primarily by having a curved upper surface on the wing. The airstream is deflected from its straight course by the curvature, and thus must travel further in moving from the leading to the trailing edge of the wing. It can get there in time only by increasing its speed. This speed increase reduces its pressure, thus providing lift. In addition, the wing is so mounted that it strikes the air at a slight positive angle, called the angle of attack (Fig. 1). As this angle is increased, so the deflection of the air from its original course is greater and the lift is further increased. As well as the lift caused by the upper surface of the wing, the lower surface also plays its part. It is obvious that, in pushing a wing through the air at a positive angle of attack, there will be a build-up of pressure on the underside. This adds to the lift but its contribution in normal circumstances is much less important than that of the reduced pressure above the wing.

Skin Friction and Form Drag

The movement of a glider through the air to obtain lift carries with it a penalty, known as drag. This comes in several varieties, some more obvious than others but none particularly attractive since all drag reduces a glider's performance. To start with the more easily understood kind, there is skin friction. The smoother the surface of a wing or fuselage the easier it slips through the air. It is because of this that a glider's owner will lovingly polish its wings—and at upwards of 300 square feet per wing it must be worth it. Then there is form drag, caused by the shape of the aircraft. The designer's answer to form drag is streamlining.

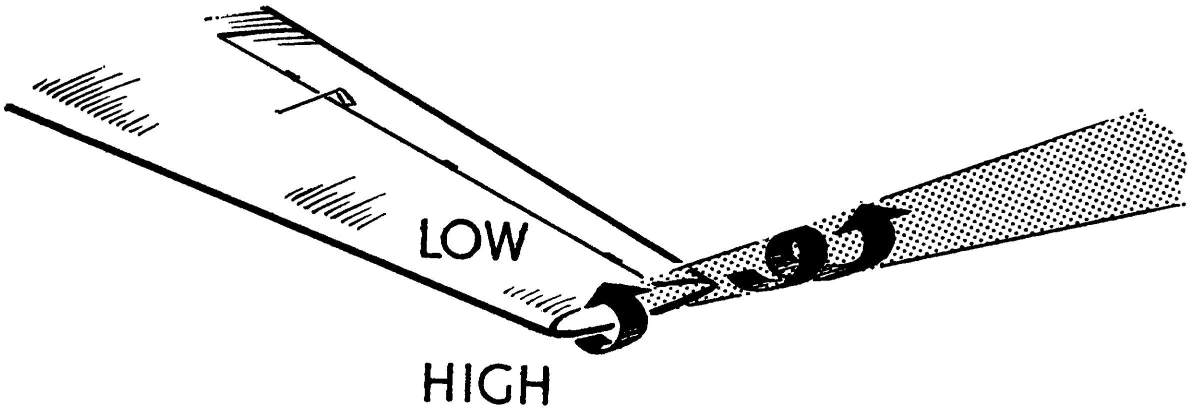


Fig. 2. Induced drag—the wingtip vortex

Induced Drag

Another interesting type of drag—induced drag—is the direct result of the production of lift. A lifting wing has reduced pressure above, increased pressure below. Now air always tends to flow from high to low pressure, but in this case there is a wing in the way. At the tips, however, a flow from the lower to the upper surface can develop as a continuous swirl of air. The rotation of this, called a wing-tip vortex, creates an area of low pressure at its centre which acts on the wing as drag (Fig. 2). The long narrow wings of high-performance sailplanes (technically, wings of high aspect-ratio) reduce the amount of induced drag, but it is never possible to get rid of it completely.

All this talk of drag makes it seem that the glider has no hope of getting off the ground but, in fact, the ratio of lift to drag, even in gliders of the poorest performance, is seldom less than 15 to 1. High performance gliders are flying today with L/D ratios which are better than 40 to 1. Put another way, this means that from a height of 5,000 feet (a round-figure mile) they could glide forty miles in still air before landing.

So now we have lift, which keeps the glider up, and drag, which holds it back. All that is needed is a method of propulsion to provide the movement that gives the lift and overcomes the drag. A glider can use only one propulsive force—gravity. Throughout its flight it slides downhill, maintaining its speed in just the same way as a cyclist can when he freewheels downhill. Alteration of the angle of descent by lowering the nose will increase the airspeed, which in turn affects the amount of lift and drag. Raising the nose slows the glider and if this nose-up position were maintained, airspeed and lift would eventually decrease to the point where there would be insufficient to support the glider and it would drop into a stall. Thus it is impossible for a glider to fly level in still air for more than a few seconds. To maintain airspeed it must always be descending.

The pilot adjusts his angle of descent and also carries out the many manoeuvres of which a glider is capable by the use of three controls, the elevator, ailerons and rudder. To see how these work we shall accompany a pupil on his first instructional flight.

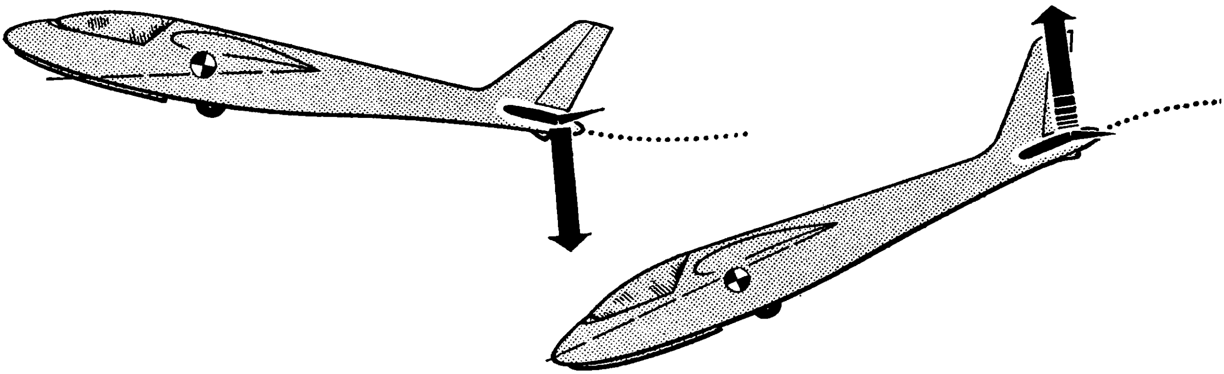


Fig. 3. The action of the elevator

THE EFFECTS OF THE CONTROLS

Having pointed out the attitude of the glider at the normal angle of descent, the instructor gives control of the elevator (Fig. 3) to the pupil and asks him to gently press the control column forward. This immediately causes the nose to lower and the airspeed to increase. Pulling back the stick raises the nose. The speed begins to fall off and if the nose is held too high the glider will stall, so the pupil is told to lower the nose to the correct attitude and then centralize the stick. This is pretty straightforward stuff and most people with enough interest to get into the glider in the first place would have known it before they walked onto the airfield. But what they would not have appreciated is exactly why the glider climbs and dives when the elevator is moved.

The tailplane (of which the elevator is the rear hinged portion) is normally a flat stabilizing surface. But lowering the elevator gives it a curve—admittedly a somewhat angular one—which turns it into a lifting surface like the wing. So the tailplane-cum-elevator now produces lift and the tail rises, the glider pivoting about its centre of gravity. This has the effect of reducing the angle at which the wing meets the air, the angle of attack, and lift is reduced. The pilot sees the nose go down as the tail rises and probably assumes that the glider begins to dive because it is pointing that way, but in fact it drops because the smaller angle of attack has reduced the lift. Similarly, when the elevator is raised the tailplane 'lifts' downwards, the angle of attack of the wing increases and the extra lift causes the glider to climb. However, back to the pupil and his instruction.

He has learned the effect of fore-and-aft stick movement and the instructor tells him now to move his stick to the right. This causes the right wing to drop as the glider rolls to the right. Centralizing the ailerons stops the rolling movement and the glider remains with its right wing down in a banked position. Because it is banked it turns and to stop turning the pupil must roll to the left, centralizing the stick when the wings are level again. The ailerons are hinged portions of the trailing edge of the wing and are mounted at the wing tips, that is, as far as possible from the centre of gravity so as to have the maximum leverage. Moving the stick to the right lowers the left aileron, thus increasing the curvature or camber of the

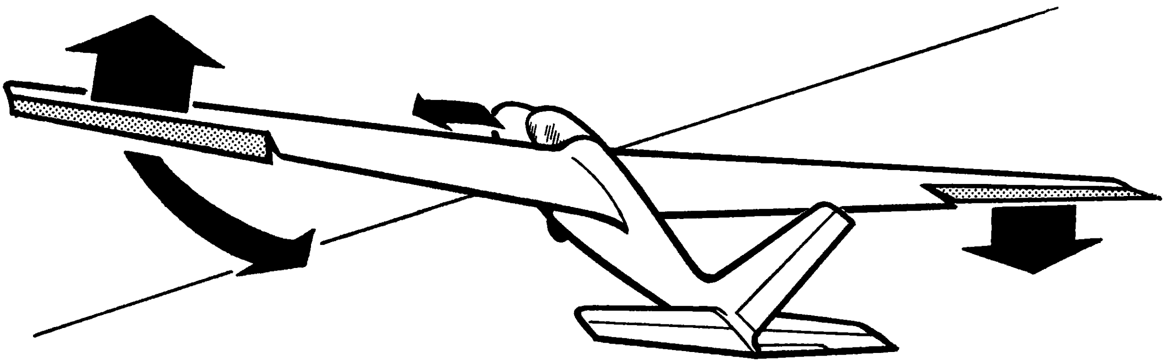


Fig. 4. The effect of uncorrected adverse yaw when rolling to the right

wing. The resulting increase in lift causes this wing to rise. By the same stick movement the right aileron is raised. This has the opposite effect as the reduction of camber reduces lift and the wing drops.

The pupil is now ready to use the rudder. Pushing forward the right foot swings, or yaws, the nose to the right. The glider will not now be turning because it is not banked. It proceeds to prove it by continuing to fly in the original direction and if the glider has an open cockpit the pupil has tangible proof of the skidding flight in the form of a substantial blast of air on his left ear. Getting rid of this breeze by applying left rudder (and remembering to centralize the rudder when the breeze has gone) teaches him the primary function of the rudder.

He can now practise the use of all three controls together, the elevator to control the attitude and speed; the ailerons by giving roll to control bank and thus turning; and the rudder to prevent unnecessary yaw and keep the glider from slipping or skidding.

FURTHER EFFECTS

As in most things, the pupil finds that there is more to it than is at first apparent. Movement of a control will certainly give him the effect he wants but might also cause the glider to move in what seems to him an unrelated direction. This is because of the further effects of the controls. Briefly, a further effect is the effect which a control is not intended to produce, but does. Happily, the elevator can be dismissed from this discussion—it has no further effect.

The Rudder

To deal with the easiest first, consider the use of the rudder. Applying right rudder yaws the nose to the right as we already know. But this same movement causes the left wing to move forwards, thus slightly increasing its airspeed. The right wing is slightly slowed and these changes in airspeed affect the lift. With extra lift on the left wing and less on the right the glider rolls to the right. This roll, which is the further effect of rudder, is not a very efficient roll and is accompanied by that skidding flight the pupil has already experienced so, if he has his wits about him and corrects the skid by removing the right rudder, he will also remove the tendency to roll.

The Ailerons

Now to the ailerons. Right stick causes right roll and, provided we started from level flight, the glider will now be banked, and thus turning, to the right. Although

Air Training Corps cadets retrieving a Dagling. Gliders of this type were in general use for the solo method of training in 1941

John Furlong chats to Flt Lt George Nunn, Commanding Officer of 615 Gliding School, Kenley

The day's task is set at the briefing by Ann Welch to all pilots who took part in the 1963 National Gliding Competition at Lasham (Photo: Alex Watson)

Flt Lt E. G. Hart

Alex Watson gives a cadet his final briefing before he takes off on the first of his three solo flights

In a Cadet Mark III the instructor sits behind the pupil, who makes his first solo flight in this type

An Air Cadets Sedbergh soaring against a background of cumulus clouds. A pupil will begin his basic training in this type of glider (photo: Alex Watson)

The French Avion-Planeur (photo: Alex Watson, by courtesy of Sutton Aviation & Marine Ltd) **see p. 100**

it is a turn, it is not a very accurate one since the glider tends to slip towards its lower wing. Exactly why it does this is somewhat beyond the scope of this chapter but it is not too difficult to believe since it seems a fairly logical thing for a banked glider to do. The slip causes the now-familiar breeze on the face (this time on the right ear) and, if it is not corrected, the glider will act just like a weathercock and yaw towards the slip. The yaw, which is the further effect of aileron and is frequently referred to as weathercocking, is caused by the air striking the side of the fuselage which, because of the large fin and rudder, has a greater area behind the centre of gravity than in front.

Note that both these further effects are preceded by inaccurate flying and if slip or skid is prevented, will not occur. There is another further effect—take heart, it's the last one—that assumes more importance than the other two. This is a further effect of ailerons and its understanding takes us back to the beginning of this chapter.

Adverse Yaw (Fig. 4)

The production of lift was shown to incur a penalty in the form of drag and any increase in lift results in increased drag. Now, for the third time, apply right stick to make the glider roll right. This it does by having increased lift on the left wing, decreased on the right. But the drag will be similarly affected and the extra drag which appears on the left wing and the reduced on the right will cause the glider to yaw to the left. This is known as adverse yaw since it is contrary to the movement of the stick. Stick right, yaw left, etc. To correct yaw, rudder is used, in this case, right rudder. The amount of rudder will depend on how much stick movement there is. A slight deflection of the ailerons needs only a small amount of rudder; a lot of stick needs a lot of rudder. It is the need to co-ordinate the aileron and rudder movement in flight that causes most difficulty to the majority of pupils. Failure to do so results in sloppy flying and things are made no easier by the insensitivity of the average human foot, especially when encased in the sort of footwear needed on a typical gliding field.

THE TURN

So now to summarize things for our slightly bemused pupil. He can move the glider in three ways: raising and lowering the nose by use of the elevator; rolling by using co-ordinated ailerons and rudder; and yawing, or more usually preventing yaw by using the rudder alone. These basic movements can be combined variously to produce a bewildering array of manoeuvres that gladdens the heart of the expert and excites the envy, or sickens the soul, of the novice. But for the moment, consider only the turn—that is complex enough.

To turn, one must bank—this we know. We also realize that the most insensitive of beings can bank and do a turn of sorts just by using an armful of stick or a bootful of rudder, but to do the job properly requires a more delicate touch. Rolling into the turn needs co-ordinated aileron and rudder—this time we'll do it to the left. For a normal turn not much control deflection is needed since the glider is quite willing to drop its wing. The rate at which the glider turns is governed by the angle of bank, so when the desired angle is reached the roll must be stopped. Easily done, centralize the controls and the glider should be turning happily. But the perceptive reader will remember a statement made in the discussion about the further effect of ailerons that a banked glider will slip towards its lower wing. This is equally true now and to maintain balanced flight the slip must be corrected (breeze on the left ear, left rudder) using what is called bottom rudder, that is, the rudder on the same side as the lower wing. So in a balanced left turn, a little left rudder is needed. Now on rolling in, left rudder has already been used to counteract adverse yaw. Usually more rudder is needed for this than for preventing slip when in the turn, so on centralizing ailerons the rudder is taken off just to the point where there is enough left to balance the turn. The control movements so far then, are: left stick and rudder, that's enough bank, centralize the stick and take off some of the rudder.

There is yet another complication and this requires some of that dimly-remembered second-form physics to understand it properly. Lift always acts at right angles to the wing. If you imagine a glider approaching head on with its wings level then the lift could be represented by a vertical line above the fuselage (Fig. 5a). The amount of lift would be approximately equal to the weight so the glider would maintain its steady angle of descent with no tendency either to climb or dive. Now bank the glider. The lift still acts at right angles to the wing and the weight still acts vertically downwards, but the two are no longer in direct opposition. To find how much lift is still counteracting the weight we must construct a parallelogram of forces, that is, split the lift into two components which together have exactly the same effect as the single lifting force. Diagram 5b has done this for us and shows that the vertical component of the lift is in fact smaller than it was in level flight. The horizontal component is that part of the lift which pulls the glider sideways through the sky and thus makes it turn. So now that some of the

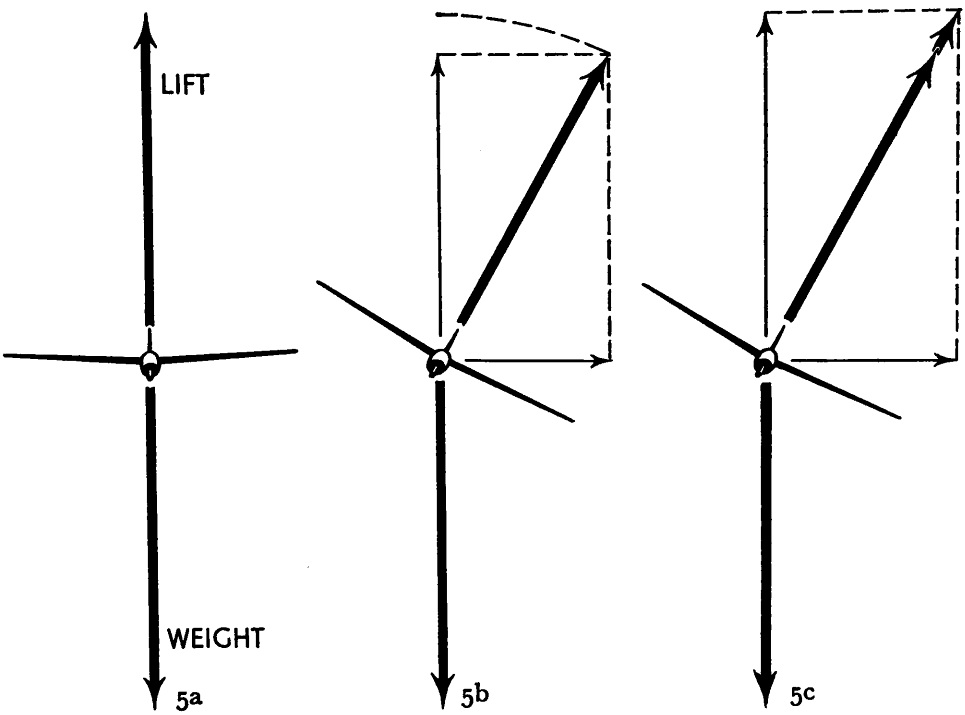


Fig. 5a. Forces acting with wings level
Fig. 5b. Showing reduced lift with bank
Fig. 5c. The restoration of lift by correction of attitude

lift is being used for turning there is less to counteract the weight and the glider begins to dive slightly. The pilot prevents this by pulling back on the stick. This raises the nose to its proper attitude, increasing the angle of attack and providing more lift. Diagram 5c shows the effect of this. There is now sufficient lift acting vertically to counteract the weight and the glider is at last in a balanced turn. The ailerons are central, a little bottom rudder is applied and the elevator is slightly back.

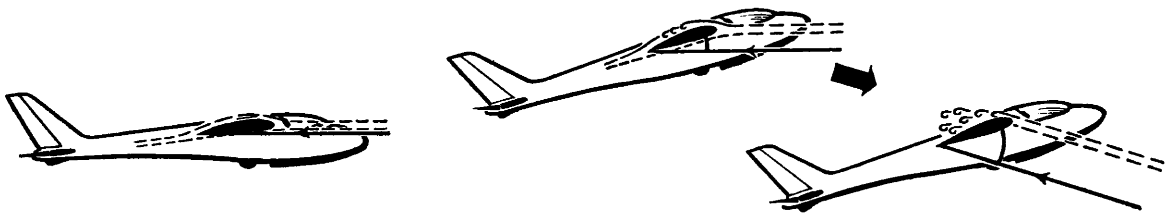
Recovery from the turn simply needs opposite control movements from those used on entry. It was a left turn so we need right aileron (plenty of it because of the slight reluctance of the glider to raise its wing) and co-ordinated rudder, at the same time easing the stick forward since we need less lift in level flight than in the turn.

It is now fairly obvious that a man who can perform an accurate turn in his glider—every time—is a pretty good pilot. In fact a lot of people never reach this standard. They become tolerant of the small amounts of slip and skid which develop when concentration is lacking and, in all honesty, provided the flying is not too atrocious, it doesn't matter very much to the man who flies for fun. So the aspiring glider pilot who reads this need not be daunted by the first manoeuvre he will learn to do. There are others which will come later in his training which he will find much simpler.

THE STALL

In all his flying, a pilot should be aware of the possibility of stalling and its dangers. For this reason, a considerable part of gliding training is devoted to stalling in its various forms so that the pilot becomes fully conversant with the prevention of and the recovery from the stall. In simple terms, a stall is a breakdown of the airflow over the wing; this will naturally result in a marked loss of lift. A pilot can easily cause a stall by increasing the angle of attack too far. As the angle increases, the deflection of the airflow from its normally straight path becomes greater and eventually its smooth flow breaks down and the turbulent eddies form. (The angle at which this occurs is called the stalling angle and is usually about 15 degrees.) The turbulence causes extra drag, which in turn slows the glider and reduces its lift and it begins to sink more rapidly. This will mean that the air is now approaching the wing from a different direction, increasing the angle of attack even further and completely stalling the wing. Because of the position of its centre of gravity the glider will drop nose first in the stall, thus automatically reducing the angle of attack and assisting recovery. In this sort of stall, usually called the straight stall because it is induced by the pilot from a normal straight glide, the glider will be flying at its slowest flying speed at the point of stall (Figs. 6a, 6b, 6c). This is, therefore, called the stalling speed and knowledge of the exact figure is important to the pilot because it is the starting point for the calculation of all the flying speeds he will use in the various stages of his flight. For this reason, it is common practice to carry out a 'check stall' at the beginning of a flight or series of flights since the exact stalling speed varies from glider to glider (even in two gliders of the same type) and also varies in an individual glider with the weight it is carrying.

The dangers of stalling are twofold. At the point of stall there is a decided loss of effectiveness of the controls, even to the point where a control has no bite on the



6a 6b 6c

Figs. 6a, 6b, 6c. The straight stall—note how the increasing sink greatly increases the angle of attack

air at all and, secondly, the loss of height following a stall might be considerable. To put that into figures, a very gentle stall and subsequent recovery could be carried out for a height loss of about 50 feet; a slightly steeper stall and/or a delay in recovery will need 100–150 feet; and a good nose-in-the-air, where's-my-stomach-gone affair could use up 300 feet or more. All this means that stalling should only be carried out where there is ample height for recovery. This is easy to arrange when stalling is deliberate; the stall that is dangerous is the one that sneaks up on a chap when he is busy positioning himself on the circuit for his approach and landing. Then the height available for stall recovery is rapidly diminishing and the awareness of the signs of the approaching stall must be sharpest.

Appreciating that a glider normally flies only about ten knots above stalling speed, the pilot must be watching for any change in his attitude that would cause an increased angle of attack, for signs of decreasing speed—lack of airflow noise, poor control response—for the slight juddering of the airframe sometimes caused by the increasing turbulence, etc. Any indication of the impending stall is immediately countered by lowering the nose to reduce the angle of attack. Partly because of the danger of stalling, glider pilots approaching the ground increase speed by various amounts according to the wind strength and the type of glider they fly, plus a couple of knots for the wife and kids. Stalling has several other tricks up its sleeve when dropping wings at the stall are considered, stalling in a turn, and the combination of stall and yaw which causes a spin, but these are included in those things to be burnt on the altar of brevity and must remain a mystery to the reader of this chapter.

LAUNCHING

The Shoulder Launch

It is now time to consider how a glider is launched. This may be achieved in several different ways. Starting from the simplest (but probably not the easiest) there is the *shoulder launch.* This involves the glider being lifted on to the shoulders of several unselfish assistants who walk forwards until the glider becomes airborne. Although on the face of it this sounds ridiculous, there are occasions when shoulder launches are practical, but only in certain strictly limited conditions. Firstly, the wind speed must be nearly equal to the flying speed of the glider, or so close to it that flying speed can be reached when the launchers walk into the wind. Secondly, the glider must be launched from the top of a hill. Almost invariably, the strong wind striking the hill face will provide a belt of rising air into which the glider has been so inexpensively launched. Flying in such strong winds, however, is for stout hearts only; all too often the launch can be entirely inadvertent and the glider is blown over backwards.

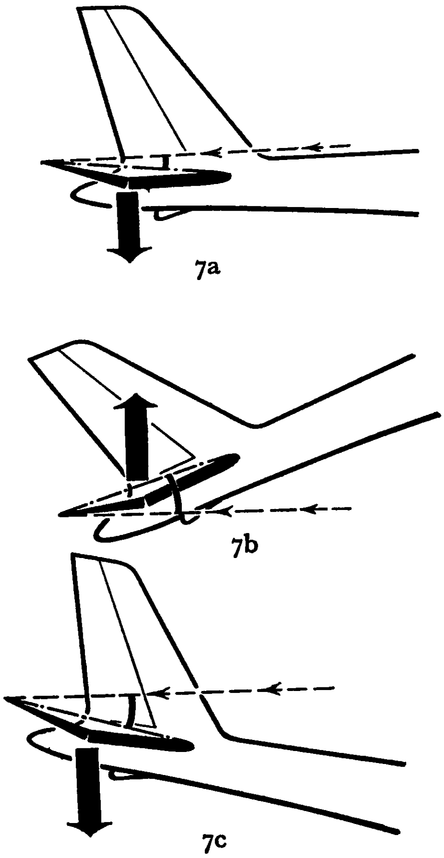
The Bunjie

In slightly less windy conditions the top of the same hill might be the scene of a *bunjie launch.* For this an even greater number of unselfish helpers tug on the open ends of a V of elastic rope or 'bunjie'. At the apex of the V a ring is placed over an open hook under the glider's nose. As the launchers run forwards the rope stretches and, when the brawny beings holding the tailskid can restrain it no longer, the glider is catapulted forwards, passing over the heads of the launchers, when the ring falls off the hook. As the tension on the bunjie relaxes, the launching crew have their own thrilling moments as they bound merrily down the hill trying to avoid both the chap in front and a broken ankle.

The shoulder launch and the bunjie launch are normally confined to hill-sites when a glider can be sure to enter lift immediately it is airborne in front of the hill. The most common method of launching is to attach a long cable to the glider which is then reeled in by a static winch or towed into wind by a powerful car or truck. This ensures a much greater launch height, usually averaging 1,000 feet which will give a glider a flight time of anything between four and eight minutes, depending on its performance.

The Auto-tow

An *auto-tow* differs from a winch launch only in that it is usually smoother and the initial climb is gentler. This is partly due to the poorer acceleration of the tow-car and to the need for care in case of a cable break when slow speed plus steep attitude would inevitably equal stall. In practice, provided that the tow-car has a long enough run, there is no need to climb steeply at first, since the full length of cable is always available, not being pulled in as it is by a winch. The winch can give rapid acceleration and the glider becomes airborne after a very short run. Even though there might be plenty of airspeed the initial climb is still fairly gentle until a safe height is reached and stalling is less dangerous. Then the pilot increases the angle of his climb by pulling smoothly back on the stick. All this time the winch is pulling in the cable, rapidly at first, then with steadily decreasing speed and, as the glider climbs, what was a forward pull only, becomes forward



Figs. 7a, 7b, 7c. The varying angle of attack of the tailplane during hunting on a winch-launch and slightly downward, then more downward than forward and finally, just before the cable is released with the glider about 80 degrees to the winch, the pull is almost entirely downward. The pilot combats this by steadily increasing his backward pull on the stick throughout the launch until, just before release, the stick might be almost fully back. To ensure a smooth release, before operating the cable release knob, he moves his stick forward, lowering the nose and taking the strain off the cable.

An enterprising pilot, by having a steep angle of climb, can get a considerable height on the launch but only at the risk of a cable break. He is also more likely to meet 'hunting', a pitching of the nose which, unless corrected, becomes rapidly worse. Hunting is caused by using too much up elevator. During the launch the elevator and tailplane are producing a down load to counteract the pull of the cable under the nose and to maintain a good angle of attack on the wing for the climb. In other words, the tailplane is operating at a negative angle of attack with the airflow striking its upper surface (Fig. 7a). The power of the elevator can be increased either by moving it further up or by an increase in launch speed. A further factor to be considered is the variation in load on the glider caused by the swinging of the cable, a lessening of the load allowing the elevator to pull the tail further down. Whatever the reason causing the downward movement of the tail, the glider would pivot about the centre of gravity. If this movement were great enough the airflow would strike not the top, but the bottom surface of the tailplane thus giving it a positive, as opposed to a negative angle of attack (Fig. 7b). The direction of 'lift' would now be reversed and the tail would be drawn upwards moving beyond its original position and giving it an even greater negative angle of attack (Fig. 7c). This in turn forces the tail down to a greater positive angle and the movement continues, getting more and more exaggerated. Uncorrected it would eventually cause the cable to break or to disconnect automatically from the hook on the glider, this being so designed that the cable will release if a down-load is applied at 90 degrees to the centre-line of the glider. The method of correction is simply to reduce the power of the elevator by moving the stick forward slightly. The hunting then dies out. Additionally, the winch driver can help by reducing speed.

The Aero-tow

An *aero-tow* is apparently a much simpler state of affairs than a winch launch for in this the glider is provided simply with a forward pull. But there are problems. The aeroplane providing the tow, and the glider, have very different wing loadings (relationship between weight and wing area) and, therefore, their handling characteristics are dissimilar. As well as this, both aircraft are operating at other than their normal speeds in that the tow plane is flying slower than its normal and the glider faster. But neither of these factors causes much trouble in calm conditions. It is when the air is turbulent that the tow becomes interesting for the glider is attached to the aeroplane by 50 to 100 yards of nylon rope which stretches readily. Any increase in speed on the glider's part and the rope becomes slack, only to immediately tighten up again and pull the glider rapidly forwards and, of course, upwards as the increasing speed increases lift. To combat this by lowering the nose would only allow the rope to go slack again, so the glider pilot must de-yo-yo himself by taking up the slack as soon as it appears, using rudder to cause skid and thus drag or, in more drastic circumstances, using his airbrakes briefly. Whatever he does he must try to stay at the same level as the tug, for if he were to rise he would lift the aeroplane's tail, causing it to dive and thus increasing the height discrepancy between the tower and the towed. Conversely, flying too far below the tug could, in the extreme, pull its tail far enough down to cause it to stall. The great advantage of an aero-tow is that the glider can be taken to a prearranged height and place and can be released when the pilot knows he is in rising air. A launch with ground equipment is restricted to a limited height at one place and the finding of rising air is more a matter of luck.

LANDING

Finally in this section on principles of flight we come, appropriately enough, to the landing. Most pupils view their first attempts at landing with apprehension but the difficulties are largely psychological.

The foundations of a good landing are laid on the final approach, which should be straight, at the right speed and with the airbrakes in the correct setting. The approach will be at a steeper than usual angle of descent and this should be smoothly checked by raising the nose as the glider approaches the ground. Done correctly, this will leave the glider flying level about a foot above the ground at a little less than the approach speed. It is at this stage that too much keenness to return to terra firma can change the landing into an 'arrival', for a little twitch forward on the stick produces either a bounce back into the air at an odd angle or a shuddering grind to a halt. What is needed is for the level flight to be maintained until the glider has lost all the excess speed it gained on the approach. As the speed falls off, so will the lift, and the pilot maintains this by steadily increasing the angle of attack with a progressive backward movement on the stick. If he wishes his touchdown to be as delicate as possible, he will also gradually close his airbrakes so that the rate of sink of the glider is at a minimum. When finally the glider sinks onto the ground, despite the pilot's efforts to prevent it, it will not be stalled. The landing is normally made on mainwheel and tailskid and in this position, the angle of attack of the wing is unlikely to be greater than 10 degrees, well below the stalling angle. As the glider touches, the pilot can ensure against bouncing off again because of bumpy ground or a gust of wind by smartly opening his airbrakes.

Gliding is a fascinating subject—what has been said in this chapter hardly scratches the surface of the things to be learned from and about gliding. It is possible to absorb enough of the bare essentials to fly solo after only twenty launches. But it is also possible to fly for twenty years and still find in gliding, aspects as fresh and intriguing as the basic principles of flight are to the newest pupil.

3 ATC Gliding and the A and B Certificates

by Alex Watson

Alex Watson's introduction to gliding was with the usual five-shilling hop at the South Down Gliding Club's site at Friston, near Eastbourne, Sussex, in 1949, where he later became a member and gained his A, B and C certificates.

He showed a keen interest in instructing and in 1950 joined 168 Gliding School at Royal Air Force, Detling, as an 'under training' instructor. He gained the C category Instructor's rating later that year, and the following year was awarded his Instructor's A category.

Early in 1955 he was commissioned in the Royal Air Force Volunteer Reserve (Training) Branch and remained with 168 Gliding School as Adjutant until the school was disbanded in October. He was then transferred to 615 Gliding School at Royal Air Force, Kenley, as assistant chief flying instructor and in 1957 was appointed chief flying instructor, the position he holds today.

He has devoted all his gliding experience to instructing and spends every week-end and two weeks a year at Kenley, and has been responsible for sending several hundred pupils on their first solo flights.

The Air Training Corps plays a large part by encouraging young men to take a practical interest in flying through the medium of gliding.

The objects are to fit them to serve their country in the Royal Air Force, its Reserves and Auxiliaries, and also in the Fleet Air Arm, and in the Army. Furthermore it provides training which is useful in civil life.

The A and B certificates are awarded by the British Gliding Association to cadets who competently complete three solo flights as follows: a straight glide of at least thirty seconds duration for an A certificate; and two glides of at least forty-five seconds, followed by a flight of one minute including an S turn, or by one right-hand turn and one left-hand circuit each of one minute's duration for the B certificate.

Gliding training is open to all boys in the Air Training Corps and Combined Cadet Force units, provided they are not less than sixteen years of age, are medically fit, and have their parents' consent to fly.

The Air Cadet gliding organization consists of two gliding centres and twenty-five gliding schools. The centres operate on a full-time basis and are commanded by regular RAF officers. Apart from training cadets on continuous courses, they supervise the gliding schools and run instructors' courses so that training methods are standardized. They are in effect the Central Flying Schools of the Air Cadets' gliding movement.

The twenty-five gliding schools throughout Great Britain are mostly located at regular RAF airfields and provide gliding training at weekends for local ATC squadrons and CCF sections. Each gliding school is established for five gliders (Sedberghs and Cadet MK 3), two twin-drum launching winches, a one-ton truck and two Land Rovers. All aircraft and vehicles are inspected and maintained to regular Royal Air Force standards.

Gliding schools are commanded by an officer, normally a flight lieutenant commissioned in the Royal Air Force Volunteer Reserve (Training) Branch, who has at his command four flying officers, also RAFVR(T), to whom he designates the duties of chief flying instructor, adjutant, equipment officer and technical officer. There is also an unspecified number of civilian instructors at each school who, when joining, may be trained or untrained but in either case will be required to attend a training course for instructors at one of the two centres. All the staff of a gliding school are required to fly; there are no non-flying appointments. Medical fitness is essential and all instructors are required to undergo an annual medical check-up.

During the year 1963 the Air Cadet gliding movement was responsible for training 2,043 cadets to the A and B standard, and this amounts to 136,345 launches.

This then is a brief outline of gliding in the Air Training Corps today, where for a shilling a day (for meals only), a boy may qualify for his A and B certificates.

GLIDING SCHOOL PROCEDURE

The gliding school at which I am chief flying instructor is at Royal Air Force Station, Kenley, some 500 feet above sea level, and is commanded by Flight Lieutenant George Nunn who has been associated with ATC gliding since its inception in 1941, and who has done much to further its objects.

ATC GLIDING AND THE A AND B CERTIFICATES

As well as the normal week-end training, we run two courses of one week each every year at which twenty cadets attend for each course; these are for the benefit of CCF RAF sections at public schools and grammar schools and for ATC cadets who live too far away to attend each week-end. These intensive training periods have an advantage over week-end courses because their vigorous continuity of training leads to much faster progress.

Cadets attending Kenley for a week's gliding course arrive on a Friday evening, when they are welcomed by the commanding officer and introduced to the officers and civilian instructors. Each pupil is issued with a booklet giving a brief outline of ATC gliding training which he hands back at the end of the course. Progress cards are given to each pupil and he fills in details of his school and private address and other information. These cards are then kept by the instructors and a complete record of each pupil's progress is recorded on them day by day.

Where there is flying there must of course be strict discipline—not only in the air but also on the ground, and gliding school rules are fully explained at this point. The most important information of all for any boy is meal times! There is plenty of hard work to be done during the week and cadets need a lot of nourishment. They have their meals in the airmen's mess on the station, and as well as not having heard any complaints, I understand that second helpings are always encouraged.

Sleeping accommodation is provided by the station and is of conventional dormitory fashion, each cadet being responsible for his own bed, mattress and blankets, and the tidiness thereof, an inspection being carried out during the week by the duty officer appointed for this purpose. Apart from the odd pillow fight among the boys, a duty officer's job is a very pleasant one. I have yet to meet the boy whose day has been filled with healthy activity who was unhappy in the evening.

The issue of suitable flying clothing is the first detail on the following day, and then on to lectures which include ground handling, principles of flight, airmanship and general flying procedures. A cadet must know how and where to hold a glider to avoid any possible risk of damage, how to attach a cable to a glider, the procedures to follow and the hazards to be avoided.

The success of a week's gliding depends a great deal on the weather; one must, therefore, make the most of fine days for flying. For this reason, lectures are kept to a minimum if the weather is suitable for flying.

There are numerous jobs to be carried out before the day's flying begins, both by cadets and instructors. Daily inspections are carried out on the gliders, winches and vehicles, and the necessary documents signed in respect of each. The Aircraft Control caravan and winches are positioned and the launching cable is checked; much time can be saved during the day if a thorough check is made on the cable before the first launch.

Finally, the gliders are towed to the launchpoint by Land Rovers and positioned ready for take-off. The first flight of the day is usually made by the chief flying instructor, or his deputy, to assess weather conditions and to decide in which direction circuits should be made.

AIRFIELD CONTROL

Control of flying operations is in the hands of the duty controller who is perched on a high seat in the control caravan overlooking the airfield. He is responsible for relaying signals to the winch driver, keeping the daily flying log book in which a record of each launch is kept, and generally keeping a watchful eye on all movements (not an enviable job, for one needs at least three pairs of hands and two pairs of eyes!).

TRAINING

Each instructor is allocated three or four cadets for training to a certain standard, beginning with an air experience or 'familiarization flight' in which the pupil takes little or no part in the actual flying, but takes note of the airfield boundary and the various landmarks, and of course obstructions and prohibited areas, all of which will be referred to at a later stage of his training. The next flight will cover the use of the controls, and the pupil will be encouraged to try them for himself to get the feel of the aircraft—how it behaves when the controls are moved—and, above all, to achieve confidence.

Thorough briefing at this stage of training is essential and a great deal of time may be spent both before and after the flight explaining each exercise. By the time a pupil has received eight or nine flights, his movements gradually become automatic; no longer is the aircraft a detached being but, in imagination, is becoming his wings strapped to his back. He soon gains confidence and in a very short time is capable of making a fairly accurate turn, and although perhaps a little 'bouncy' a reasonably smooth landing.

During a cadet's training, it is most important that he should do the actual flying, the instructor only taking control should the pupil make a mistake which might cause damage to his aircraft. It takes a great deal of skill and experience—to say nothing of courage—on the part of an instructor to know just when he should take over from his pupil; one must be prepared to let him fly as far as possible without taking this action. This is one advantage side-by-side two-seater gliders have over the tandem type: the pupil is able to see for himself that the instructor is or is not touching the controls.

On the first day's flying each cadet will receive approximately six launches in his initial training, mainly dealing with the effects of controls. With twenty cadets on a course this amounts to something like 120 launches a day; this is the average aimed for at ATC schools. The next day's flying becomes a little more advanced and usually amounts to general polishing up of the previous day's work, with the accent on turns and landings. In my experience the take-off and launch are the least difficult, and the circuit planning the most difficult. Gradually the pupil's flying becomes more and more accurate; turns are more precise; he begins to lean into the turn rather than away from it. (As I have explained many times, no one would dream of leaning over to the left when executing a right-hand turn on a bicycle.) Landings become much smoother; only the occasional bump and bounce now! The pupil is beginning to *relax* and is therefore able to devote his attention to other things going on around him; control of the aircraft is by now almost automatic. He no longer has to think which way he should ease the stick to make a turn to the left. Is the nose too high or too low? Is the speed right? The control of the aircraft is now in *his* hands; he will make it fly in the direction *he* wants it to, and he does not have to rely on his instructor to help him make decisions or coax him round the circuit.

INSTRUMENTS

Unlike light powered aircraft, basic training gliders only carry the minimum of instruments. They are: altimeter, airspeed indicator and variometer, the latter indicating climb and descent measured in feet per second. In the early stages of training a pupil is encouraged to concentrate on flying his aircraft rather than take much notice of indications given by the various instruments. Having mastered his aircraft, the instruments begin to play a vital part in his training.

The altimeter fitted to the glider has no means of vibration to ease it from its somewhat lagging tendencies; the powered aircraft has an engine to do this job. A pupil must be taught therefore to give this instrument (or rather the panel to which it is fitted) an occasional light tap with his knuckle, in the same way as one might tap an ordinary barometer! The airspeed indicator also has a very slight tendency to lag; again allowance must be made by the pupil. Reference to these instruments will, as in the handling of the aircraft, become second nature, and will be interpreted by the pupil at a quick glance.

STALLING AND SPINNING

Most gliders fly at between seven and ten knots above the stall and it is therefore necessary to teach a pupil how to recognize the approach of a stall and how to deal with it. A stall is by no means dangerous, provided there is sufficient height in which to recover. Intentional stalling is carried out at safe height and demonstrated by the instructor. The pupil then takes the controls and tries out a few stalls for himself; this is an important lesson to be learned, for unintentional stalling caused by the effects of turbulence near the ground could end disastrously.

Spinning is yet another part of the training at this stage. Although most basic trainers are reluctant to spin, it is important for the pupil to be shown the incipient stages for he must be able to recover satisfactorily before he is permitted to go solo.

By the third day's flying the pupil is usually ready for circuit procedure; this entails flying to a square circuit pattern. Here is the exact sequence that is followed: The cable is released at a given height (usually between 500 and 600 feet at Kenley). He then makes a 90-degree turn across wind and at a predetermined point makes another 90-degree turn towards the downwind boundary for a third 90-degree across wind; finally, yet another 90-degree turn into wind for the approach and landing.

Heights are not altogether critical in circuit planning with the exception of the final turn for the approach, which cadets are not allowed to make below 100 feet. This gives the pupil time to survey the landing area and to avoid such things as parked aircraft and retrieving vehicles. I always advise pupils to look for the open spaces so as to avoid these likely obstructions. A well-planned circuit (and above all a good approach) will invariably lead to a good landing. Bad approaches so often lead to bad landings.

One question is invariably asked on the subject of gliding—what happens if the launching cable breaks? This is covered in the sequence of instruction during a pupil's training. He must be prepared at all times during the launch for the possibility of a cable-break or power failure, and for this reason at least three simulated cable-breaks are given to pupils at the latter part of their training. The instructor will, without warning, pull the cable release knob in the glider and await (with some trepidation, I may add) the pupil's reactions. Cable-breaks are

Cumulus and pre-frontal cirrus over north-west Scotland (photo: T. A. M. Bradbury)

Cumulus heads, taken from a sailplane at 13,000 feet over Gloucestershire (from a colour transparency: T. A. M. Bradbury)

Wave cloud over Berkshire (photo: T. A. M. Bradbury)

Cumulonimbus over Gloucestershire (from a colour transparency: T. A. M. Bradbury)

Ken O'Riley

An Olympia 2b (photo: Alex Watson)

The pilot's view of an aero-tow (photo: Alex Watson)

A Skylark 4 on aero-tow from Lasham (photo: Alex Watson)

given at various heights and in any order, the idea being to provide an element of surprise. In many cases the antics performed in this exercise surprise even the instructor!

Having completed all the exercises in the book, the cadets begin to look forward anxiously to the day on which they will go solo. A certain amount of tension begins to build up among them, much discussion goes on both before and after lights-out in the billet. 'Do you think you will be going solo tomorrow, Boots?' (Nicknames are usually invented for the course.) 'I don't know, I had a right old session with the CFI this morning, he made me do just about everything. In fact I didn't think I was going to make it at one time but I got the hang of it in the end.' 'Did you see all those bounces the Professor made? I counted at least five, it looked like a kangaroo going up the field.'

The discussions between cadets are many and varied but the day's flying is usually the top subject, and on several occasions little whispers get back to the instructor—not all, I'm sure, but those that do usually concern some part of their training, and I for one have learned many lessons in this way which have helped me in my approach to teaching boys to fly.

It never ceases to amaze me how quickly these cadets get to know each other and weld themselves into a team. They are mostly of school age and their vocational choices cover a wide field: doctors, mechanical engineers, surveyors, school teachers—the list is never-ending. Some boys may even have a job already, perhaps as an aircraft fitter or garage mechanic. The fact remains that their sense of comradeship and adventure is brought out on a gliding course.

There is no doubt that gliding will involve days of hard work. There are always gliders to be retrieved; wings to be held up; cables to be attached, and many other equally tiring tasks, but one seldom hears moans or groans from these boys. The team spirit seems to come in with a resounding bang as they organise themselves into small parties to make their work lighter. As with most outdoor activities, a hard day's work or play in the fresh air makes the sight of bed very welcome, even though it may be hard, but after a good night's rest cadets surge onto the airfield ready for another day's flying and the ever constant thought—'I wonder how long it will be before I go solo?'

THE FIRST SOLO

There are at least two essential weather conditions before a cadet is permitted to fly solo: good visibility, and a wind speed of not more than fifteen knots. If these conditions exist and the instructor considers the cadet is up to the required standard, a check flight is carried out by the CFI or another instructor who holds an 'A2' category. The solo check usually takes between two and six flights, at the testing instructor's discretion; it is his responsibility alone to determine whether or not a cadet is ready for solo. He must satisfy himself that the pupil is able to cope with existing conditions with a high degree of safety. In some cases a few more circuits, stalls or cable-breaks are required before one can be sure that the pupil is ready to take to the air on his own for the first time.

The great day finally arrives. Mitchell (better known as Mitch to his colleagues) has finished his check flight and is receiving a quiet briefing from the CFI. The news travels like wildfire—'Mitch is going solo! Hope he makes better landings than he did first thing this morning.' Little groups of boys begin to gather near the launch point to have a quick natter about the first solo of the week, some hopeful that it may be their turn next for a check flight. But their discussions are short-lived. A stern voice from the control caravan, 'You lot standing there doing nothing! Go out and retrieve that glider!'

There is always a thorough briefing before a pupil is sent solo for the first time. He is reminded of his cable-break procedure, it is pointed out that because there is less weight on board, his aircraft may tend to lift off the ground a little quicker, and certainly he can expect to gain slightly more height from the launch. 'Don't forget to tap your altimeter and make sure that you turn in towards the airfield at the correct height' are usually the parting words of the instructor who has just finished his briefing and walked away from the aircraft leaving the pupil to prepare for his first solo flight.

There is bound to be a little nervousness or anxiety attached to a first solo, both on the part of the pupil and of the instructor; I always consider it to be normal if the pupil has a few butterflies in his stomach (little does he know that I have fully grown eagles in mine!).

With twenty-two dual flights to his credit (cadets are not permitted to fly solo under twenty flights unless they have previous power-flying experience) 'Mitch' is about to qualify for his ATC Proficiency award which means three solo circuits, one of which must be in the opposite direction, and of course his A and B certificates.

Everything is ready, the briefing is over and the instructor's vacant seat straps secured; a cadet is standing by waiting for the order from the pilot to attach the cable, thus supplying the motive power for the launch. The cadets nearby give a few words of encouragement and wish him the best of luck.

The now familiar cockpit check is carried out; controls, full and free movement;

instruments set at zero; spoilers, open and in line, closed and flush; release mechanism O.K.; straps tight and secure; 'All clear above and behind.' 'Cable on!'

All is ready but for the final words which will initiate the launch and set the pupil off into free flight. 'Take up slack'—the aldis lamp begins to blink its message from the control caravan to the winch driver at the far end of the airfield. The cable begins to move, slowly becomes taut: 'All out!'

The aldis lamp blinks even faster now, the cable becomes more taut, the glider starts to move forward, slowly at first but quickly gaining speed until, within ten or twenty yards, it lifts gently off the ground and becomes airborne.

Mitch remembers the drill, 'Stick gently back until I reach a safe flying speed, keep the wings level, check the yaw . . . I'm sure I'm climbing a bit too steeply. Stick forward a little . . . that's better. I bet the CFI nearly had kittens then.'

The glider is now climbing steadily away at an airspeed of about forty-five knots. It will soon be time to release the cable which will relieve the aircraft of its heavy load.

Near the top of the launch now, stick forward, pull the release and 'click' the cable is away; free and silent flight at last! Do I hear my irate instructor yelling in my ear, Get that nose up!? All is quiet and very peaceful. The funny part is all the butterflies have disappeared, and I didn't notice them go.

A turn to the left now, stick to the left and little rudder to the left. Gosh! Look at those tiny cars, never seem to have noticed them before. I wonder if all the people down there know I'm flying solo? Turn downwind now and head for home, mustn't forget to tap the altimeter, 500 feet. I wonder if I shall be able to get back to the launch point with the correct amount of height? 300 feet. It's getting near the turning point now, 200 feet turn across wind. Hello! the butterflies are back again, I must try to relax, this is the most important part of the circuit and I must try to put up a good show. 150 feet. Turn finals and straight up the field. There they are, the whole lot of them gazing up at me. I bet they wish they were up here.

All set for the landing now; keep it straight, wings level, hold off, and gently let it settle down. There, I don't think that was too bad. Boy! am I glad that's over! but at the same time I'm looking forward even more to the next one.

INSTRUCTOR'S VIEW

Almost before Mitch has touched down, the retrieving truck is on the way to bring him back to the launch point, and once there, it's congratulations all round. 'Well done, Mitch, how did you like it?'—the boys gather round eagerly.

It is an instructor's duty to watch his pupil's solo circuits with eagle eyes and make a mental note of any mistakes to be corrected next time. It is only after some years of experience that an instructor is able to analyse a pupil's flying from the ground, but then one can anticipate his every move, as if he were actually flying the circuit with him.

I am often asked by junior instructors, 'How do you know when a pupil is ready for solo?' I can only say that in my own case, apart from his flying capability—which of course should be competent—there is something else, a sixth sense if you like, which tells you that he will be able to cope.

Mitch is now anxiously awaiting his second solo flight and as his instructor approaches to give the necessary briefing, 'Hope I didn't put the wind up you too much on that one sir!' a sense of achievement is written all over his face. The next two circuits are over only too quickly and it is with reluctance Mitch leaves his aircraft after his third solo flight. There is no reluctance, however, in the way in which he carries on with his ground duties in order that his friends will the sooner qualify for their solo circuits.

The number of instructional launches required before a pupil is ready for solo depends largely upon his aptitude; some obviously learn quicker than others, but on average between twenty and thirty flights are necessary.

In any event, a cadet must complete at least twenty-five to qualify for his Gliding Proficiency Award. Those who do not qualify during the week's course owing to unfavourable weather conditions are invited to attend at week-ends in order to complete their training.

With good weather conditions during a week's course, all the cadets are likely to qualify for their Proficiency and usually receive somewhere in the region of forty flights each. There is sometimes the added thrill of elementary aerobatics, as a passenger of course, or if really lucky with the weather, a ten-minute soaring trip.

A gliding course is over all too quickly and it is not long before the last cadet has completed his three solo flights; it is only then that one begins to notice a few dismal expressions on the boys' faces.

There only remains the final parade in which the cadets receive their certificates from the commanding officer. This is usually of a formal nature, the boys giving their uniforms just that little extra attention.

It seems to have become the custom at Kenley for cadets to present the instructors with a small 'gift' as a mark of their appreciation for a week's gliding. It usually takes the form of a plaque made from scrap material and inscribed with the names of each cadet and the instructors.

Two such plaques have their place of honour in the school's headquarters. One is a red shield depicting an angel playing a harp on a cloud; the angel wearing a sash on which is written 'Instructor'; the caption reads: 'Their Lives in our Hands!'

The other shows even more their sense of humour; it was a lavatory seat inscribed 'To the Instructors and Staff of 615 Gliding School, Kenley'. An appropriate ending perhaps to this chapter.

Still glides the Stream, and shall for ever glide;
The Form remains, the Function never dies

WORDSWORTH

4 The Ever-Changing Sky

by C. E. Wallington

C. E. Wallington started his meteorological career in 1939, but after two years at Bomber Command stations, he was assigned as assistant to the Air Attaché in Lisbon, Portugal. After a short spell with RAF Coastal Command on his return to England in 1943, his RAF duties were mostly with Transport Command until being posted as a flight lieutenant to the Far East.

After the war his meteorological duties included aviation, press, lecturing and research experience, and for good measure he used some spare time to get a B.Sc. in mathematics and an M.Sc. in meteorology and aerodynamics. In 1956 he was invited to Canada to write a training manual for the International Civil Aviation Organization and in 1962 was awarded the L.G. Groves Memorial Prize for outstanding contributions to safety in aviation. His experience as a forecaster for gliding since 1956 and membership of the British gliding team enabled him to write a book on Meteorology for Glider Pilots *in 1961. Married, with two children, his hobbies are gliding and sailing, and as relaxation from his official duties as superintendent of a meteorological research division he edits the magazine* Weather.

A PAPER dart or toy glider launched in a room never flies for very long; apart from a few very short-lived aerobatics it always loses height. Out-of-doors the flight may be longer if the dart happens to be caught in local up-currents in the turbulent eddy motion which is almost always present in the wind. If a pilot flew a full-size glider in the still air of a huge cavern he, too, would come to the ground fairly quickly. Of course, with the aircraft under his full control he could carry out aerobatics if there were sufficient room, and he could steer it past obstacles before making a gentle landing on the ground. But, like the paper dart in a room, the glider would inevitably come to rest after a very short flight. In the open air a gliding flight is extended when the glider flies into some of the up-currents often present in the atmosphere, and the flight can be prolonged if the pilot searches out these up-currents and keeps his aircraft flying in them. The up-currents required to lift a glider are much bigger than the gusts and eddies which toss the paper dart about. The glider pilot looks for up-currents broad enough to circle in and strong enough to sustain his flight—this means that the air must be rising at more than about 180 feet per minute.

HILL LIFT

The most obvious places to look for rising air are the windward slopes of hill ridges. When air flows at about 15 m.p.h. or more up and over a steep hill ridge, its upward speed as it flows over the windward escarpment is usually sufficient to sustain soaring flight. This type of up-current is known as 'hill lift'. Seagulls soar in hill lift over the windward edges of cliffs, and condors keep flying with scarcely any movement of their wings in the same type of lift among mountains. Gliding clubs situated at hill sites in the British Isles include the London Club at the foot of Dunstable Downs, the Midland Club at the top of the Long Mynd in Shropshire and the Derby & Lancashire Club on Bradwell Edge in the Pennines. At these sites there are steep 200 to 400 feet escarpments several miles long. Turbulence and eddies in the wind at hill sites can be dangerous for inexperienced pilots but training is usually thorough and the technique of staying in the hill lift is basically simple to learn.

Of course, hill lift can be fickle. I remember being launched by 'bunjie' off the top of the escarpment at the Long Mynd into wind which must have been waiting for an unsuspecting meteorologist. Within seconds of the launch the wind veered about forty degrees so that its component up the slope was no longer sufficient to lift my glider above the top of the escarpment. For twenty minutes I soared to and fro in front of the hill while a growing crowd of club pilots gathered at the launch point to look down on me and voice comments or advice which, fortunately, I could not hear. The situation would not have been so embarrassing if I had not been due to brief these very pilots on how to use the current weather to set out on the day's gliding contest. But eventually I was forced to land in a muddy field at the foot of the escarpment—whereupon the wind backed to its original direction.

WAVE SOARING

For most pilots at hill sites a more exciting feature of airflow over mountains is the likelihood of 'lee waves'. Have you ever watched ripples in a shallow brook as the water flows over a submerged rock? The water rises over the rock, dips sharply on the downstream side and, if the rock is in the form of a ridge placed across the stream, the water surface will rise and fall a second, third or several more times downstream. The crests of the ripples form a series of bars parallel to the rock and, with the water flowing through them, these bars remain in almost stationary positions in the stream. Substitute an airstream for the brook, a mountain for the rock and we begin to visualize the form of lee waves in the atmosphere. In certain weather conditions, which are not uncommon, a mountain ridge can trigger off a wavelike motion in the airstream. This special type of motion starts with a strong flow down the leeward escarpment before undulating up and down in the lee wave pattern. The pattern itself is more or less stationary—the air simply flows through it. So in lee of a mountain ridge there are often alternate zones of ascending and descending air as the air flows up to the crest of each wave, then down to the trough.

The presence of lee waves is often betrayed by special forms of cloud. When air rises in the atmosphere it expands and cools, and if its temperature falls to the dew point of the air then some of its water vapour will condense and become visible as cloud. So when moist air flows up towards a wave crest it is likely to form cloud. On the downwind side of the crest the air descends and gets warmer—and the cloud evaporates as the air descends past its original condensation level. Thus, by a continuous process of condensation at the leading edges and evaporation of the trailing edges the clouds appear to be stationary in the sky. Clouds of other forms move with the wind, but lee wave clouds stay put with the wind blowing through them. Sometimes the wave clouds are isolated and shaped like almonds; sometimes they are in the form of long bars parallel to the upwind mountain ridge. In the Cross Fell district of the Pennines the local name of the wave cloud is the helm bar and local folk have a saying that 'The bar never crosses the Eden'. If you are none the wiser for this odd piece of information they can explain that the bar (of cloud) sometimes observed downwind of and parallel to the steep escarpment of Cross Fell usually moves very slowly downwind during the mornings, but, just as it seems about to cross the River Eden in the valley, it appears to change its mind and retreats back towards the escarpment. Thus 'The Bar never crosses the Eden'—and the meteorological interpretation of this saying was a useful clue in the complicated theory devised to account for lee wave phenomena.

The 'wave lift' in the rising air in lee wave flow often extends to very great heights. In the British Isles glider pilots have soared to over 15,000 feet in lee waves, and the world altitude record of 46,000 feet was attained by a glider pilot soaring in waves in lee of the Sierra Nevada range of the Rocky Mountains. Long-distance flights have also been made in wave lift. The distance between one crest and the next is usually between two and twenty miles; so when the wave train is well developed it is possible to gain height in front of one crest and then fly quickly downwind to the next crest where the height lost in crossing the belt of descending air can easily be regained.

One of the characteristics of lee wave flow is that the air is neither extremely smooth nor extremely rough for flying. Sometimes the air at heights below a few thousand feet is rough while that aloft is smooth, the transition between the two regimes being very sharp. Wave clouds in the rough low level flow are sometimes called 'roll clouds' because they appear to be rolling around a horizontal axis, and the flow is called a 'rotor flow'. Turbulence in such a flow can be violent. One of the gliders used in an investigation of lee waves in the Sierra Nevada region was broken up by such turbulence. The pilot's report read something like this: 'Suddenly there was a fantastic acceleration which threw me first to the left, then to the right, then held me down in my seat. I felt myself blacking out. Then just as suddenly as all this commotion started it stopped and I felt myself falling with something holding my feet.' The something holding his feet was the rudder bar. The rest of the aircraft had been torn from him. Fortunately for glider pilots most rotor flow is not as violent as this. Indeed, once one has climbed up into the smooth air, soaring in lee waves can be the most delightful and peaceful of all forms of gliding.

ANABATIC SOARING

Before leaving the mountains, mention must be made of a type of soaring that is practised in the steep valleys of Austria and Switzerland. When the sun shines brightly on a mountain slope the air close to the slope becomes warmer than the air at the same level over the valley and this causes air to flow up the heated slope. The upward flow is called an 'anabatic' wind and it is occasionally strong enough to support a glider in flight. In order to get the full benefit of the updraught pilots often have to fly very close to the mountainside, but for experienced pilots anabatic soaring is indeed an exhilarating sport.

THERMAL SOARING

Although hill lift, lee waves and anabatic winds make mountainous regions particularly interesting for the glider pilot, by far the majority of cross-country gliding flights are made over fairly flat countryside. Such flights are usually made on sunny days, often with the sky dappled with fair-weather cumulus clouds. Looking like puffs of cotton wool floating gently in the sky, these clouds are sign-posts to upward convection currents which glider pilots call 'thermals'.

To understand the mechanism of the convection current we need to know something about the way the air is heated on a sunny day. The sun's rays pass through the atmosphere almost without heating the air itself, just as they pass through the glass of a greenhouse without warming the glass. It is the ground which is heated by the sun's rays, and the ground in turn warms up the air close to it. Thus the air is heated from below by the ground rather than by the sun from above.

Some of this heat is spread upwards through the atmosphere by the turbulence and eddies almost invariably present in any wind, but when the wind is light or moderate the rate at which the ground warms the air close to it is greater than the rate at which the warmth is carried upwards by the general turbulence. Then, the air close to the ground gets warmer and warmer and before long bubbles of this warm air break away from ground level and rise into the cooler air aloft. These rising bubbles are the glider pilots' thermals. On a sunny day they are large enough and numerous enough for the glider pilot to use. To make cross-country flight, the pilot searches for a thermal which he can detect by means of clouds, his sensitive variometer, by the movement of his glider, by feel or by watching other gliders in the air. He then tries to gain height by circling in the rising air. Between leaving or losing one thermal and finding the next he increases his flying speed to cover as much ground as possible for the minimum loss of height.

An elementary but inadequate concept of a thermal is to regard it as a blob of buoyant air which breaks away from a particularly warm patch of ground and is quickly organized into a more or less spherical bubble—in much the same manner as a drip of water falls from a wet ceiling. But the air motion within a thermal resembles that of a vortex ring; that is to say, it is like a ring of air which is continually turning itself inside out. The inside, or core, of the thermal rises faster than the outside and when a pilot locates this core he has a good chance of climbing towards the top of the thermal and staying there. He is carried up in the centre rather like a ping-pong ball being kept up by a jet of water. Without this vortex ring motion, glider pilots could seldom stay for more than a few seconds in the bubbles of buoyant air which go to make up small cumulus clouds. These cumulus clouds are formed when the air in the thermals rises high enough for the cooling by expansion to cause condensation of the water vapour in the thermals.

Fresh winds can distort the thermals and make them difficult for the glider pilot to use, but occasionally such winds tend to organize the thermals into long lines or 'streets' running along the wind direction and a few miles apart. When such streets form, the pilot can often fly along them confident that thermal lift will be plentiful, but he also knows that in the spaces between the streets there are likely to be strong downdraughts as air descends to take the place of that rising under the streets.

DRY THERMALS

In some types of weather situations, and especially in anticyclonic conditions, air at heights above a few thousand feet tends to sink or subside very slowly. As it subsides it warms up, and, because bubbles of warm air will not convect upwards into even warmer air, this subsiding warm air acts as a lid on thermals which rise from ground level. Often these thermals cannot rise high enough to form cumulus clouds—and they are known as 'dry thermals', or sometimes 'blue thermals' because they are associated with blue skies. If these thermals extend up to about 3,000 feet, they usually provide lift enough for cross-country soaring, but if the subsidence limits the depth of thermal activity to 2,000 feet or less, prolonged soaring is difficult, especially as such conditions are often accompanied by thick smoke haze.

Some years ago the name 'evening thermals' was given to lift which appeared to develop during occasional evenings at some sites, but it now appears that this evening lift was usually due to lee wave formation which is often at its best for a short spell at least during evenings when conditions are generally favourable for lee waves.

THUNDERSTORMS

If the airstream aloft is cold enough, bubbles of relatively warm air from ground level may ascend to many thousands of feet into the atmosphere and produce towering clouds whose cauliflower shaped tops give the impression that the cloud is boiling over. At this stage the cloud tops are often at levels where the temperature is well below the freezing point of water, and when millions of water drops in the cloud freeze the cloud takes on a new look; the hard cauliflower top changes to a flat-topped structure with fibrous-looking sides. The top is often stretched out by strong winds aloft and takes on an anvil shape when viewed from afar. This is the type of cloud which usually produces heavy showers, hail or thunderstorms. Air motion within the cloud is rather chaotic. Glider pilots fly in such storms but naturally they are cautious. Turbulence is often encountered. Ice forming on the glider can cover the windscreen, jam the controls or destroy the aerodynamic efficiency of the aircraft. Sparks, known as St Elmo's Fire, flash between the instruments; pilots themselves have often received electric shocks and gliders have been struck by lightning. This sort of experience is not necessarily dangerous, but it is, of course, very frightening. The glider pilot's main worry in a storm is hail, which may ruin the beautifully smooth wing surfaces that make high performance gliders so efficient.

The strong up-currents in thunderstorms can help glider pilots to climb very quickly. Pilots have climbed at 2,000 feet/minute and more in these large convection clouds. They have also been thrust downwards, for these storms can generate strong downdraughts, too.

Sometimes these downdraughts are persistent; the descending air goes right down to ground level whence it spreads out along the ground as a flood of cold air. Such a downdraught can be dangerous to pilots (of powered aircraft as well as gliders) because it produces sharp wind changes at low levels; a pilot making an approach to land may find the wind at, say, 200 feet above the ground is being undercut by the cold air flowing from a different direction.

LINE SQUALLS

However, the downdraught effect does produce a bonus for the glider pilot. Sometimes the cold air spreading out acts as a wedge forcing the air in front to rise—thereby triggering off more upward convection currents. Storms sometimes become organized into lines across the wind direction and propagate themselves across the countryside in this fashion. Downdraughts from the storms produce sharp squally wind changes, the whole configuration being known as a 'line squall'. The wedge-like action of the cold air also produces a belt of rising air along which the glider pilot can soar—if he happens to be in the right place at the right time.

SEA BREEZE SOARING

We are all told at school that on a warm sunny day the air inland becomes warmer than the air over the sea and air begins to flow from the sea-shore inland. The explanations given are oversimplified in many textbooks, but the fact remains that sea breezes do tend to blow inland during warm sunny days. It is not at all uncommon for a flow from the sea to converge with air from well inland along a line inland of and parallel to the coastline. The converging air then rises, sometimes at speeds of more than 200 feet/minute, which is sufficient to support a glider in flight. The belt of 'sea breeze frontal lift', as it is called, is narrow and down-draughts exist on either side, but the glider pilot often has visible guides to the rising air in the form of a line of cumulus clouds. Smoke from bonfires can also be a guide to the sea breeze frontal lift; from the air the smoke plumes can be seen converging towards the belt where the sea breeze meets the flow from the land. Yet another indicator of this sea breeze effect is occasionally present in the form of a tattered curtain of wispy cloud in the belt of rising air. Although we associate sea breezes with warm sunny days, a well-developed sea breeze usually continues to move inland until well into the evening and glider pilots have been able to remain airborne in long belts of rising air until after 8 p.m. on some summer evenings.

'LIFT' DETECTORS

Naturally in gliding there is an eternal quest for a technique or device for locating 'lift' in the air. At present pilots rely on experience plus somewhat sketchy theories on thermal structure and thermal sources, but there are always a few pilots who try to supplement their skill and experience with experimental instruments for thermal detection. Some experimenters have designed devices for measuring temperature or humidity differences between the wing tips of a glider, the argument being that thermals should be warmer and moister than the surrounding air and that a turn towards the warmer or moister wing tip would take the aircraft into the nearest thermal. Measurements of electrical potential in the air at the nose, tail and wing tips of a glider have also been made in attempts to locate thermals. However, it appears that whatever temperature, humidity or electrical potential differences there are, they are usually small and difficult to measure and their linkage with thermal lift is still very obscure. Some time ago I had the opportunity to fly a glider equipped with electrical potential measuring apparatus and other devices. The instrumental display was fascinating—but I seemed to arrive at the ground quicker than usual.

Birds can be useful guides to thermal lift. If you see a bird climbing or maintaining height without flapping its wings then it must be in rising air. Swifts or swallows can also be useful indicators because they usually hunt for insects carried aloft by rising air. Thermal streets have been marked by radar echoes from swifts; in fact, radar echoes in the form of lines or arcs puzzled radar operators until a telescope coupled with a radar scanner brought into view hundreds of swifts, hunting insects, carried up in a line squall.

FRONTS AND DEPRESSIONS

Soaring conditions occur only when the weather systems bring just the right winds, temperatures and clouds. In most temperate regions the principal systems are depressions, or low-pressure systems and anticyclones, or high-pressure systems. Although the weather can vary considerably throughout any one system, depressions are usually associated with cloudy and rainy and changeable weather and anticyclones with more settled conditions. The depressions usually harbour fronts which can be loosely described as boundaries between distinctive air masses. A warm front is said to mark the boundary between warm air following a cold mass; a cold front delineates a warm air mass from a following cold flow. In the British Isles warm fronts often bring too much cloud or rain to allow thermal soaring conditions to develop, but the wind ahead of a warm front is often suitable for lee waves.

Cold air often brings showery conditions with large convection clouds, but the best cross-country soaring conditions are often found on the outskirts of anticyclones provided the wind is not too strong.

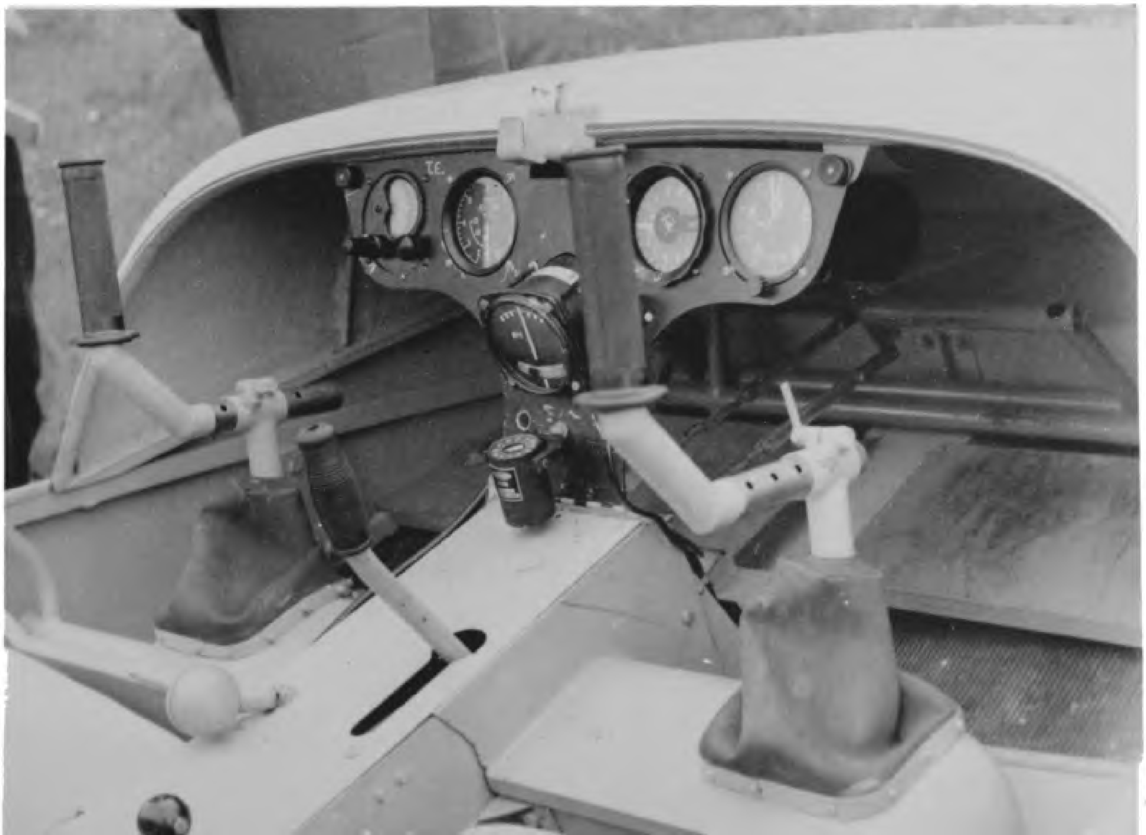
WEATHER FORECASTING FOR GLIDING

No other sport is so interwoven with the ways of the weather as gliding, and most experienced glider pilots acquire considerable weather wisdom. They know that if they fail to interpret weather signs correctly they will either waste soaring opportunities or endanger themselves and their aircraft. They also know the limitations of guessing the coming weather by merely looking at the sky. The advice of the professional meteorologist is in great demand, particularly at gliding championships. During a championship, flying tasks for competitors are set each day according to the meteorologists' predictions. As well as trying to predict the types of lift already mentioned, he tries to discern patterns of cloud and visibility on up-to-date hourly charts covering the whole country. He uses gas-filled balloons to measure the winds aloft, and he has an aircraft at his disposal to make local temperature soundings up to several thousand feet. The exchange of information between forecaster and pilot is, however, a two-way traffic; glider pilots are not only keen to receive the meteorologists' advice, they are also ready to pass on to him countless snippets of information they acquire as they explore the maze of weather phenomena.

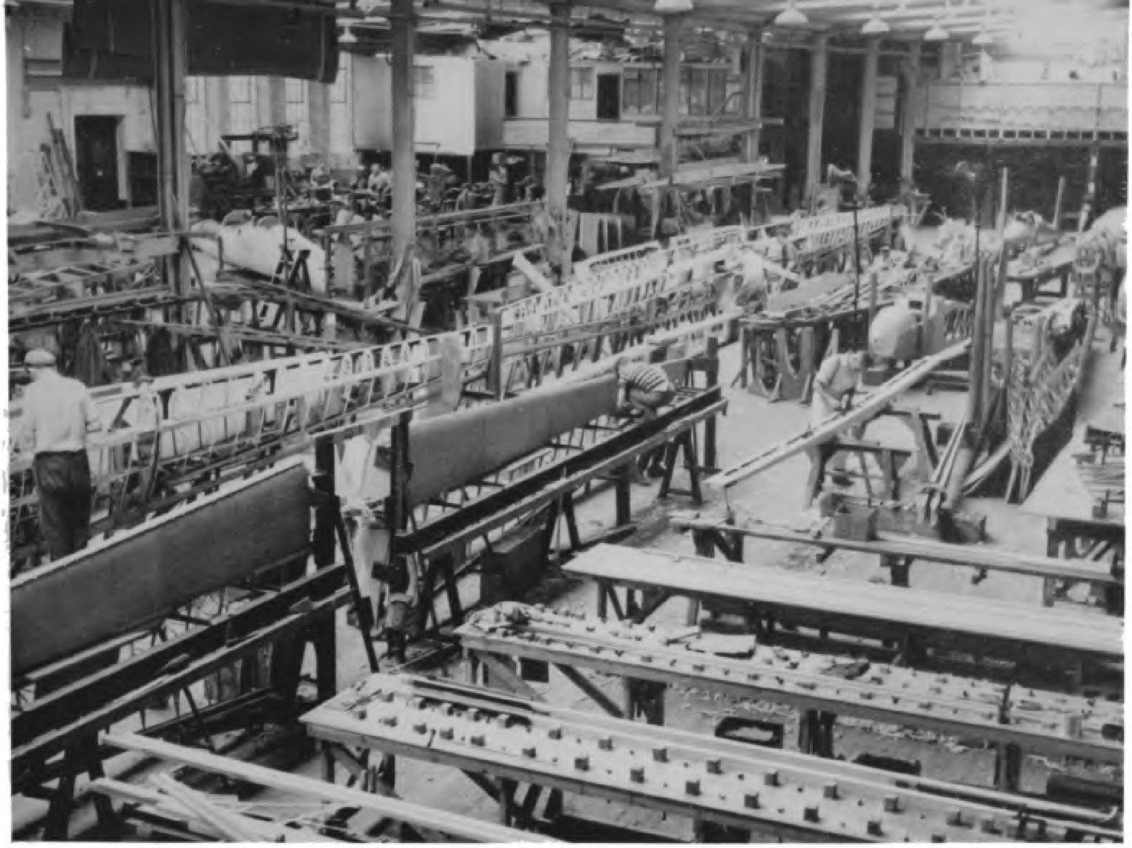
Instrument panel: Cadet Mark III

Instrument panel: Skylark 4

Instrument panel: Slingsby T49



The Slingsby T49 Advanced Trainer (photo: Charles E. Brown)



The main shop of Slingsby Sailplanes Ltd, showing Skylark, Dart and Swallow wings under construction (photo: Alex Watson)

F. N. Slingsby explains to Richard Serjeant a detail of the canopy for a two-seater Sailplane, the T49 (photo: Alex Watson)

A moulded Perspex canopy for a Skylark 4 being fitted up by an expert in moulding technique (photo: Alex Watson)

A Skylark 4 fuselage in the fitting-up shop (photo: Alex Watson)

5 Higher Degrees

by Ken O'Riley

Ken O'Riley first started flying as a pilot with the Royal Air Force in Africa in 1941. Later he took up gliding with the Air Training Corps and assisted in forming 148 Gliding School at Southend.

In 1949 he was transferred to Royal Air Force, Detling, and took command of 168 Gliding School later that year and remained with this school until it was disbanded in 1955.

In 1956 he assisted in reforming the pre-war Kent Gliding Club at Detling and was chief flying instructor until 1959, when he left and joined the Surrey Gliding Club at Lasham, and later became chief flying instructor.

THE FIRST steps in gliding are learning the effects of the controls, becoming familiar with the techniques of take-off, level flight, simple turns, approaches and landings, and learning to plan each flight so that a landing is made, from a safe approach, at the point intended. These are the elements, and can be learned in quite a short time. The next stage introduces the factor of 'lift', the student experiencing the effects of a rising current of air. He will also meet more efficient aircraft and begin to handle them much more accurately.

THE C CERTIFICATE

The goal is, of course, the achievement of true soaring flight, that is, taking advantage of the meteorological conditions described in Chapter 4 and thus extending flying time, altitude, and distance flown. After the first two hurdles in gliding have been overcome—the A and B Certificates—the object of all clubs and centres is progress with soaring flight, and the first move towards it—the C Certificate—involves a flight during which height is gained or maintained without loss for a period of at least five minutes.

Certificates after that rise in a progressive series:

The Silver C requires

(*a*) DURATION.—A flight of not less than 5 hours.
(*b*) DISTANCE.—A flight of not less than 50 kilometres (31·07 miles) made in a straight line (amended from 1st January 1964).
(*c*) GAIN OF HEIGHT.—A flight with a gain of height of not less than 1,000 metres (3,281 feet).

The Gold C requires

(*a*) DURATION.—A flight of not less than 5 hours.
(*b*) DISTANCE.—A flight of not less than 300 kilometres (186·42 miles) made in (*a*) a straight line; (*b*) a broken line of not more than two legs, one pre-declared turning point, no minimum distance imposed for either leg; (*c*) a triangle of which the shortest side must measure at least 28 per cent of the total distance: the turning points must be previously declared; (*d*) Goal and return.
(*c*) GAIN OF HEIGHT.—A flight with a gain of height of at least 3,000 metres (9,843 feet).

The Diamond C requires

(*a*) DISTANCE.—A flight of not less than 500 kilometres (310·7 miles) made as under Gold C distance (*a*), (*b*), (*c*) or (*d*).
(*b*) GOAL FLIGHT of not less than 300 kilometres (186·42 miles) made as under Gold C distance (*a*), (*b*), (*c*) or (*d*), but a landing at the declared (final) goal is compulsory.
(*c*) GAIN OF HEIGHT.—A gain of height of not less than 5,000 metres (16,404 feet).

It will be noted that if a triangle is attempted but failed, even if the 300 or 500 kilometre distance has been exceeded, the task will not have been achieved since more than two legs will have been flown.

These certificates are indications of achievements rather than levels of competence, and in this way they differ from the various powered aircraft ratings of Private Pilot's Licence through to the Instrument Rating required for Airways flying.

At the end of this book there is a list of clubs and centres where the art of soaring can be learned. Each will have dual-instruction aircraft, suitable launching equipment in the form of winches or cars, or both, and probably facilities for 'aero-tows' by powered aircraft; there will also be skilled instructors, and of course endless opportunities for talking and arguing about the many problems of gliding and soaring flight. The aircraft themselves vary from simple robust ones suitable for early training to high-performance two-seater sailplanes such as the T.49 shown in Plate 17. The people you meet will be the instructors, the administrative staff, other students, and some very experienced pilots, who may have aircraft of their own. You will find them a remarkably dedicated and unified body of people, invariably full of helpful advice for the new member.

CLEAN FLYING IS THE AIM

Let us assume that someone joins our centre, having already got his A and B certificates, and tells me he wants to learn soaring flight. We discuss it at some length; I find that he has read a good deal about the theory of it, and on the whole he doesn't really think that he will have any special difficulty. I have heard this before, but suggest we go up and try to find some lift; this will give me the opportunity of finding out just how accurately he can fly, because a great deal depends on this.

Now this chap may have done a total of about forty launches, and not long gone solo. Without any doubt we shall have to go right back to the circuit stage and try to find out if his flying is acceptable, rough and safe, or plain suicidal. What most people don't realize is how extremely accurate one's flying must be before any soaring is attempted. It really is a complete waste of time to try to soar unless you are a very proficient pilot, and a great deal of time is spent initially on training people up to the standard of flying necessary. The trouble is that people imagine they are flying well just because they can get round a circuit and make a good landing, but what we are aiming at is really *clean* flying.

The manufacturers take a lot of trouble to make sailplanes clean in their lines and extremely sensitive to their controls, and we just can't have people jerking on these controls and wasting those clean lines. It is by no means easy to fly cleanly and it takes a considerable amount of practice. I would say that only a very few people have a natural aptitude for it, although most can learn to do it in time. When I had done 159 hours and had really been trying hard with my flying I went to Germany for a fortnight's course. The Germans set a very high standard of accurate flying, and it was only in the middle of the last week that I was let loose on something more exotic than a Grunau Baby.

The vital part of this clean flying is the ability to make really accurate turns. I do find people who have been flying for years yet still turn badly. Power pilots are often very sloppy about their turns; they don't seem to worry at all about a little slip, or having their nose up a bit, and this kind of flying is just no use to the soaring pilot. You *must* be able to start and stop these turns exactly when you want to, without a suspicion of slipping or skidding. You must be able to make really tight accurate circles, not something which turns into an oval. For an average thermal you want to get round a 360-degree turn in 20 seconds, and for a small thermal it might be 15 seconds. Some of you know that the ordinary 'Rate One' turn used in powered flight for instrument patterns takes 120 seconds; by comparison a 15-second turn seems positively aerobatic, and what's more it may have to be maintained for minutes on end. This takes a great deal of practice, and the trouble is that people are so anxious to get some soaring experience that they just don't want to spend ages practising turns, so when they do find a thermal they can't stay in it.

You may think I am over-emphasizing this business of accuracy, but our experience as soaring instructors is always the same; our aim is to get a pupil to the highest standard of flying we can, and impress on him that he alone, by constant practice and never wasting flights, can raise his standard of flying to the required level. Every flight should have some specific purpose, whereas a large percentage of pilots waste almost every flight. You really do have to spend a lot of time practising accurate flying, and a good time to do this is in the winter. The experience gained will repay you handsomely. When you can keep going round and round these 15-second turns at an even rate of knots, and then come out on a precise heading, without a trace of slip or skid, you will have no difficulty with 'thermalling'.

KNOW YOUR SITE

Gliding sites vary considerably in the amount and type of lift available. On the whole, the less rich the site in 'lift'-providing features, the more skill and accuracy is required of the pilot, but he does need some encouragement and it is normally an advantage to fly at a good flat thermal site with first-class winch-launching facilities. Other sites will provide lift for ridge soaring, and there are one or two fortunate sites offering ridge soaring, lee wave soaring and also good thermal activity. At sites near the sea, the period of thermal activity is often limited by the sea breeze, which brings stable air inland, but the front, usually marked by a line of cloud, at the junction of this stable air and the warmer air over the land mass, is very active and fine soaring flights can be made in it.

To be able to find thermals, it helps considerably to have knowledge of the geographical features surrounding your airfield, and by far the best way of getting this knowledge is to fly around with a good map until the features are fixed in your mind.

There is certainly no doubt about the effect that a first soaring flight has on a pupil. He gets desperately keen, reading everything he can lay his hands on, and talking to everybody. However, it is difficult for him to relate all these bits of information, because until he has had quite a lot of practical experience with a good instructor, he can't integrate everything in his mind and make that rapid, almost subconscious, decision to 'go over *there* for the best lift'. It is definitely a matter of understanding the theory, and then applying this continually under varying conditions and combining this with very accurate flying.

Now that aero-tows to 2,000 feet or more are available at most sites, it is easy, given suitable conditions, for a relative beginner to find a thermal, and even stay in it long enough to gain a bit of height. Having achieved this, the inexperienced pilot is inclined to feel that he can now soar and should therefore be sent off on a cross-country flight without further delay. It is a great mistake to think that soaring can be learned in this, or any other easy way. Unfortunately it is necessary to make a number of mistakes, and then to realize you have made them and not make them again. This doesn't mean bad mistakes, which are even more undesirable now than they were when aircraft were a lot cheaper and less complex, but it certainly includes all the tactical errors you can make when hopping from thermal to thermal at a safe height.

NO SHORT CUTS

I do not think you can master this soaring business until you have realized it consciously a number of times under different conditions with a qualified instructor who is used to it and can put you right if you do anything wrong. In the end you will integrate all this experience subconsciously and will find yourself doing the right thing without thinking about it. There are no short cuts to really satisfying soaring flight, it is quite a hard grind. The shortest way of achieving it is to make sure that every single flight serves some specific purpose, and if you can't do anything else, you can always go up and practise those turns.

What makes a good soaring pilot?

It is a combination of hard work, good theoretical knowledge, sheer experience, accurate flying and a touch of cunning. (The cunning pilot is the chap who joins someone else's thermal.) One must also admit that quite often finding a thermal is purely a matter of luck, especially those dry thermals without a cloud to indicate their existence (see Chapter 4).

The question of entering cloud is a very important one. On the Continent it is prohibited, but in fact a great deal of extra lift can be gained if you know what you are doing. At cloud base the temperature of the rising air has dropped to the point where the water vapour content condenses, thereby giving up the heat it originally took to evaporate. This keeps the temperature constant until all the water vapour has condensed, but as the outside air temperature continues to drop with height, the strength of the convection increases and therefore as cloud is entered, the strength of the lift increases. It is possible to reach great heights in this way, but there are two very important points about cloud-flying. The first is that it is illegal on airways, quite apart from the obvious danger. Secondly, it is quite impossible without at least one gyro instrument—usually a *turn and slip indicator* and preferably an *artificial horizon* as well. These are, of course, in addition to the normal basic instruments carried in a modern sailplane, namely the *airspeed indicator*, *altimeter*, *variometer*, and *compass*.

In addition to these instruments, an increasing number of gliders now carry radio, and for competition flying two-way radio is essential. Modern radio equipment for gliders is transistorized and very light. There are two frequencies allocated, 129·9 and 130·4 mc/sec.; thus a pilot is enabled to keep in constant touch with his retrieving crew, so that they can follow the glider and find him when he lands. It is necessary to have an R/T Licence for the operation of this installation, and application should be made to Radio Services Department, General Post Office, H.Q., St Martins Le Grand, London, E.1.

INSTRUCTOR AND PUPIL

I should like to say something about the relationship between an instructor and his pupils, and it must be obvious that I am now speaking in a very personal way. I am often asked if I can assess a pupil's ability accurately from first impressions. The answer to this is 'Usually, yes', but there are exceptions. I may fly with one or two people one day and gain an impression that has to be modified considerably at a later date—perhaps after a dozen flights. Our big problems are over-confidence and under-confidence. It is usually not too difficult to deal with over-confidence—

we just give the pupil something quite difficult to do—but under-confidence requires perseverance on the part of the instructor.

At one time we had a young girl pupil who was very under-confident and nervous. Her whole attitude towards gliding was one of extreme caution, but nevertheless she was very keen to fly and finally after much perseverance she went solo at about the 150-launch mark. Some three years later she came to see me and said she was thinking of joining a syndicate to purchase a sailplane and did I think this was the right thing to do, at the same time adding that she had no intention of going on any cross-country flights. I gave her a flying check in the Eagle, which includes spinning and other aerobatic manoeuvres, and decided that not only was she a very capable pilot but would be perfectly able to attempt a cross-country flight. I told her this, but also said that if she had no particular desire to do a cross-country she should not let other people bully her into it. I lost touch with her again for some time, and then one day she came up to me dressed in a very smart flying suit and looking very brown, and told me that she had just come back from Norway where she had completed her Silver C and indeed had only missed her Gold height by about 1,000 feet.

At the other end of the scale I had a pupil who was a perfect pest. He came to me having learned to fly at another club and now he wanted to soar and to instruct. His flying was anything but good, and after he had put up a number of 'blacks' I finally had to stop him flying. However, he came back to it after about a year, and later went to France holding a C certificate with a total of about twenty hours' flying. Within a very few launches during the first week in France he managed to get some wave-lift which shot him up to 20,000 feet, and in fact he proceeded to collect his Silver, Gold and Diamond heights all on this one flight.

Another question often asked is how long it takes to get the various certificates, and it is almost impossible to answer this one except in the most general terms. At Lasham we present each pupil with Flying Cards during his training. The first of these might be earned after only about twenty solo launches and perhaps two or three aero-tows; he gets a thorough check in a high-performance two-seater, and if this 'acceptance check' is satisfactory he is given a Red Card. When he has done thirty or forty hours' flying and is getting near the stage of being able to go on a cross-country flight he gets a Yellow Card, which indicates a very high standard of accurate flying. This Yellow Card is not, however, endorsed for cross-country flying until all the landing exercises have been completed; this means anything up to fourteen difficult landings on the airfield over obstructions and in some cases in nearby fields as well. There is no better way of letting a pupil prove to himself that he is able to judge height and distance well enough to get his glider into a small field if necessary. The clubs are indeed very conscious of their responsibility for looking after the safety of individual members. In my own club I will not let anyone go on cross-country flights unless I am certain to the best of my ability that he is capable of making a safe away-landing. There must be no chance about it.

An instructor has an enormous responsibility to be certain that his pupil is fully trained for what he sets out to do. I sometimes think when I'm training that my standards may be fixed higher than is necessary, but at least I do know that when my pupil selects a field in which to land it will almost certainly be a lot bigger than the field for which he has been trained.

Gliding has changed a lot since the old days. The would-be daredevil is no longer welcome and it caters for all age-groups of both sexes. There are many thrills to be had from straightforward soaring flights above and around one's own airfield without taking unnecessary risks.

WHAT IT COSTS

Finally, a word about costs. The average club subscription would be 7 to 8 guineas a year. Entrance fee, 4 to 5 guineas. Initial instruction varies from 6s. for each winch launch. Very few clubs would get a pupil off solo in less than fifty launches, at which point he will gain his A and B certificates—a total cost of very roughly £15. After that, it depends very much on individual aptitude as regards the time necessary to reach the cross-country stage, but instruction on a high-performance two-seater will cost about 15s. an hour, plus launch fee, while the charge for a modern high-performance single-seater might be 15s. to £1 an hour. Aero-tows usually cost about £1 to 2,000 feet.

If you get really dedicated you will begin to think about buying a glider of your own, and this will mean special arrangements for hangarage, service, transport and retrieving from away-landings. Many of these aircraft are owned by syndicates, which of course considerably lowers the cost to individual members. The problem of *accommodation* at gliding sites during gliding holidays or for the ten to fourteen day period of a championship is often solved by the use of caravans, either rented or privately owned. Renting a caravan at a gliding site costs between 10 and 15 guineas a week.

6 Making Gliders
by F. N. Slingsby

Frederick Nicholas Slingsby was born in Cambridge on 6th November 1894, of Yorkshire parentage, a member of the family of Yorkshire Slingsbys, one of the oldest families in England. He served in the Royal Flying Corps from March 1914 to February 1920, and was awarded the Military Medal for bravery during aerial combat, 'when as a flight sergeant acting as a gunner observer on photographic reconnaissance over hostile territory, after his pilot had been killed, he regained control of the aircraft and flew the machine back to the British Lines'.

He has been a designer, manufacturer and pilot of glider aircraft since 1930; his first sailplane was awarded the Wakefield Trophy in 1932. From 1930 to 1934 he made his gliders in his furniture works at Scarborough. He later transferred to Kirbymoorside, and founded the company of Slingsby Sailplanes Ltd in 1938 with Major J. E. D. Shaw, J.P., T.D., as chairman, and himself as managing director and chief designer.

He was elected an Associate Fellow of the Royal Aeronautical Society in 1943, and a Fellow in 1958.

Fred Slingsby was awarded the Paul Dissandier Trophy by the Federation Aeronautique Internationale in 1958, and the British Silver Medal for Aeronautics, for 'practical achievements in the design and construction of sailplanes', by the Royal Aeronautical Society in 1962.

I GOT into the gliding business the hard way; in fact one could say I was forced into it. Early in 1930 the British Gliding Association was formed with offices in London; very soon there was a clamour for information from enthusiasts throughout Britain. I, and a few ex-RAF types, founded the Scarborough Gliding Club in the early spring of 1930. The local press gave us quite a lot of support and in a few weeks we had an astonishing list of members all eager to glide.

The same sort of thing was happening in nearly all the large towns of Britain; I doubt if more than fifty people in the country had any experience of flying a glider or what a glider was capable of but by the end of 1930 over 100 clubs had been formed.

To satisfy the insistent clamour for gliders, the BGA Council persuaded Mr R. F. Dagnal of the R.F.D. Co. of Guildford to build a number of primary machines to blueprints supplied by the American Gliding Association. These prints were readily available for 25s. per set of five sheets and clubs were advised to make their own gliders, but very few had either the facilities or the inclination to do months of woodwork, especially when the R.F.D. Co. offered the complete aircraft for the modest sum of £55 ex works. So the Scarborough Gliding Club ordered a Dagling from R.F.D. Co., then occupied the waiting time for the delivery by holding numerous meetings and social events to raise money to pay for it. We appointed as chairman of the Scarborough Gliding Club an energetic hotel manager with very vigorous ideas. His hotel was one of the high-class establishments in the centre of the town, so our numerous meetings were very popular and well attended. I was appointed honorary ground engineer and instructor, because of my years of service with the RFC and RAF. Moreover, I was a partner in a furniture works in Scarborough and so had skilled woodworkers and workshop facilities; that fact alone seemed to be very important to the other club members, because news was seeping through from clubs already actively engaged in attempting to glide, that frequent minor repairs were to be expected. That I found, was the understatement of the year.

WORKSHOP REPAIRS

The R.F.D. Dagling glider arrived in due course and I 'hopped' it on the moors near Scarborough. The next day numerous other club members, eager to have a go, each tried hard to get a better performance than his fellow, and the consequences were inevitable. We took the pieces back to Scarborough and dumped it in my workshop. Very little furniture was made for the next few days. However, I was the honorary ground engineer; the club had to be kept going, so somehow or other we always managed to patch up the primary in time for the next week-end, and a smashing time was had by all except myself. There was, of course, a limit to what could be done in an honorary capacity; with some reluctance I had to make a charge for repairs, however modest. Thus I got into the gliding business. After a few months my workshop staff practically rebuilt that blessed glider many times; nevertheless it was interesting if not profitable work.

Nineteen-thirty was the year Amy Johnson did her epic solo flight from England to Australia. On hearing of her safe arrival our club chairman immediately cabled an invitation to be president: she replied, 'honoured to accept'; we then became an important organization in Scarborough. Town councillors thought up ideas for an official reception on her triumphant return to Britain; it was to be a great feature. Flushed with this successful coup, the committee asked the BGA to organize a soaring demonstration in Scarborough by German experts in the late summer. The BGA responded by sending along Robert Kronfeld who selected the Castle Hill for the soaring site.

In due course Robert Kronfeld and Carli Magersuppe turned up with their beautiful sailplanes; the wind roared up the north-west slope of the Castle Hill; the sun shone and that same afternoon the German Graf Zeppelin airship cruised in the air off the Scarborough coast. This was quite a coincidence but it added to the tremendous attraction of the day, and the club got the credit for the extra bit of publicity. Unfortunately, the first launch taken by the German, Magersuppe, was disastrous. He struck the wooden fence with his port wing-tip as he was launched over the cliff. He rose into the strong updraught for about 100 feet, but turned and flew over the crowd, to put down into the sea off the Marine Drive. The sea was very rough; a fishing boat fished him out and towed back the remains of his once magnificent Professor sailplane. We dried him out and in a surge of goodwill appointed him professional instructor to the club, on the spot, at a salary of £10 per week; quite a nice sum in those days.

Carli Magersuppe was a clever lad about twenty-two years of age. He certainly was an excellent sailplane pilot; moreover he had also been given intensive training in the repair and maintenance work of gliders, in Germany. I allowed him to use my workshops for his numerous repair jobs in the months that followed. But I was getting bored with so much crashing; business was frequently upset by the confusion of glider repair work.

MY FIRST SAILPLANE

During the winter of 1930, we invited Gunther Groenhoff, a highly skilful German gliding expert, to visit the club; he spoke excellent English, so I had an opportunity of discussing the prospects of building a sailplane for my own use. It was evident that the frequent hops on the weary Dagling would not satisfy my ambition to soar. I asked Groenhoff what he thought of the Prufling, a German intermediate type. He advised me to get the blueprints of the German Falke which, he declared, was just what I wanted but was perhaps rather more complicated to build. I bought the prints of the Falke from the German Aero Club: a garage owner and member of the club made the metal parts and the job was completed in the spring of 1931. It was beautiful to behold. As soon as conditions were suitable my garage friend and I, together with wives and a group of 'well-wishers', took the sailplane, now proudly named 'British Falcon' (and why not indeed?) to a hill top near Levisham Moors about twenty miles from Scarborough. I was catapulted over the brow of the hill by a launching team of school children, and in great triumph soared along the hill at a height of 200 feet, backwards and forwards for just over twelve minutes. Coming in to land, however, was fraught with peril, but land I did, quite safely. Then my garage friend took his turn; he was, incidentally, a power pilot and had done some good flights on our primary glider: he seemed a likely chap for flying the Falcon. After a short beat along the hill top he stalled on a turn and nosed straight into the heather. It was indeed a shocking sight for wives to witness. However, apart from a sore back and a few bruises my friend was quite serviceable; but the Falcon was a sorry sight.

AIRSPEED LTD—AND NEVIL SHUTE

We repaired the damage in our works in about three weeks; my men were now quite skilled in glider work and in fact rather preferred it to furniture making. Like a good sportsman, my garage-owner friend paid in full for the cost of the repair work; but he completely lost all interest in gliding and took to sailing. I teamed up with a York chemist, J. P. Watson, who had also built a glider, and together we visited many moorland sites looking for a suitable place for regular week-end flying. It was during this period that I met a team with similar aims. A firm had been started in York under the name of Airspeed Ltd, the chairman being Lord Grimthorpe. Alan Cobham, Hessel Tiltman and N. S. Norway were directors. They had designed and built a sailplane which they had named the Airspeed Tern and were looking for a site with the aim of putting up a speed record for a British sailplane. We found a good site on the northern slopes of the Cleveland Hills, which we knew as Ingleby Greenhow, and a Major Petre flew the Tern and made some modest record flights, details of which have escaped me for the moment. But it was on this occasion that I qualified for my C certificate. Major Petre, as an official Royal Aero Club observer, was able to witness my flight and sign the application form. The Airspeed team and my York friends and I had many happy meetings at Ingleby Greenhow. N. S. Norway later took up writing as a career under the pen name of Nevil Shute. Many thousands of people must have read his absorbing novels.

All this activity brought me into some prominence in gliding circles. Friends went to great lengths trying to persuade me to sell my precious Falcon, but I was enjoying my flying too much to set about building a replacement.

FALCONS FOR A FRIEND

In the autumn of 1932 the BGA held a gliding competition at Ireleth in the Furness district of Lancashire, the home of the Furness Gliding Club. I took my Falcon, with the assistance of my York friends. Conditions were very good for a day or two; I received four or five awards for the performance I was able to put up with the Falcon. A leading member of the London Gliding Club, Mungo Buxton, borrowed my sailplane and made a record cross-country flight of thirteen miles to the northern shore of Lake Coniston. The BGA awarded the Falcon the Wakefield Trophy for this flight. During the meeting I had the very good fortune to meet Charles Espin Hardwick, a Birmingham stockbroker, whose greatest ambition was to pilot his own glider as he had seen people fly at Ireleth that week. Espin was a most charming personality; by the end of the Ireleth Meeting I had promised to build him a Falcon. That was the start of many years of a beautiful friendship; he kept his Falcon to the end of his days. After his death (he was always delicate), I learned that he had left the Falcon to me in his will. Espin Hardwick was my first customer, and for the years he was spared, he was a very great help to the progress of British gliding: for a short period he held the chairmanship of the British Gliding Association. He founded the Midland Gliding Club at the Long Mynd, in Shropshire; I was the first man to soar over the Long Mynd and that was in Espin's Falcon. How he loved that old sailplane!

A year or so later he asked me if I would design for him a two-seater version of the Falcon. This was to me a terrific task. However, after many months of hard and almost hopeless endeavour, working far into the night I completed the drawings in 1934 and sent them off to the BGA technical committee for check stressing. To my delight they were found to be up to requirements; so in 1935 Espin got his Falcon 3, side-by-side dual-control two-seater. Fortunately he paid for the work as it proceeded, otherwise I doubt if my resources would have stood up to the extra expenditure. I eventually built about twenty of the Falcon 3 type. Many clubs used them for training. The machine had an excellent performance; much higher than I had expected.

My workshop at Scarborough was far too small for the pile of work crowding in from all over the country. The entertainments manager of the Corporation of Scarborough allowed me the use of the old tramsheds for a workshop during the summer of 1934. In the winter, the sheds were for the storage of the small Scarborough pleasure-boats, so I had very little time to fix up some accommodation.

The previous year I had discovered an excellent soaring site east of Thirsk on the Scarborough main road, the A170, known as Sutton Bank. We had held a few demonstrations on this site since early 1933, and also a successful competition meeting.

THE YORKSHIRE GLIDING CLUB

As the Scarborough Gliding Club was rapidly falling apart, I proposed an amalgamation of the club with the Bradford and District Gliding Club under the chairmanship of Norman Sharp. The result was the Yorkshire Gliding Club, and we decided to arrange with the owners of the flat moors on top of Roulstone Scar to lease us about forty-four acres for the club ground. Sutton Bank is a magnificent gliding and soaring site; the proposal was received with enthusiasm by the BGA and was in fact acquired with the idea of using the site for all future annual contests. Philip Wills (nowadays the chairman of everything connected with gliding) had just become a member of the London Gliding Club and visited Sutton Bank. He joined Norman Sharp and me in our efforts to get a lease of the land and to find someone to build a wooden hangar for the Yorkshire Club aircraft, with an annex for use as a clubhouse. One week-end we found ourselves at Kirbymoorside where we located an agricultural engineering works.

ACTIVITY AT KIRBYMOORSIDE

These people seemed quite willing to build us a hangar for £300. At Kirbymoorside we met a very tall gentleman who smoked an enormous pipe and carried a heavy walking stick, presumably to balance out his pipe. Thus Major J. E. D. Shaw made contact with me and British gliding. Major Shaw lived at Welburn Hall near Kirbymoorside and owned, as well as other lovely things, a private aeroplane, and a flying field with hangar and workshop. He also employed a pilot to fly him around, although he himself could fly very well indeed. We got a very good hangar for £300, plus a hard apron in front of it as a donation. Moreover, when during conversation with Major Shaw I mentioned my workshop restrictions at Scarborough, without hesitation he invited me to take over some workshops adjoining the agricultural engineering premises at Kirbymoorside. I could hardly believe my good fortune and insisted on paying a rent but 'The Major' would only accept an absurdly low figure. We moved into Kirbymoorside in the autumn of 1934, and established Slingsby Sailplanes, Kirbymoorside, with myself as owner of a firm devoted entirely to the design and production of gliders and sailplanes. The immediate prospects seemed bright enough; the future was, I admit, rather obscure.

Major Shaw was delighted to have the works in Kirbymoorside. He visited me nearly every day and discussed all sorts of ideas for bigger and better gliders, but I plodded steadily on, training my local craftsmen to adapt themselves to aircraft work; teaching them to splice control cables, to use the metric system which I found from my experience when building the Falcon from German drawings to have many advantages.

In the spring of 1935, Major Shaw invited me to amalgamate with the agricultural engineering company and become a member of its board of directors. This took some of the strain from my personal finances. The new company, Slingsby, Russell and Brown Ltd, of Kirbymoorside, now seemed capable of producing anything from gliders to universal harvesters, with automobile engineering as a side line.

I had an order for a Grunau Baby intermediate sailplane, for the London Gliding Club. This machine was a very attractive type, cheap and simple to construct and very popular with the clubs. I tried to get the production rights for the GB2 so that I could jig up for quantity production. After a few weeks of negotiation, I came to terms with the German firm holding sole rights.

THE KIRBY KITE

After some study of the market for the two or three years ahead, I designed a more eye-catching sailplane based on the GB2. This I named the Kirby Kite. It was an immediate success. The machine had very attractive 'gulled' wings, and a monococque fuselage. It sold for £160 at a profit, in those far-off days; such a sailplane built nowadays would have to sell at over six times the price! Our little works at Kirbymoorside produced Kirby Kites for nearly all the British clubs and many private owners. We even exported a few.

As one would imagine, all this high-pressure work was placing a great strain on me personally. I was working sixteen hours a day for weeks on end. I had a good team of men in the workshop, but the routine office correspondence, costing, material purchases, inspection, sales and design work fell on my shoulders. For my average day, I allowed two hours for office work, five hours for workshop supervision and inspection, and from five to seven hours, mostly in the evening, for drawing-office work because I was then least likely to be disturbed. My long-suffering wife saw very little of me except for meals. I had an early breakfast and could hardly wait to get down to the workshop. I returned late at night, weary and with drooping eyelids from my drawing board. My wife dutifully gave up our fine comfortable house in beautiful Scarborough and moved to Kirbymoorside to live in a dreary little cottage, which had been a blacksmith's shop in the days of the notorious George Villiers, Duke of Buckingham. The generations that followed had converted the smithy into a dwelling of sorts. When we went into it, all the walls and ceilings had been lined with plywood, real hard drummy stuff. My wife, Fluff, spent many lonely evenings listening to the swarms of mice dancing on the ceiling panels. When we did get some poison into the cavities, dead mice were found in houses all down the street. The old smithy must have been a rallying point for all the mice of the town.

Our week-ends were nearly always spent with gliding clubs in various parts of Britain. We made hosts of friends, but life was very hard indeed. For all the work I put into gliding, I allowed myself a salary of £500 per year and the use of a car. I kept the designs as simple as possible, and my men worked with remarkable enthusiasm, putting in hours of overtime without extra rates. In fact many begged to come back at nights to finish off interesting jobs. Consequently our selling prices were competitive and the demand steadily grew. The reputation for Slingsby Sailplanes was spreading wider and wider.

KADET, TUTOR AND KING KITE

Then in 1936 a young man joined my staff. He was a York schoolboy who had been with our wandering parties over the Yorkshire Moors in the early days. He asked to be taken on as a fitter. I knew he could draw so I started him as a draughtsman. He became the first member of my drawing-office staff, and he was a very good boy. Very soon we produced a secondary trainer and named it the Kirby Kadet. It was rugged and simple but had a disappointing performance. However, it seemed to be good enough for the clubs because it sold well. A few months later we produced a modified set of wings for the Kadet, giving it larger span, and a better aspect ratio. This was a remarkable success, and many are still in use. I named this the Kirby Tutor. Hundreds of this type were sold to the Air Training Corps during the war years. Quite a good trade was done in the sale of kits of parts for both the Kadet and the Tutor.

The Dart 15-metre sailplane, No. 51 of the Slingsby sailplanes and the very latest. The first production machine was delivered in April 1964, ready for the British National Gliding Championships of that year, held at Lasham, Hampshire (Photo: Charles E. Brown)

Nick Goodhart swapping tall stories with Steven Bennis after a race from Elmira, New York to Wilmington, Delaware. This was during the 1955 American National Championships, won by Capt. Goodhart (competing *hors concours* because of his nationality)

Light icing on the wing of a Skylark 2 (from a colour transparency by T. A. M. Bradbury)

A Skylark 4 soaring over Lasham (photo: Alex Watson)

Wave clouds at Bishop, California

The Sierra Nevada mountains which produce the Bishop wave. This group includes Mt Whitney, 14,254 ft

The thrill of it all (photo: Alex Watson)

In 1937, Mungo Buxton, a very clever aeronautical engineer, and one of the leading experts on all gliding matters in those days, asked me to co-operate in the design and production of a high-performance sailplane, which he hoped to persuade the BGA to use for the next World Gliding Championships in Germany. In 1935 we had built a sailplane for Mungo, to his own design, the Hjordis, and it had been very successful with Philip Wills as pilot. We made three competition sailplanes to Mungo's latest design; we named the type the King Kite. This had quite a good performance, but also had a tendency to drop a wing at stall or near the stall. The type was not up to expectations, and was abandoned. Many years later I was making an incidence check on a King Kite wing and discovered to my surprise that instead of the three degrees 'wash-out' we had specified, the wings had two degrees 'wash-in'—hence the tendency to drop a wing and spin at low speeds. I was fated to have this miserable design error thrust upon me on two more occasions in the following twenty-five years; fortunately on those occasions I was able to find it out before the aircraft was ready for test.

THE GULL

After the Gliding Championships in Germany, my young York fitter-cum-draughtsman left me and joined the firm of Airspeeds Ltd, now a very large concern with huge premises in Portsmouth. Once again I was on my own in the little drawing-office at Kirbymoorside. This meant more night work, but single-handed I got out a design for a 50-foot-span strutted sailplane, which I named the Gull. It was a very successful machine. I introduced the prototype to a gliding contest at Ratcliffe Aerodrome near Leicester, and after I had made a couple of soaring flights, I sold it on the spot to an old friend of the early days of gliding, Dudley Hiscox, of the London Gliding Club. His first flight took him to Bicester Airfield; he was very happy with his Gull for several years. Another member of the London Gliding Club shared a Gull with his friend and had some happy flying, this was 'Steve' and Greig. One splendid soaring day, Geoffrey Stephenson was launched at Dunstable, the home of the London Club; he climbed in a vigorous thermal, flew south, and when over the south coast, finding he had over 6,000 feet to his credit, decided to make for the French coast. He made it comfortably, and thus established a record for the first sailplane pilot to soar across the English Channel. Other gliders had been towed up by aeroplane to a great height and just dashed across. Steve had done it the proper way. Not only that, he had done it on one of my Gulls. Unfortunately it was a costly job getting him retrieved from France.

THE PETREL

We made about ten machines of the Gull type. Then I started on a high-performance two-seater with a span of 65 feet. This was a full cantilever type with side-by-side seating and a fully enclosed cockpit. I allowed this to lapse for a time while I got out an urgent order for an 18-metre span sailplane for a dirt-track rider, Frank Charles of the Furness Club. This was the Petrel, which was merely a gull wing version of the German sailplane, the Rhonadler, but it took up precious time. We made about six of this type; some with stabilized tails and some with 'pendulum' type tails. The latter were by far the better machines for performance. Strange to say, the very latest type in production in 1964 has a similar type of tail unit arrangement, and the performance is marvellous. I wonder why we discontinued this in 1939? One reason, of course, was because war came along in that year.

WAR WITH GERMANY

With all the glider work pressing heavily on the limited workshop space of the premises at Kirbymoorside, we decided that more room was necessary. So my benefactor of the earlier years again came to my assistance, formed a new company, Slingsby Sailplanes Ltd, and bought a piece of land near his private aerodrome. Then together we went down to London to view the steel structure of some railway carriage washing sheds at Neasden Junction. We bought two sections and had them erected at Kirbymoorside. Then Jack Shaw said, 'Leave the rest of the job to me.' I did; he built a splendid factory, more or less regardless of expense, with its own electric supply by diesel generators. We made all our arrangements to move the jigs and tools into it by the first Monday in September 1939. But on the Sunday before this, we were at war with Germany. Gliding was stopped throughout the land—it looked as though we were in for a very bleak time of it.

I kept the men working on completing the jobs in hand. The Gull 2 two-seater was one of these, but of course we were not allowed to fly it. Gradually the works came to a standstill, and I tried desperately to get something to keep us in existence. We got a contract for Anson rudders which kept our hearts up. Then we sold a few gliders for radar experiments. After that came orders for the design and production of the Hengist troop carriers, the supply of gliders to the Air Training Corps, which kept us very busy for a very long time because we also did the repairs and spares. As the ATC had no two-seaters for instruction, but had to rely on verbal instruction and the 'slides' method, the repair work was very heavy indeed. Later we built a tandem and side-by-side two-seater as a private venture and put both forward for a decision. The decision was difficult because the ATC liked the tandem, and Training Command preferred the side-by-side. They did not place an order for either.

BIRTH OF THE SEDBERGH

A few months after the termination of the war, we tendered for a tandem training glider to a specification drawn up by the ATC and the MAP. We received a contract for three prototypes. They were known as Type No. TX8. We quoted a production figure of £800 each for a quantity. This price was considered to be far too high, and the project was therefore abandoned. The TX8 had no civil application, so we let it go. I knew that the ATC must eventually have a dual two-seater trainer, so I got out what I thought would suit the average gliding club and could be used by the ATC when funds were available. This was our Type No. 21. It was a great success from the first production machine. All the clubs bought them, and the ATC bought them in quantities. We also sold the T21 to many countries and they have been used to good effect. The T21, known as the Slingsby in many lands abroad, was named for Service use the Sedbergh after the famous old Yorkshire school of that name. When the Air Ministry decided upon the name, they wrote to me to obtain permission from the school governors to use it for the T21. Unfortunately my typist spelled the name as 'Sedburgh' instead of 'Sedbergh'; the reply I got from the school governor makes me blush to recall it. In spite of the error, we got the permission.

For some months after the war, the works made many other things to Government contracts and so was fully employed. Not so with a certain furniture firm in the south. They sensibly made up some sailplanes to a popular German design. The blueprints were issued free to various countries before the war for preparation of gliders for the next World Championships, which were to be held in Finland in 1940. The clubs and private owners were eager to get their hands on some post-war sailplanes so the demand for the Olympia sailplane was brisk. It was, and still is, a good type. I know the man who designed the Olympia (or Meise), Hans Jacobs, who was the world's leading man in his field in pre-war years.

THE SLINGSBY SKY

To keep my drawing office enthused we designed a 50-foot-span type known as the Gull 4 and sold about ten of them. The Gull 4 was in every respects a fine sailplane, but rather more expensive to produce than its foreign competitor. I was advised by Philip Wills, the leading pilot of this country, to produce an 18-metre span sailplane based on the Gull 4. I stretched the Gull 4 in two directions, span and length, and behold we had the Slingsby Sky. This name was thought up by John Furlong, an old friend of the early days, who could always be relied upon to buy a sailplane of every new type I produced. I was rather hesitant about such a name as 'Sky' until I found it was made up of the initials of the words 'Slingsby Kirbymoorside York'; nothing could be better than that for a name.

In 1951 the British National Contests were held at Camphill, the home of the Derby and Lancashire Gliding Club. Two Sky sailplanes were entered, and flown by good pilots. But the best pilot, Philip Wills, flew a German Weihr, up to that time the best available in its class. However, the two Sky pilots made rings round Wills, who was delighted with the success of the Sky. Arrangements were made to equip the British team for the 1952 world contests with four of our latest machines. We also received orders from Holland and Argentina for the Sky for the world event. For the first time the World Championships were won by a British team, and seven of our machines came home in the first fourteen. The British team and my firm were congratulated in a speech made in Parliament. I was very proud of my men and the firm, that day.

AND NOW THE LARK

I then decided to design a very simple and small-span sailplane, with a chord of three feet, an aspect ratio of 18, and to make the wing in three parts, so that experiments could be carried out on the outer panels to find the best type of lateral control devices. I named this the Skylark because it was really built for a 'lark'. We used a laminar flow aerofoil section for the first time. The Skylark was great fun, had an excellent performance and very effective dive brakes. It also had a high stalling speed which some thought would be too high for the average pilot, if there is such a creature. I had many happy flights in the Skylark 1, and the high stalling speed did not worry me in the slightest. I think this little sailplane was ahead of its time. With a little encouragement it would have done very well. Instead, I was talked into taming its spirit by increasing its chord and span. Thus we got the Skylark 2. This put up a good show, but was far from being the type I had originally aimed at. Some good records were put up with the Skylark 2, then there arose a clamour for the 18-metre version. Remembering the success I had with the Sky, the stretched-out version of the Gull 4, I decided to give the 'Two' the same treatment, but the operation was not quite as easy as all that. Anyway, we increased the span to 18 metres; and did quite a lot of other mods as well. The result was the Skylark 3. Then followed a series of mark numbers, from 3A to 3G.

By this time a youthful crop of gliding enthusiasts had blossomed from the waters of natural kindness and friendly headpatting, into long-haired pundits. A new and eager generation had donned the mantle of gliding wisdom and their voices had to be heeded, and so the Skylark tails became larger and struck new attitudes—but we continued to sell them. While all this was going on, we designed a two-seater tandem type which flew in 1954 and had some promise. It was developed and flown by the British team in the 1956 World Championships held in France. With that excellent and very astute pilot, Nick Goodhart, and Frank Foster as co-pilot, it gained the highest marks for two-seaters.

The World Contests of 1960 were held in Germany and everyone was impressed by the Polish sailplanes in which the pilots laid almost on their backs to be accommodated in a small cross-sectional area for the fuselage and so cut down drag. These machines had a very large speed range, and in certain conditions got away from all others. In marginal conditions the story was quite different. So the next Skylark was designed to give the pilot a more reclined seating position, but with some restraint. Other mods were made, but the tail remained as for the '3'; we just had not the time for more mods. Nevertheless, I am sure that, had we extended the fuselage and gone back to the old Petrel tail set-up of years ago, the 1963 World Championships would have had different results.

THE DART

But this was remembered for the next type, the new T51. This has a better-shaped fuselage, less taper ratio in wing plan, a longer tail arm, and the 'pendulum' type tailplane, plus of course the modern anti-balance tabs, for selective trimming. The T51, now named the Dart, bears the likeness and family characteristics of a long line of Slingsby sailplanes; in flight it has the keen eagerness of a trained greyhound, with all its controls in harmony. In turbulence it is docile and responsive; in difficult landing conditions it is friendly and comforting. What more can one ask for?

Very soon somebody will come up to me on a gliding site somewhere, and ask for an 18-metre version; this is bound to happen sooner or later, but it will be a long time before the British gliding fraternity will get a better sailplane than the Dart. The existing version is bound to pass through a series of structural modifications as new ideas are developed. We are considering all-metal wing spars; an 18-metre version must certainly have such spars.

In the (nearly) thirty-four years I have devoted to gliding, my works had produced more types than I have mentioned in this short chapter. The excitements, troubles, hardships and disappointments of all those years would fill many volumes. In case the question should arise, we actually did put a little engine in a glider. The glider was our old friend the Cadet 2 or as known in civil clubs, the Tutor. The engine was a 37 h.p. Continental JAP and the Motor Tutor got a full C. of A. The ARB told us, unofficially of course, that they only had two headaches that year; one was the Slingsby Motor Tutor, the other was the mighty Brabazon. I suppose one was too small and the other too large. Of course they were joking. I do know we built two Motor Tutors, and only two. One was sent to an island in the Caribbean, and the other is at Lasham Airfield. And yet there is a mysterious third which is occasionally seen flying over the Cleveland hills, and is unmistakably a Motor Tutor. Nobody knows where its nest is. I suppose even glider families have their troubles.

ON TO T.52

Then there was that tail-less glider, a third scale model of a monster designed to carry in its grip a seven-ton tank. This strange warlike combination was a formidable battlecraft, and a first-class surprise for somebody. The general idea was for the Thing to swoop into battle from the sky, with its tracks revving, and its guns spitting blue murder in all directions. On touch-down, it would cast off its swept-back wings, and the rest was left to the military genius of its crew, or remnants of the crew who were serviceable after the touch-down. The designer was a very old friend of mine who, by some persuasion managed to land a design contract for the special wing of third scale, for flight tests. My company was given the contract to build it. The third-scale model handled very well. Robert Kronfeld was given the job as test pilot, because he was the only man in Britain at that time, who had any experience of testing a tail-less type glider. I remember that the pilot's cockpit was rather cramped, and poor Robert had no room for a parachute, so did all the tests without one. The full scale version was not built, because the war finished before any further development work was carried out. However, it was a very interesting experience; it also gave my firm an opportunity to try out the Slingsby Patent Bellows Flap on a tail-less type. This flap had been developed for use on one of our troop carrier gliders, and was very good indeed, on that occasion.

MAKING GLIDERS

Now that we have Type 51 in production, we are clearing our drawing boards for the next—Type 52. Well, at the moment it looks as though it will be every bit as tough to create as all the others.

Sublime on the towers of my skiey bowers,
Lightning my pilot sits;
In a cavern under is fettered the thunder,
It struggles and howls at fits.

SHELLEY
(The Cloud)

7 Achievement
by H. C. N. Goodhart

Captain H. C. N. Goodhart, RN, joined the Navy as a Dartmouth cadet in 1933. Five years later he had his first introduction to aeronautics when he gained his C certificate in a two-week gliding course with the Yorkshire Gliding Club. This whetted his appetite for flying in all its forms and he finally induced the Navy to let him transfer from marine engineering to become a Fleet Air Arm pilot. He saw active service as a carrier-borne fighter pilot in the last few months of war in the Far East, and on return to UK, he did the Empire Test Pilots Course, which led to employment at Boscombe Down test-flying new Naval aircraft. In 1951 he invented the Deck Landing Mirror Sight, a device which has since been fitted in all British, American and French aircraft carriers and which has been a major contributor towards reduction of deck landing accidents. In 1952 the Navy sent him to Washington, DC, for duty on the British Naval Staff and this enabled him to take advantage of the outstanding gliding conditions in the USA to gain the British height record of 37,000 feet in the Bishop Wave and also to complete a 500-kilometre cross-country flight to become the first British holder of the coveted Diamond C award.

He first competed in the National Championships in UK in 1950 and in that and the four later years in which he has been able to compete he has never been placed lower than second in his class. He has won the US Nationals (hors concours) *on one occasion as well as gaining a first, second and fourth in the World Championships in which he has represented Great Britain on four occasions.*

Gliding, perhaps more than any other sport, always offers a goal just ahead of all participants, be they brand-new pupil or old hand. It is the achievement of these ever-unfolding goals that gives to gliding the special appeal which so firmly holds its devotees.

In the earlier chapters of this book you will have read of those achievements which mark progress from new pilot to serious high performance gliding. Now we turn to those ultimates in achievements—records and top competition flying; but perhaps 'ultimates' is really the wrong word, for today's records become tomorrow's commonplace events and who shall say when the ultimate has been reached.

Achievement in gliding in the earliest days centred almost entirely on the time for which a glider could remain airborne; in other words the pilots of those days looked on the achievement of staying airborne as the main aim. Since that day there has been a steady evolution of the direction in which gliding achievement has progressed. Once the ability to stay up at all was established, the natural aim was to try to climb higher so that altitude records were added to duration.

Then in the 1920s came the great break-through to cross-country gliding. Up to that time all gliding had been done by hill lift, and thus distance was entirely circumscribed by the length of hill. Then thermals were discovered and slowly, as he learned to use them, the glider pilot was freed from the shackles of his hill and able to roam far and wide across the country. Distance records were born. But the performance of the gliders was such that average speeds were low and gliding against any appreciable wind was not feasible. This resulted in distance records being always made in a downwind direction with a special category for landing at a pre-selected goal. The pre-selected goal was of course always chosen in a downwind direction.

After World War II, and partly as a result of it, glider performance increased rapidly and it became possible to make progress into wind and thus closed circuit courses became practical. This initiated a completely new type of record for speed round a closed circuit.

This is the stage we have reached at present and gives us a list of nine records which are currently competed for in the three categories World, British and UK. This latter category applies to records starting from UK, whereas British records can be created in any part of the world by a pilot of British nationality. In the UK category only, a further four records are also given for speeds over various straight line distances.

A list showing the current records in the single-seat category is given below:

SINGLE-SEAT GLIDING RECORDS

	World	**British**	**UK**
Altitude			
Absolute	46,267 feet	37,050 feet	30,580 feet
	Bikle (USA)	N. Goodhart	Rondel
Gain	42,303 feet	29,100 feet	29,100 feet
	Bikle (USA)	Rondel	Rondel

ACHIEVEMENT

Distance			
Straight line	544·3 miles Bezler (Germany)	460·5 miles Lane	360 miles N. Goodhart
Pre-selected Goal	487·2 miles Parker (USA)	360 miles N. Goodhart	360 miles N. Goodhart
Out and Return	434·4 miles Jackson (S. Africa)	351 miles D. O. Burns	222 miles Stone
Speed			
100 kilometre triangle	79·8 m.p.h. Moffat (USA)	52·2 m.p.h. Anne Burns	46·3 m.p.h. Foster
200 kilometre triangle	67·0 m.p.h. Schreder (USA)	49·1 m.p.h. Anne Burns	40·5 m.p.h. Strachan
300 kilometre triangle	67·2 m.p.h. Moffatt (USA)	53·8 m.p.h. Anne Burns	41·2 m.p.h. N. Goodhart
500 kilometre triangle	66·6 m.p.h. Dommisse (S. Africa)	64·2 m.p.h. Anne Burns	
100 kilometres straight	World and British records are not given in these categories		71·1 m.p.h. Bird
200 kilometres straight			71·1 m.p.h. Strachan
300 kilometres straight			57·4 m.p.h. Moore
500 kilometres straight			56·4 m.p.h. N. Goodhart

The most noticeable point about this list is that endurance has now disappeared altogether; in fact the modern glider pilot looks on plain endurance flying as being as pointless as pole-squatting or marathon-twisting. The real interest in this day and age lies in fact somewhat in the opposite direction, in how quickly one can get round a set course or how far one can get in the available flying time.

That then is the picture as it stands today; who knows what goals the glider pilot of twenty years hence will set himself, but the sport is developing so rapidly that it is inconceivable that new discoveries will not have improved the performance of gliders enormously. Already there are fascinating possibilities for exploiting the mysterious jet streams that so frequently exist at high altitudes.

It does not seem impossible that within twenty or thirty years a pilot might glide from coast to coast in the USA or Russia, or perhaps even across the Atlantic. It will take great progress in aerodynamics, in meteorology, materials, skill, and above all it will take great courage, but there is no reason to believe that all these ingredients will not be forthcoming.

But the purpose of this chapter is to tell of current achievement, not to speculate on the future, so let me now try to give you some of that special synthesis of rapture and despair that makes high performance gliding almost unbearably dramatic.

DOES LUCK PLAY A PART?

International Championships, which are normally held every second year, are undoubtedly the high point in any glider pilot's flying career. Even to be selected to represent his country is quite an achievement—to do well on every competition day (there can be as many as ten) against the world's best pilots calls for iron nerves as well as skill of the highest order.

At first sight it may seem that luck must play an important part in competition gliding and yet, surprisingly enough, the same names continually come to the top. Undoubtedly luck makes some small contribution and perhaps this makes the sport even more tantalizing, for you never know on any particular occasion whether you have perhaps let your attention slide for a moment and missed that vital point or whether it was sheer bad luck that you had to land.

A good example of this was the last day of the 1960 World Championships. The task was simple in itself, being nothing more than a 200-kilometre triangle over relatively easy country. The difficulty lay in the weather, which was overcast with an approaching warm front. To stay up at all was difficult, to race practically impossible. By the first turning point, most had already landed and I found myself slowly circling with a few others in a very weak lift. The front was supposed to be coming in towards us and I assumed that its arrival would kill the few weak thermals which were still to be found. Obviously the thing to do was press on and keep ahead of the front, which was what I did, but ten minutes later I was in trouble and twenty minutes later, despite a desperate attempt to ridge soar in virtually no wind, I had landed in a minute field of spinach halfway down the side of a very narrow little valley. It was the only feasible landing place.

Bad luck, but probably the others will not have done any better, I said to myself, and then turned to the more immediate problem of discussing in somewhat heated German (a language with which I have no more than the most rudimentary acquaintance) the current price of spinach.

Fifteen minutes later the sky cleared and I saw a glider go overhead. It was then that I knew that my position in the lead of the Championship was in jeopardy and sure enough it was those who had been close to me in total points who, though not completing the course, went significantly farther than I did. Thus was my lead converted to fourth place.

Bad luck? No; bad judgment! I should have realized that in Germany, far from the ocean, a warm front could be so weak as to permit soaring right through it. Patience was called for and I pressed on. It is no good pretending that one could not possibly know. How was it that the three high scorers close behind me got it right, or at any rate less wrong?

But there is the other side of the coin. In the 1962 British Championships there was one day which stands out in memory for the opposite reason. The task was a curious one in which, after starting at Aston Down in Gloucestershire, we first had to fly south to Yeovil and then east to Lasham and finally north as far as we could go, the greatest distance being the winner.

I got an early start and got away well. I was, as far as I knew, leading the pack which in a distance task is the right place to be, since it gives one the greatest chance of going farthest before the last evening thermal dies. And then quite suddenly, north of Winchester, I found that the next thermal simply was not there. At 2,000 feet or so this is not a disaster, but you do have to make up your mind pretty quickly and decide where to go for lift. I chose a village which was lying sweltering in the sun—nothing there. Now down to perhaps 800 feet above ground the position was desperate. Somewhere, certainly, the heat of the sun must be kicking up a thermal. Of all the surrounding country, the best bit looked like a group of mown hay fields offering a good contrast to the surrounding fields. I arrived about 300 feet above ground and there was at least a little turbulence. I circled trying to lift the glider by will power if nothing else. Soon there was no more than 200 feet between the glider and the fields. The strain was terrific and I put everything possible into absolutely perfect flying: not one twitch of the control column must create so much as an ounce of additional drag. For a moment the lift increased and I thought I had it made, then it fell away again. The temptation to end it all and pull the air brakes and land was terribly strong. It was the right thing to do at this height, indeed by all the normal rules I should have committed myself to a landing several hundred feet higher up. But I clung on by my eyelids, yet poised at any second to land if the faint puffs of updraught I was getting should die completely.

Then suddenly I saw a very hopeful sign; the washing on a line outside a nearby cottage gave a lazy flap and the leaves on the trees below me began to rustle. Within twenty seconds the thermal reached me and I began to climb away at increasing speed.

The whole incident wasted something like half an hour, during which I had made no progress, but nevertheless I went on to get the best distance for that day and this gave me a sufficient lead to stay in front for the rest of the contest.

Was it bad luck that I got so low in the first place, or was it good luck that saved me from having to land? I rather think the latter; in any case it was a very near thing. Such is the margin between failure and success.

CHAMPIONSHIP PROBLEMS

Failure and success, the stuff of which a competition glider pilot's dreams are made; and yet when actually racing this is not what one thinks about. The key question that has to be continuously answered is 'Am I doing the very best that is possible in the light of the present situation?' This is a question with so many facets that your brain is going at full speed the whole time.

Imagine gliding along a course with a clear idea of which cloud will provide the next thermal. It will take perhaps five minutes to get there. It would seem that all is easy and peaceful and you can just enjoy the scenery until you get there. But competition gliding is not like that. At any instant there is a best speed to fly, which depends on the strength of the next thermal and current instantaneous down- or up-draught; thus you must always be keeping one eye on the instruments to keep the speed reasonably right. The cloud which is to provide the next thermal must be watched hawk-like to see that it does not start to decay. The whole area must be watched for other competitors who may show you where better lift is. The whole sky must be watched for indications of change of weather or areas where there are either no cumulus clouds or too many with consequent cutting off of the sun. You must keep an accurate check of exact position to make sure that you do not get off track or, worse still, lost.

Coupled with all this, a great deal of mental agility is required to work out such problems as the exact course to steer (to ensure that the right compromise is struck between zigzagging all over the countryside in search of thermals and a straight line to the next turning point) or the right height to break off a climb to ensure that you arrive at the right height to round the turning-point markers.

Looked at like this, you begin to wonder what is the attraction of competition gliding? The answer lies in the sheer fascinating drama that accompanies practically every flight. Moments of depression (both mental and physical) are followed by periods of almost unbearable suspense as you approach an area where the next thermal just has to be and finally, if the selected thermal is really there, moments of joy amounting almost to rapture as you wind into a really good 'mother lode' of a thermal that somehow you know is going to hoist you rapidly to cloud base.

ON TOP OF THE WORLD

In the 1956 International Championships in France, in which I flew an Eagle with Frank Foster in the two-seater class, I remember (I shall never forget!) a period of classic drama in the Basses Alps. The task was one of distance along a fixed line, a particularly difficult one in mountainous country. We just cleared a ridge, behind which was a narrow valley and then an almost sheer-faced mountain rising far above us. In the valley there appeared to be one small hayfield which might have been just large enough to land in without serious damage. There were no thermals, but there was a strong wind blowing against the face of the mountain. Unfortunately this wind was only high up, and down in the valley where we were it was ominously calm. We passed over the hayfield and still had about a mile to go to the mountain face. Frank watched out backwards to try and give me the best guess of when it was too late to get back to the hayfield. I held on straight for the mountain. Messages from the back seat were, 'It's getting a bit marginal', 'I'm not sure we can make it back', and still we had not quite reached the mountain face. And then suddenly we were there—a sharp turn and we were skimming the trees with our right wing. The variometer flickered 'zero'—'up $\frac{1}{2}$'—'down $\frac{1}{2}$'. By now it just had to work or else we landed in the trees; our hayfield was now quite out of reach.

Tantalizingly the trees waved in the strong breeze two or three hundred feet above us; but at our level there was practically nothing. Suddenly a small gully showed a sustained rate-of-climb and we risked all on a desperate series of figure-of-eight turns in this gully. It did the trick and soon we approached the strong wind area.

First there was heavy turbulence and then suddenly an unseen giant hand seized us and we were rushing up the side of the mountain like an express lift. We actually had a sustained climb of 2,000 ft/min. which is really quite something for hill lift. And of course as we rushed up the side of the mountain our hearts rose in sympathy. Five minutes later we were literally and figuratively on top of the world.

LOW-LEVEL FINISH

Another moment of high drama which also I shall never forget occurred in the 1960 Internationals. I had struggled round a 300-kilometre triangle and was approaching a rather ragged cumulonimbus, which I expected to give me enough height to complete a final glide to the finishing line. It turned out to be a dying cloud with little lift left, so needing about another 1,000 feet for the final glide I went on through the cloud to see what else lay between me and the finishing line. Disaster! There was nothing but absolutely clear blue sky. Obviously the cloud was part of a local thunderstorm front which had killed all thermals and which was moving fairly quickly away from the field.

There was nothing for it but to go back to the front and try and find an active thermal to give the extra height I needed. But it was getting late and the front too was dying. I squeezed everything I could out of it and then set off towards the finishing line on the home airfield. There were twenty-three miles to cover and calculation showed I needed 200 to 300 feet more than I had to get there. There was nothing to do but sit there holding the glider absolutely steady at 43 knots—the speed for maximum range.

Slowly, desperately slowly, time went by and height ran out; miles went by too, but always it seemed that there were just more miles to go than height left. When the airfield came in sight it seemed ludicrous even to expect to make it. At six miles there was only 1,000 feet of height left. Fortunately there were fields on the final run in to the airfield so I knew there would be little problem in landing if I did not make it.

Soon I could see the crowds out by the finishing line. I had radioed ahead that I was coming, so everybody was watching. This looked as if it was going to be a classic failure. A mile to go to the airfield boundary, and only 150 feet showing, and anyway the line was another mile beyond the airfield boundary. It seemed certain I could not make the line but I might make the airfield, but this meant deviating my track. I held on but suddenly realized I could not get over the hangar and windsock on the airfield boundary. Round the hangar I went and once on the airfield right down to six inches from the ground, for a glider has improved performance very close to the ground. But now the speed was dropping, 43—42—41 and still 200 yards to go; 40—39—38 and I swished across the line to a great roar of applause from the tensely waiting crowd. I might have been able to go another 50 yards but certainly no more. When I looked down at my altimeter it was showing *minus* 40 feet. The pressure had gone up while I had been in the air and I was actually 40 feet higher than I thought. That was the most valuable 40 feet I have ever had.

RETRIEVING CAN BE COMPLICATED

There is another aspect of International Championship flying which is also absolutely fascinating, and that is the process of getting back from landings which may take place literally anywhere in the hinterland of some entirely unknown foreign country. My own experience covers France, Poland, Germany and Argentina. In the first three of these each glider had its own retrieving crew, so the problem was simply one of getting one's crew to know exactly where one was and then waiting until they drove up. In Argentina it was even more interesting as one was retrieved by means of an aero-tow provided by the organization.

It may sound quite simple to tell your crew where you are but in practice it is very far from easy. Let me tell you about a fairly straightforward retrieve in Poland. The task was free distance and with a strong following wind, I last had radio contact with my crew at about 3.30 p.m. when I was about eighty miles in front of them. By 7.00 p.m. all thermals had died and I set up my final glide roughly along a road which appeared to be marked on my map (1:500,000) and I knew that I would be landing about ten miles short of the Russian border. Thank Heaven I was not to be faced with the problem of whether I was actually in Russia or not when I landed. Shortly before I was down to landing height my road stopped going in the right direction so I had to leave it and go straight on, but could only make about another one and a half miles before landing.

The field was all right and I drew to a comfortable standstill. It is a glorious moment when a good flight is over and you are reasonably sure you have done well. For eight hours or so you have been striving madly to squeeze the last ounce of performance out of yourself and the aircraft and now it is all over. Peace reigns and you can relax. But not for long! Inevitably people and children appear almost miraculously quickly. In the less sophisticated places they are respectful and somewhat in awe of the whole thing (but land in the UK Midlands and the glider will be torn apart if you relax your vigilance even for a second!).

The first job is to make the glider reasonably secure and this you usually do by picketing it down. The next job is to explain to everybody that the glider is very, very fragile and on no account must be touched. With no common language whatever, which is usually the case, this is a slow business. After that you have the problem of finding out exactly where you are and where the nearest telephone is. In this particular case, it turned out that there was one telephone in the village a mile and a half away.

When the car and trailer arrive, it will be dark so the important thing to do while walking out to the village is to find and memorize a route which will be feasible for getting the car and trailer to the glider. In this particular case the countryside was very flat and boggy and the few tracks that did exist had ruts and puddles of such a size that it seemed unlikely that we would be able to get in.

Once in the village you must find out its name and the identification of the road running through it. The only safe way to do this is to actually sight a road sign. Just the name of the village will not do as there are frequently several in the same general area with the same name.

The peasants are of course infinitely helpful but there are very few who can read and they have no conception of the rest of the world. An attempt to find out what is the distance along the road to the next major town is quite unavailing. As far as they are concerned, the road is the one that leads to the communal granary or the forest or some such place of importance to them.

It is a frustrating and slow business but at last the post-office is reached and the postmistress devotes herself to the intricacies of a communication system which would be a treasured museum-piece in a more advanced country. Clearly the batteries ran down tens of years ago and the system is now sound-powered. After ten minutes' hard shouting, the postmistress gives up the unequal struggle and a male voice of unsurpassed capacity is called into play. My grubby message written out on the prepared form becomes even grubbier but success is apparently being achieved. Smiles appear and at last the instrument is hung up; immediately wine and bread are produced and at last we are all on common ground. This is a subject of interest to all, particularly to me as my last meal was breakfast about twelve hours ago and 320 miles away.

But before dark it is essential to ensure that my trailer, when it turns up, will be able to find the glider. This is done by hanging up a large flag I have brought with me with a pocket in one corner which contains a message telling the crew exactly where I am.

As darkness falls I navigate back to the glider, still followed by a large group of spectators, and prepare to sit it out by the glider until the crew turn up, wondering first whether in fact the message from the post-office ever did get through to base and then whether the crew have themselves ever succeeded in getting through and transcribing the message; whether they have had trouble on the road or whether the message has become confused somewhere and they are pressing on to entirely the wrong place.

Very occasionally a vehicle comes along the road and I switch on the radio. Being a VHF set it is no good except over 'line-of-sight' distances and unless one happens to land on the very top of a hill has remarkably little range once one is on the ground.

Suddenly, at about 10.30 p.m., I get a reply and know that my crew is here. Now I have no more problems. From then on the crew is in charge; they have driven 400 miles and are just as tired as I am but their job is to get me back again in the best possible state of health and mind for the next competition day.

Many willing hands practically carry the trailer and car over the potholes and the glider is rapidly stowed in the trailer.

An hour later we arrived at a biggish city and from various sources of information discovered that the next day would not be a competition day so we stopped at a hotel.

That night was a fascinating one, for no sooner had we managed to get a room and were just turning in than the door flew open and in marched the police accompanied by a beautiful girl. Not having pyjamas, we covered our confusion as best we could while we tried to determine the exact function of the girl. It turned out after a while that she had simply been brought along as an interpreter and they wished to tell us where another glider had landed and would we go and fetch it.

At intervals throughout the night either the police, the girl (who turned out to be French), or both, woke us up to tell us of other gliders in the district. The basic idea—one trailer, one glider—never did seem to get home to them.

Next morning we had a leisurely breakfast and a splendid shave by courtesy of the hotel barber who turned out to be a Canadian, and set off to drive back to the airfield stopping for a couple of hours in Warsaw to sightsee.

On the way back we passed a trailer in the ditch with a badly damaged glider on it. My crew chief was dead right to insist that we stopped for the night and did not try to drive straight back through the night as this other team had done. Championships are not won only in the air.

RECORD-BREAKING

So far I have written about championship flying as the ultimate in gliding achievement, but there is also the entirely separate aspect of record-breaking. It is certainly an ultimate but the approach is completely different; competition flying is a hard school in which one's every achievement is measured by the performance of others and this goes on relentlessly day after competition day for as many as ten days on end. Yet the actual performances achieved may be very ordinary indeed and would otherwise soon be forgotten.

Of course, there have been occasions when a record-breaking day turns up during a competition and then one gets competitive record-breaking—always assuming that the task-setters are sufficiently skilful to foresee the possibility and set a suitable task.

In general, however, record-breaking is only likely to be achieved by a determined effort to be ready to take maximum advantage of the right weather conditions on the rare occasions when they occur.

The prospect of getting world-record-breaking weather conditions in UK is negligible as we have neither a sufficient land mass area nor any mountains of sufficient size. Thus, to break a world record it is necessary to go to the middle of a suitable land mass. Currently favoured spots are USA or South Africa, but there seems no reason why Central Europe, Russia and Australia should not produce equally good conditions.

Such special trips abroad for record-breaking purposes are of course fairly expensive and could be a complete failure if the weather does not come up to expectations. However, to prove that it can be done, there is the classic case of Anne and Denis Burns who went to South Africa for three weeks in late 1963, early 1964, and came back with three world records and four British national records.

For many people trips abroad for record-breaking purposes are not possible but this does not mean that they do not have the opportunity to do some record-breaking. The special category of records known as United Kingdom records has been specially set up to cater for the limitations imposed by the weather in UK. For these records the only important rule is that the starting point must be in UK. The nationality of the pilot is not important, though at the time of writing no 'foreigner' has ever held any of these records.

The list of records that one can try for are, except for two, all speed records. Three are, in fact, straightforward speed round triangular courses of 100, 200 and 300 kilometres. The next three are distance records, in a straight line, to a declared goal, and to a declared turning point and return, but since these can only be achieved by covering the greatest distance during the time that thermals are active in any particular day, they are in effect races. The remaining two are height records, absolute height and gain of height, and are in a class by themselves and require entirely different preparation.

In UK there are perhaps four or five days a year on which one or another of the UK records might be broken. There are also probably about twenty-five pilots who will have a reasonable chance of breaking a record if they are ready and fully equipped on the right day. Since nearly all pilots have to earn a living, the chance of their being available with the right equipment on the right day is fairly small. For this reason the UK records have not been pushed very high and there is still considerable scope.

The British sailplanes currently in use are designed for winning competitions in UK, and since UK competitions are frequently fought out in very weak conditions, British sailplanes have very low wing loadings. The UK records have now reached a stage where fairly strong thermals are required to achieve the cross-country speeds necessary to break them. The best wing loading for these thermal strengths is very much higher than that currently used; thus the stage is beginning to be reached when it will be necessary to use a different glider for record-breaking from that used in competitions. If the same glider is to be used for both, then we must at least have a ballast carrying system to enable wing loading to be varied according to the thermal strength.

From the foregoing, it will be seen that record-breaking is dependent almost entirely on the right pilot being available on the right day with the right machine and the right equipment. In other words it is not so much the flight as the preparation for it. The actual flight when it takes place must almost inevitably be a fairly tame affair since, if a speed record is to be broken, there cannot be any harrowing period of near disaster and last-minute saves by a weak thermal at 200 feet above ground.

Perhaps the most exciting feature of a record-breaking flight is the succession of fast climbs that must be achieved. It is enormously exhilarating to break off a climb at say, 5,000 feet because the lift has fallen from six to four knots and press on at seventy to seventy-five knots straight into another six-knot thermal. Better still you may find a cloud street under which it is possible to cruise virtually continuously at high speed without even circling. Such conditions do occur, but you can so easily begin to assume that they will go on and on and they very seldom do. You must never let good progress lull you into a false confidence.

In UK it is very likely that a record-breaking day will be one in which small cumulonimbus are continuously forming and disintegrating. This is a fairly rare form of weather, since it is likely that such a day will either over-convect and form a layer of upper cloud which cuts off further heating from the sun and thus kills itself, or the thermal cell size will increase and large thunderstorms will develop. When there are large thunderstorms, it is not generally possible to achieve any large distances as such thunderstorms get much too far apart with large areas of sink in between. Any question of following a set course under such circumstances is completely out.

On the rare days when there is a good development of small cumulonimbus or cumulus congestus the record-breaking pilot is really stretched to the limit. Let us assume cloud base is 5,000 feet and the good lift goes to 10,000 feet. Under such conditions most flying will be done in the bracket from 3,000 to 8,000 feet. This means that the greater part of the climbing will be done in cloud and the greater part of the straight flying will be done above cloud base with very limited view of the ground. Thus the pilot's ability to cloud fly will be tested to the full and his navigation will have to be accurate despite a fairly infrequent sight of the ground.

CONDITIONS FOR A UK RECORD

Let us assume that there is not too much wind and we have set ourselves a 300-kilometre triangle. There are only three or four climbs and glides on each leg, and the last climb on each leg has to be broken off at such height as will enable the turning point to be reached below cloud base so that proof of turning can be recorded by photograph. On the last leg, climb must be broken off at the right height to reach the finishing line at ground level. To break off at the right height requires that we know exactly where we are and how far to go to the turning point; then having broken off in the middle of the cloud we must steer the right course and come out on track to the turning point.

The final glide is perhaps even more fascinating since it may be made from as much as thirty to thirty-five miles out but in this case the last twenty miles or so will be below cloud base which makes the navigation less difficult.

All in all, record breaking is therefore simply a question of a competent pilot having a successful flight on a good day. Nine-tenths of the success depends on choosing the right day and having the right equipment ready.

HEIGHT RECORDS

So far, I have not mentioned the two types of height records. These are gain of height and absolute altitude. Once again these records depend on choosing the right weather conditions. There are two entirely different sorts of weather suitable for height records.

Given a mountain of suitable shape and size a strong wind which increases with height is likely to produce lee waves downwind of the mountain; these waves, which are strongest when the atmosphere is stable, are capable of providing strong lift up to a very great height indeed. For instance, the present world absolute height record was set up in the lee wave behind the Sierra Nevada in California. The mountain range is about 8,000 to 12,000 feet high and the height reached was 46,267 feet. Even at this height lift was still available and the limit was set by the fact that the pilot was flying an unpressurized sailplane.

In UK we have yet to find out what are the maximum waves likely to be produced by our own mountains. Only in the last two or three years has any systematic investigation of waves been undertaken and we have obviously got much to learn about the possibilities in our more mountainous regions. Crossings have been made both from Scotland to Ireland and vice versa, using waves originating in the country from which the start was made. The maximum heights reported so far have been in the 15,000 to 20,000 feet bracket, but no doubt further exploration will produce even greater heights. It remains to be seen whether waves in this country will ever produce heights as great as have been achieved by the other form of high flying weather—thunderstorms.

The present UK altitude record of 30,580 feet was achieved by climbing in a thunderstorm. This somewhat specialized form of soaring is in complete contrast to the more usual cross-country flying. There are a whole series of hazards which must be understood and prepared for; to be unprepared for them would be just plain foolhardy. The penalty for failure in a height record attempt can very easily be loss of the glider or even loss of life, whereas in ordinary cross-country record-breaking the penalty for failure is no more than just not breaking the record.

In high altitude thunderstorms flying the main items to be reckoned with are the need for oxygen, cold, icing and lightning. Of these perhaps the most important is the oxygen: it simply must not fail. At heights much over 30,000 feet oxygen failure would undoubtedly be disastrous since it would not be possible to get down to safe heights in time even in a steep dive with dive brakes out.

Cold is unlikely to be fatal but it is certainly something to be reckoned with as I once found out when flying in the Bishop Wave. After spending five hours in temperatures as low as *minus* 50F. I found myself getting worried about frostbitten feet. Actually no harm was done though they did freeze up solid. What so often happens in this country is that pilots get into a good thunderstorm without having planned for it. They then find themselves at great heights and correspondingly low temperatures in their shirt sleeves. Many a climb that might have gone considerably higher has been broken off because of the cold.

Icing in a thunderstorm climb is inevitable and as much as three or four inches of ice may be picked up on the wing leading edge. The glider will often become very sloppy but provided the controls are moved continuously and kept free, icing is unlikely to produce any serious adverse effects. The canopy probably ices up both inside and out but as the inside of a thunderstorm is completely opaque anyway there is no point in being able to see out! At one particular height in the climb ice is nearly always encountered in the form of hail. This does not stick to the glider but if it happens to be large enough it does severe damage to the leading edge of the wing and possibly to fabric-covered surfaces.

Lightning is a severe hazard. It is clearly only a matter of time before a glider is struck severely enough to fuse a control cable. Already there are cases on record in which a control cable has nearly failed. In addition, lightning strikes may cause severe damage to the structure of wooden gliders without this being very obvious from outside. There is nothing much that can be done about lightning and thus it must remain as one of the inevitable hazards of thunderstorm flying. Fortunately the glider appears to act as a sort of Faraday cage so the chance of the pilot getting a fatal electric shock is low. Minor electric shocks are, however, an invariable accompaniment of thunderstorm flying.

From all this it can be seen that breaking the height record by means of a thunderstorm climb is a fairly specialized variety of soaring requiring not only a considerable amount of preparation of the glider but also involving a fair degree of risk of damage to the glider. It is, however, just like all other record-breaking from the point of view of waiting for the weather. No amount of preparation and organization will get you a record unless you are prepared and organized on that very occasional day when the right thunderstorm builds up in the right place.

WHAT OF THE FUTURE?

With all this discussion on record-breaking, one begins to wonder what the absolute possibilities are. What will the records be in ten or twenty years time?

Considering first the distance records, the limitation at present is the length of time that thermals are active during the day, but there is nothing in the rules that says a flight must be completed in one day. One can visualize a flight in which a long thermal flight is made during the day, followed by a night of ridge soaring on a suitable ridge, and then another day's soaring when the thermals start again. Such a flight could amount to 700 to 800 miles and is well within the limits of human capability.

On the speed round a course record, the problem is very different. In this case it is a question of getting more speed out of a glider on a good day. The solution to this depends on aerodynamicists and structures experts who must between them produce ever better machines. If, for example, a really good variable area wing could be produced so that the glide ratio was kept at its maximum value over a wide speed range, fantastic average speeds could be achieved perhaps as high as twice those currently being recorded.

For greater achievement in height, the problem is a human one, that of keeping the pilot alive in the stratosphere. A pressure cabin sailplane or full pressure suit is required and with it we may find wave conditions going as high as 60,000 feet.

Whatever happens, it is clear that gliding will go on to performances at present scarcely dreamed of, and perhaps it is this ever widening horizon that keeps the soaring devotees so in thrall.

Appendix I
The Question of Powered Gliders for Training

THREE major problems face the gliding movement and hold up its growth:

(1) The lack of suitable sites for new clubs.
(2) The difficulties in increasing the launching facilities at existing clubs to cater for greater numbers of pilots and gliders.
(3) The difficulty in training larger numbers of pilots without restricting the number of launches available for solo flying.

It is in the training of glider pilots that we must hope to see the greatest progress in the near future.

The real problem is that a glider is only efficient and economic in soaring conditions when it can make long flights from each launch. Unfortunately, for pre-solo training, the need is mainly for rather short, circuit flights and for these a powered aircraft is much quicker and therefore more economic.

Anyone who has recently learned to glide will agree that it can be a frustrating business involving hours of waiting for only a small amount of flying. This is unavoidable with gliders because they are dependent upon winching or another aircraft for a launch and must sit idle on the ground until they have been man-handled back to the launching point and another launch is available.

Present-day light aircraft are not particularly suited to teaching glider pilots because the handling characteristics and gliding performances and speeds are very different. The ideal would be a specially designed machine of gliderlike configuration and ample power to allow operating from any gliding site.

The advantages are obvious:

(*a*) Flying could begin as soon as an instructor and one pupil were available because it would not require any ground handling.
(*b*) The length of flight could be varied to suit the stage of the pupil.
(*c*) Very rapid consecutive circuits would be possible.
(*d*) Normal glider circuit procedure could be taught by simulating the normal glider performance with the use of a small amount of power instead of stopping the engine.
(*e*) Glider-type air brakes could be used to teach normal glider approaches and landings.
(*f*) Cross-country flying, soaring technique and even field landings could be taught without the risk of stopping all training for the day because of the delays of retrieving the aircraft by trailer.
(*g*) A system of booking instructional flying becomes really practical.
(*h*) Only a very small number of glider launches would be needed before flying solo in a glider.
(*i*) In addition, it could achieve more than twice the amount of instructional flying possible with a glider while at the same time releasing a large number of glider launches for solo flying. The overall costs of training to solo standard would be no more than with a modern glider because of the far better utilization.

It is obvious that if the gliding movement is to expand in any fruitful way, steps must be taken in the immediate future to make the training period an efficient and economic proposition for the promoters and attractive and stimulating for pupils. This can only be achieved by a radical review of the present system of operating.

Once we have solved this problem of training, we shall have cleared the way for the future development and expansion of all gliding activities.

DEREK PIGGOTT
Lasham Gliding Centre,
January 1964.

NOTE. The French Avion-Planeur is a single-seat aircraft with a span of 36ft 9in. and a lift/drag ratio (see p. 22) of 18:1. With engine it cruises at 100 m.p.h. and has a range of 300 miles. Without engine it can be flown as a glider, and in April 1965 attained an altitude of about 35,000 ft in a wave-lift over the French Alps.

Appendix II

Clubs and Centres

BRITISH GLIDING ASSOCIATION
(Secretary: Miss F. Leighton)
Artillery Mansions, 75 Victoria Street, London, SW1.
(Tel.: SULlivan 7548)

FULL MEMBER CLUBS AND SITES	**NAME AND ADDRESS OF SECRETARIES**
AIR TRAINING CORPS Tel.: Maidenhead 2300	The Gliding Officer, HQ, Flying Training Command, RAF, White Waltham, Nr Maidenhead, Berks.
*BEA SILVER WING GLIDING CLUB RAF, Booker, Nr Marlow, Bucks.	Mr D. W. Fearson, c/o Planning Sections, BEA Eng. Base, LAP, Hounslow, Middx.
BRISTOL GLIDING CLUB Nympsfield, Nr Stonehouse, Glos. Tel.: Uley 342	Mr R. W. Sanderson, c/o The Club.
CAMBRIDGE UNIVERSITY GLIDING CLUB The Airport, Newmarket Road, Cambridge. Tel.: Cambridge 56291	Mr G. R. Thomson, Peterhouse, Cambridge.
CORNISH GLIDING (& FLYING) CLUB Trevellas Aerodrome, St Agnes. Tel.: Perranporth 2124	Mr J. Kenny, 7 Duncannon Drive, Tregenver, Falmouth.

* **These clubs have a restricted membership and are open only to employees of the firm concerned**

COVENTRY GLIDING CLUB Baginton Airfield, Nr Coventry. Tel.: Toll Bar 3377	Mr J. C. Large, 15 Sunningdale Avenue, Kenilworth, Warwickshire.
DERBYSHIRE & LANCASHIRE GLIDING CLUB Camphill, Gt Hucklow, Tideswell, Derbyshire. Tel.: Tideswell 207	Mr J. B. Jefferson, 15 Northumberland Road, Sheffield 10.
DEVON & SOMERSET GLIDING CLUB Dunkeswell Aerodrome, Nr Honiton, Devon. Tel.: Luppitt 287	Mr N. Hatton, 'Windyhurst', Churston Ferrers, Brixham, Devon.
*IMPERIAL COLLEGE GLIDING CLUB Lasham Aerodrome, Nr Alton, Hants.	The Secretary, Imperial College G.C., Prince Consort Road, London, S.W.7.
KENT GLIDING CLUB Squids Gate, Challock, Nr Ashford, Kent. Tel.: Challock 307	Mr R. J. Wilson, 56 Ninehams Road, Caterham, Surrey.
LONDON GLIDING CLUB Dunstable Downs, Tring Road, Beds. Tel.: Dunstable Downs 63419	The Manager, at the site.
MIDLAND GLIDING CLUB Long Mynd, Church Stretton, Salop. Tel.: Linley 206	Mr S. J. Curtis, 43 Lickhill Road, Stourport-on-Severn, Worcestershire.
NEWCASTLE GLIDING CLUB Carlton Moor, Stokesley, Middlesbrough, Yorks.	Mr R. C. Stoddart, 5 East Boldon Road, Cleadon, Sunderland.
NORFOLK GLIDING CLUB Tibenham Airfield, Norfolk. Tel.: Tivetshall 207	Mr J. W. Lawton, School House, Filby, Great Yarmouth, Norfolk.
OXFORD GLIDING CLUB Weston-on-the-Green, Nr Bicester, Oxon.	Mr L. A. Speechley, 139 Crestellain Mansions, London, W.9.

APPENDIX II

SCOTTISH GLIDING UNION Portmoak, Scotlandwell, by Kinross. Tel.: Scotlandwell 43	Mr W. A. Shanks, 7 Stanmore Avenue, Lanark, Scotland.
SOUTHDOWN GLIDING CLUB Bo Peep Hill, 61 Alciston, Nr Polegate, Sussex.	Miss Madge Dugdale, Faraday Mansions, London, W.14.
SURREY GLIDING CLUB Lasham Aerodrome, Nr Alton, Hants. Tel.: Herriard 270	Mr A. W. Barker, 34 Inverness Terrace, London, W.2.
YORKSHIRE GLIDING CLUB Sutton Bank, Thirsk, Yorks. Tel.: Sutton (Thirsk) 237	Mr R. W. Pearson, Buckingham House, Bridge Street, Helmsley, N. Yorks.
ARMY GLIDING ASSOCIATION	Lt-Col Sir Charles Dorman, Bt, Hutton House, Finchampstead, Wokingham, Berkshire.
Aldershot District Gliding Club, RAF Station Odiham, Nr Basingstoke, Hants.	Capt. M. J. Reynolds, KOSB, New College, Sandhurst, Camberley, Surrey.
Army Soaring Club, Lasham Aerodrome, Nr Alton, Hants. Tel.: Herriard 270	Mr G. Sharp, c/o Sgts Mess, Army Apprentices School, Arborfield, Reading, Berkshire.
Southern Command Gliding Club, Netheravon, Nr Salisbury, Wilts.	Lt E. Stark, RE, c/o 2 Strategic Reserve Mc Sqn, McMullen Bks., Marchwood, Nr Southampton, Hants.
ROYAL AIR FORCE GLIDING & SOARING ASSOCIATION	Wg Cdr E. C. S. Fewtrell, DFC, RAF,
RAFGSA Centre	RAF Shinfield Park, Reading, Berks.
Bannerdown Gliding Club	RAF Bicester, Oxon.
Cheviots Gliding Club	RAF Colerne, Chippenham, Wilts.
Chilterns Gliding Club	RAF Acklington, Morpeth, N'berland.
Clevelands Gliding Club	RAF Benson, Oxon.
East Anglian Gliding Club	RAF Leeming, Nr Northallerton, Yorks.
East Midlands Gliding Club	RAF Waterbeach, Cambs.
	RAF Swinderby, Lincs.

Fenland Gliding Club	RAF Feltwell, Thetford, Norfolk.
Four Counties Gliding Club	RAF Wittering, Northants.
RAF Halton Gliding Club	RAF Halton, Aylesbury, Bucks.
Mendip Gliding Club	RAF Locking, Weston-super-Mare, Som.
Moonrakers Gliding Club	RAF Upavon, Pewsey, Wilts.
Red Hand Gliding Club	RAF Ballykelly, Limavady, Co. Londonderry, N. Ireland.
White Rose Gliding Club	RAF Church Fenton, Tadcaster, Yorks.
ROYAL NAVAL GLIDING AND SOARING ASSOCIATION	Lt Cdr Vine, RN, HMS Vernon, Portsmouth, Hants.
Condor Gliding Club	RNAS Arbroath, Scotland.
Fulmar Gliding Club	RNAS Lossiemouth, Nr Elgin, Moray.
Heron Gliding Club	RNAS Yeovilton, Ilchester, Somerset.
Portsmouth Naval Gliding Club	Lt Cdr L. D. Vine, RN, HMS Vernon, Portsmouth, Hants.

ASSOCIATE MEMBER CLUBS AND SITES	**NAMES AND ADDRESSES OF SECRETARIES**
ABERDEEN GLIDING CLUB Litterty, Nr Turriff, Aberdeenshire.	Mr J. P. Whitehead, 136 Union Street, Aberdeen.
*AVRO GLIDING CLUB Woodford Aerodrome, Woodford, Cheshire.	Mr D. A. Nadin, High Lea, Hawkins Lane, Rainow, Macclesfield, Cheshire.
BATH GLIDING CLUB Keevil Airfield, Nr Melksham, Wilts.	Mr R. D. Cherry, Cerasus, Northleigh, Bradford-on-Avon, Wilts.
BLACKPOOL AND FYLDE GLIDING CLUB 'The Kite', Blackpool Airport, Lancs. Tel.: Blackpool 41526	Mr J. S. Aked, c/o W. T. Aked & Co. Ltd, St. George's Road, St Annes-on-Sea, Lancs.
*CROWN AGENTS GLIDING CLUB Lasham Aerodrome, Nr Alton, Hants. Tel.: Herriard 270	Major J. E. G. Harwood, 4 Millbank, London, S.W.1.

APPENDIX II

*COLLEGE OF AERONAUTICS GLIDING CLUB Cranfield Aerodrome, Bucks. Tel.: Cranfield 321	Mr R. G. Thory, College of Aeronautics, Cranfield, Nr Bletchley, Bucks.
DONCASTER & DISTRICT GLIDING CLUB The Airport, Ellers Road, Doncaster.	Mr H. H. Keeble, 7 Hornsby Road, Nutwell, Armthorpe, Doncaster.
DORSET GLIDING CLUB Gallows Hill, Wareham, Dorset.	Miss J. Haslam, Foys, Chetnole, Sherborne, Dorset.
DUMFRIES & DISTRICT GLIDING CLUB Townfoot, Thornehill, Nr Dumfries.	Mr P. D. Johnston, 'Ardfern', New Abbey Road, Dumfries.
ESSEX GLIDING CLUB RAF North Weald, Nr Epping. Tel.: North Weald 222	Mr J. W. R. Unsworth, 3 Hartland Road, Epping, Essex.
EAST MIDLANDS GLIDING CLUB (Leicester) Rearsby Aerodrome, Tel.: Rearsby 321	Mr K. Moseley, The Ginn Stables, Coleorton, Leicester.
GLASGOW & WEST OF SCOTLAND GLIDING CLUB Couplaw Farm, Strathaven, Lanarkshire. Tel.: Strathaven 2309	Mr T. J. Goodwin, 87 Hawthorn Avenue, Bearsden, Glasgow.
HALIFAX GLIDING CLUB Ringstone Edge, Barkisland, Yorks.	Mrs N. Marshall, 70 Upper Washer Lane, Pye Nest, Halifax.
*HANDLEY PAGE GLIDING CLUB Radlett Aerodrome.	Mr R. N. Bond, 84 Cumbrian Gardens Pennine Drive, Cricklewood, N.W.2.
LAKES GLIDING CLUB Tebay Ghyll, Tebay, Nr Penrith.	Mrs R. Allen, 'Quietways', Fell Foot, Staveley, Nr Kendal, Westmorland.
LASHAM GLIDING SOCIETY Lasham Aerodrome, Nr Alton, Hants. Tel.: Herriard 270	The Manager, at the site.
NORFOLK & NORWICH GLIDING CLUB Swanton Morley, Norfolk. Tel.: Swanton Morley 274	Mr T. Daniel, 102 Earlham Road, Norwich 08G, Norfolk.

NORTHAMPTONSHIRE GLIDING CLUB
Cranfield Aerodrome.

Mr D. T. Jones, 9 Winchester Close, Delapre, Northampton.

NORTHUMBRIA GLIDING CLUB
Currock Hill, Nr Hedley-on-the-Hill, Co. Durham.

Mr R. C. Gains, 47 Claremont Road, Whitley Bay, Northumberland.

OUSE GLIDING CLUB
Rufforth, Yorks.

Mr R. Taylor, 26 Bewlay Street, Bishopthorpe Road, York.

*PERKINS SPORTS ASSOCIATION GLIDING CLUB
Spanhoe Airfield, Nr Harringworth, Northants.

Mr J. A. Kilby, c/o Perkins Sports Assn, F. Perkins Ltd, Eastfield, Peterborough, Northamptonshire.

POLISH AIR FORCE ASSOCIATION GLIDING CLUB
Lasham Aerodrome, Nr Alton, Hants.
Tel.: Herriard 270

Mr J. K. Przewlocki, 73 Calbourne Rd., London, S.W.12.

*ROYAL AIRCRAFT ESTABLISHMENT GLIDING CLUB
RAE Farnborough, Hants.
Tel.: Aldershot 24461

Mr G. I. Lewis, 14 St. Michael's Road, Farnborough, Hants.

SOUTH WALES GLIDING CLUB
Bedwas, Nr Cardiff.

Mr D. E. Fletcher, 6 Windemere Avenue, Roath Park, Cardiff.

*STAFFORDSHIRE GLIDING CLUB
Meir Aerodrome, Nr Longton, Staffs.

Mr J. M. Marshjones, 21 Ravens Lane, Bignall End, Stoke-on-Trent, Staffs.

SWANSEA GLIDING CLUB
Fairwood Airport

Mr W. D. Miles, 2 The Beeches Close, Hendrefoilan, Swansea.

SWINDON GLIDING CLUB
South Marston Aerodrome, Swindon, Wilts. Tel.: Stratton St Margaret 3391

Miss B. Sanders, 118 High Street, Hungerford, Berkshire.

ULSTER & SHORTS GLIDING CLUB
N. Ireland Army Command Vehicle Park, Long Kesh, Hillsborough, Co. Down.
Tel.: Hillsborough 284

Mr G. Mackie, P.O. Box 38, 200 Springfield Road, Belfast 12, Northern Ireland.

WEST WALES GLIDING ASSOCIATION Flying Control, Withybush, Haverfordwest. Tel.: Haverfordwest 3665	Mr W. Sheppard, Holloway House, Haverfordwest.

OVERSEAS CLUBS

RAF GERMANY GLIDING ASSOCIATION Sites at: RAF Bruggen RAF Geilenkirchen RAF Laarbruch RAF Detmold	Flt Lt G. Holding, RAF HQ, RAF Germany, Radio 1B, BFPO 40, Germany
PERAK GLIDING CLUB	The Secretary, P.O. Box 161, Ipoh, Perak, Malaya.
GHANA GLIDING ASSOCIATION	Mr R. E. Lewis, P.O. Box 1748, Accra, Ghana.

OTHER CLUBS AND CENTRES

Australia

Gliding Federation of Australia, Box 1650 M, GPO Adelaide, S. Australia.

Austria

Osterreichischer Aero-Club, Wien IV, Prinz Eugen-Str. 12.
Four major gliding schools at present operate in Austria. They are: the Spitzerberg Segelflugschule, situated between Hainburg and Bad Deutsch-Altenburg in Lower Austria, which was founded in 1934 but has recently had extensive alterations and improvements made; the Zell am See Alpine Segelflugschule, in Salzburg Province, also with up-to-date facilities; the excellent Aigen Union-Alpen Segelflugschule, in the Styrian Enns Valley; and the Wien-Donauwiese Segelflugschule, opened in April 1960, and situated very conveniently on the outskirts of the Danube metropolis.

Belgium

Aero Club Royal de Belgique, 53, Avenue des Arts, Bruxelles 4, Belgium.

Canada	Mr T. R. Beasley, PO Box 621, St Laurent, Montreal 9, P.Q.
Czechoslovakia	*Aeroklub Ceskoslovenske socialisticke republiky*, Opletalova 29, Prague 1.
Denmark	*Kongelig Dansk Aeroklub*, Osterbrogade 40, Copenhagen.
France	*Aero-Club de France*, 6 rue Galilee, Paris XVIe. Courses at the French National Gliding Centres of La Montagne Noire (near Castelnaudary) and Saint Auban sur Durance (Basses Alpes).
Germany	*Deutscher Aero Club e.V.*, Bockenheimer Landstr. 19, Frankfurt/Main. Courses at the famous *Wasserkuppe School*, Post Gersfeld/Rhon, the *Hornberg Gliding School*, (14a) Hornberg Lei Schwabisch Gmund; the *Segelflugschule Juist*, Juist auf Juist ; the *Alpensegelflugschule Unterwossen/Chiemgau*, Unterwossen/Chiemg.; the *Segelflugschule Oerlinghausen e.V.*, Oerlinghausen/Kreis Lippe.
Holland	*Koninklijke Nederlandse Vereniging voor Luchtvaart*, Josef Israelsplein 8, The Hague. Courses at the *Koninklijke Nederlandse Vereniging voor Luchtvaart Gliding Centre*, Terlet, Nr Arnhem.
Hungary	*Magyar Nepkoztarsasag 'Fehervari Miklos' Kozpont Repulo Klubja* Engels Ter. 14, Budapest V.
Iceland	*Flugmalefelag Islands*, Reykjavik Airport, Reykjavik.
Ireland (Eire)	*Irish Aviation Club*, Dublin Airport, Dublin.
Italy	*Aero-Club d'Italia*, via Cesare Beccaria 35, Rome. Courses at: *Gliding National Centre*, Rietl; *Alpine Gliding Centre*, Varese; *Gliding Club of Milan*, Bresso (Milano) For details about these Centres, please apply to the Aero-Club d'Italia.
New Zealand	*New Zealand Gliding Association (Inc.)*, PO Box 709, Christchurch.
Northern Ireland	*The Ulster Gliding Club*, Belfast. Please contact Mr C. A. Beck, 116 Marlborough Park (Central) Belfast, or Mr W. Liddell, 42/44 Upper Queen Street, Belfast.
Norway	*Norsk Aero Klubb*, Karl Johansgt, 18, Oslo.
Poland	*Aeroklub Polskiej Rzeczypospolitej Ludowej*, Krakowskie Przedmiescie 55, Warsaw.
South Africa	*Aero Club of South Africa*, 109 Winchester House, Loveday Street, PO Box 2312, Johannesburg.

Spain — *Real Aeroclub de Espana,* Carrera de San Jeronimo 19, Madrid.

Sweden — *Kungl. Svenska Aeroklubben,* Malmskillnadsgatan 27, Stockholm. Courses at the *Gliding Centre Alleberg,* Falkoping. Details of the gliding centre and other clubs in Sweden from the Kungl. Svenska Aeroklubben.

Switzerland — *Aero-Club de Suisse,* Hirschengraben 22, Zurich. Gliding Schools at Rigi-Kulm, Nr Lucerne; Bern; Birrfeld and Samedan. Details from the Aero-Club de Suisse.

USA — *The Soaring Society of America Inc.,* Box 66071, Los Angeles 66, California.
The following are a few of the soaring schools and commercial establishments listed by *The Soaring Society of America.* For complete lists please apply to *The American Soaring Society* direct:
Holiday Soaring School, Airport (PO Box 6), Tehachapi, California.
Hudson Valley Aircraft Co. Inc., Randall Airport (PO Box 320), Middletown, NY, 55 miles NW of NYC, 1 hr via throughway and Rte 17.
Schweizer Soaring School, Schweizer Aircraft Corp., Chemung County Airport (PO Box 147), Elmira, NY, 10 miles NW of Elmira, just off Rte 17.
West Texas Soaring. N end of Ector County Airport (1703 W Crescent Drive, Odessa), 4 miles N of Odessa, Texas.

Yugoslavia — *Vazduhoplovni Savez Jugoslavije,* Uzun Mirkova 4/1, Belgrade.