THE SOLO GLIDER PILOT

W.D. & H.O. Wills Glider Pilot Competition 1967

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the

Solo Glider Pilot

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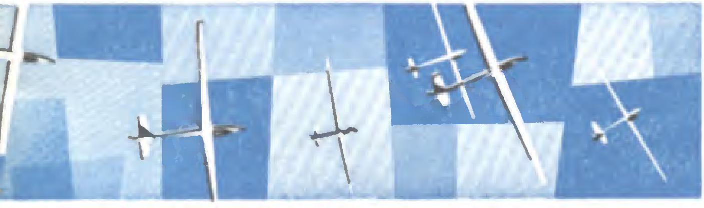

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THE SOLO GLIDER PILOT

To a pilot who has struggled through months of dual flying it is probably cold comfort to say that only now that he is solo can he really start to learn to fly. But it is true in the sense that he is now a pilot in his own right, and responsible for his own decisions.

The solo pilot has almost certainly got his sights set on an unlimited future of cross-country soaring, and competition flying, and obviously wants to taste these delights as soon as he can, but such skill does not come overnight; the soaring pilot plastered with diamonds, has worked long and hard for his fun.

Some experienced pilots treat flying like a bicycle ride; they know what feels right, and they know intuitively how to produce the right results, without having to analyse how they do it. Other pilots, particularly those with an analytical mentality, become much better only if they understand the theory behind what they are doing. It is for these pilots that the technical part of this book is primarily intended.

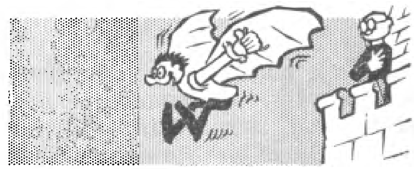
The book also contains, collected together, those aspects of flying which experience has shown are often misunderstood or forgotten; parts of it may seem too elementary, as for example, the section on effects of controls, but this is included for completeness, and because it is thought that it will be of value to some.

Gliding involves not only flying, but launching and looking after the aircraft; these three aspects cannot, in practice, be separated, and so the pilot who can do all of them will get more flying in the end.

It is *not* intended that this book should in any way replace the instructor. There is no substitute for direct person to person teaching, because without questions and answers, there is no feed back. For this reason the student pilot should not just read up in this book a particular subject and go off and try it for himself. He should talk it over with his instructor first.

A.W.

FLYING SOLO



Before a pilot can really start to get involved in the object of gliding, that is soaring, he must be reasonably competent in the routine art of flying his aircraft. To the soaring pilot the launch, flying about, and the approach and landing are simple straightforward things needing little thought as to their execution. He has done them before, he knows how to do them, and so he can devote his energies to the soaring part of the flight. But before anyone can get to this stage each flight must have ceased to be an emotional experience, with the pilot able to deal with all the ordinary aspects of flying properly and safely.

The best way to progress from early solo to this competent stage is by a series of gradual steps. First of all the pilot must fly regularly, since if he does not get airborne for several weeks at a time he will definitely lose ground. Secondly, he must learn how to analyse his flying and then teach himself. He must set himself specific things to do, and criticise himself on their execution. To begin with, the task should be a simple one—a perfect 360 degree turn, an accurately judged approach, or a landing at a precise spot. If he undershoots the point at which he had elected to touch down, he must not kid himself that this was where he really meant to finish his landing run. He must work out why he undershot—was the final turn too far out, or did he open the brakes too soon or too much?

Following from such personal de-briefing, the pilot must determine to jog himself when he does things wrong. When driving a car and being unexpectedly overtaken, the good driver feels guilty that he had not seen the other car in his mirror. In the same way, the pilot who realises that he has not done his cockpit check properly, looked round before turning, checked the wind direction on the approach, or has suddenly noticed a glider near him which he had not seen before, should feel the same prick of conscience.

Before every solo take off the pilot should decide what is the purpose of his flight. Is he going to try to improve his circuit planning, or to stay up in local thermals endeavouring to centre in each thermal more quickly? No flight should be made without a purpose, and after releasing is not the time to start thinking what to do.

As the pilot improves his handling skill, he should start to carry a map to recognise landmarks, assess visibility, cloud base height, imminent changes in the weather, and generally to become familiar with the environment in which he is operating.

He must discover how to see other aircraft in the air, and how to plan his flying without either getting in their way, or remaining under-confident about his ability to join them safely in a thermal. He should practice looking out for other gliders well before he commits himself to his landing line so that, in order to avoid having to come in close alongside another aircraft, his approach plan will be sufficiently flexible to allow him to open his brakes and go in early, or to know that he can safely vary his circuit and follow in after the other aircraft.

It is worth making a considerable effort to do all these things, because only the pilot who flies well can hope to stay up and go places.

1. PREPARATION FOR FLIGHT

1. Before getting into the glider: Take a general look over the aircraft, and see that it is clear of obstructions and in a suitable position for launching.

2. Before allowing the cable to be attached, do the cockpit check:

C.—Controls—Check that elevator, ailerons, and rudder work freely, fully, and in the correct sense.

B.—Ballast—See that the aircraft is correctly ballasted for the cockpit load.

S.—Straps—See that the harness straps are done up (both occupants).

I.—Instruments—Check that the altimeter is set as required (at zero or airfield height) and that other instruments are serviceable. Start barograph.

T.—Trim—Check operation and position of trimmer lever, for winch launch normally in middle of range, for aerotow further forward.

C.—Canopy—Check that it looks fully closed, locked and secure, that bolts or catches are fully home, and that it does not yield to upward pressure.

B.—Brakes—Check that airbrakes or spoilers work freely and together, and that they are shut and locked. Flaps (if fitted) set for take-off.

3. Get the cable attached to the appropriate hook. And, if the first launch of the day, make a test release, using the words "Open—Close—Test—Close" when doing this. Check that the take-off path is clear. Check that there is no one in front of any part of the glider, or near the tail plane. See that the wing-tip man is holding the wing-tip correctly. Tell the signaller that you are ready to start the launch.

4. If for any reason you do not wish to proceed with the launch, release the cable and shout "Stop" to the signaller.

* * *

The cockpit check 3 star item is AIRBRAKES, because you have the biggest chance of breaking the glider for a very small mistake. If your brakes come out on aerotow the tug pilot will have to ditch you even at a low and difficult height. Having the brakes out may not make much difference on a winch launch, but after release your return to earth will be rapid— even if you don't add to the rapidity by stalling as well. Ensure airbrakes are shut AND LOCKED.

2. EFFECT OF CONTROLS

1. The primary effect of each control surface is in its own plane, i..e., the elevator causes pitching, the ailerons rolling, and the rudder yawing. These effects are always the same regardless of the attitude of the glider.

2. Like all other bodies, a glider possesses inertia; to alter its attitude a force must be applied for some period. This is especially marked in the rolling plane.

3. If an aircraft is banked (by using the ailerons), the rudder being held central, it will sideslip in the direction of the lower wing. As a result of this sideslip, the air will strike the side surfaces of the aircraft and will tend to yaw it in the direction of the slip, the nose going round and down towards the lower wing tip. The yaw is due to the fact that the glider has more keel surfaces at the rear (fin, rudder, rear fuselage) than it has in front. It is the result of the natural "weathercock" stability of the glider.

4. The yaw caused by the sideslip is sometimes called the "further effects of aileron control," although it should be noticed that it is only indirectly the result of the movement of the ailerons.

5. The rudder control may also have a "further effect," but it is of less importance. If an aircraft is yawed by using the rudder, the ailerons being held central, it will none the less tend to bank. The bank is caused partly by the outward skid, which is the result of making a flat turn, and partly because the outer wing travels faster than the inner and thus gets more lift. The reason why the skid causes bank is that the natural lateral stability of the aircraft (dihedral angle, etc.) acts in such a way that the outer wing, due to the direction of the airflow, gets more lift than the inner.

Thus the primary effect of the rudder is to yaw the aircraft, and the further effect is to start a rolling movement. Once the aircraft has started to bank the primary effect of the rudder (yawing the aircraft) now causes the nose to drop below the horizon.

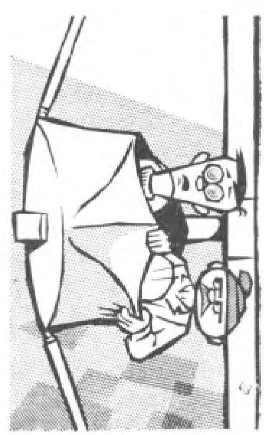
6. On most gliders, when the aileron control is used coarsely there is also a tendency for the aircraft to yaw in the opposite direction. This is called aileron drag. Because the downgoing aileron has to be pushed down into the full force of the airflow beneath the wing, that wing produces more lift which rolls the

aircraft, but it also produces more drag. On the other wing, the upgoing aileron causes the wing to produce less lift, which also helps the aircraft to roll, but reduces the drag of that wing. The result is that if left aileron is applied the right wing has more drag than the left, and this yaws the aircraft to the right.

3. TURNS

1. An accurate turn is a change of direction at constant rate, constant airspeed, and without slip or skid.

2. In order to turn an aircraft it is necessary to provide a force acting upon it in the direction in which the turn is intended. This can be done by banking the aircraft so that the lift, instead of acting vertically upwards, is now inclined towards the direction in which the turn is to be made. The vertical component of the lift will remain equal to the weight, while the horizontal component will provide the necessary force, to balance the centrifugal force acting outwards. The greater this inward force the smaller will the radius of the turn be. Hence, if it is desired to turn sharply, the angle of bank must be greater than when turning gently.



3. Since the lift must be sufficient both to support the aircraft and to provide the inward force, it must be greater than in straight flight. This increase in lift can only be achieved by increasing the airspeed or by some increase in the angle of attack or both. Unless the airspeed is increased by the pilot the angle of attack may approach that of the stall. This effect is not pronounced in medium and gentle turns, but becomes important in steep turns.

4. Each control should be thought of as having one definite function during the turn; the ailerons controlling the angle of bank, the elevators the position of the nose, the rudder preventing or correcting any slip or skid.

5. It has been explained that if an aircraft is banked it will automatically yaw owing to its natural stability. The rudder is not used primarily to yaw the aircraft. It is used to prevent slip. On most gliders this slip is noticeable and the rudder should be used, but only so much as is necessary to eliminate it. If rudder is used during a turn it is called "bottom rudder" when applied towards the lower wing, and "top rudder" when applied towards the higher wing.

6. On some gliders as aileron is applied the aircraft may yaw in the opposite direction to that in which it is desired to turn; this is aileron drag and has already been explained. In such types a certain amount of initial rudder in the direction of the turn will be needed to counteract the adverse effect of the ailerons.

7. When a glider is turning, the inner and outer wings travel on different paths and this causes two effects: (*a*) the outer wing going faster than the inner tends to get more lift, and (*b*) the outer wing travelling on a larger spiral is flying at a smaller angle of attack than the inner wing and so tends to get less lift. These two effects more or less cancel each other out, although on some high performance gliders the effect of the outer wing travelling faster is the greater, and so the angle of bank tends to increase. The important consideration is to keep the bank constant, using the controls as necessary to achieve this.

8. A medium turn is made by applying bank, with ailerons, and the yaw is produced for the most part automatically by the resultant slip acting on the weathercock stability, but is helped by rudder if such stability is insufficient. During the turn the bank is held constant with the ailerons and the yaw is automatic; but if there is any slip or skid, rudder is applied in the direction of such slip or skid. To come out of the turn, bank is taken off with the ailerons, and the yaw is eliminated by weathercock stability, any skid being corrected by rudder.

9. FAULTS IN TURNS. Bank should be held constant throughout the turn. At about 30 degrees few faults are likely to occur. Too little bank will result only in too little turn, but increasing bank will result in a steepening turn which may get out of hand.

The nose may rise above or fall below the horizon; this is corrected by use of the elevator.

10. If the glider is slipping in it can be felt by the pilot tending to slip inwards on the seat; this is corrected by applying more rudder in the direction of the turn. Skidding out can only happen if there is too much rudder.

In correcting one fault it may be found that another is caused, e.g., when the rudder is moved to correct slip or skid it may cause the nose to move above or below the horizon which in turn may necessitate elevator movement. But it is easier to think of each fault separately, and in practice smooth co-ordination of the controls can be soon achieved.

Steep Turns

11. Although a steep turn is only an ordinary turn made much more rapidly, it is an extremely good exercise for improving a pilot's flying, and satisfying when it is done well.

12. When making a steep turn, the lift on the wings has to be increased considerably compared to that in straight flight;

the stalling speed is therefore greater, as is shown in the following table:

Angle of bank	g	Stalling speed × stalling speed in straight flight	Typical stalling speed (knots)
0°	1	1	33
10°	1.02	1.01	33
20°	1.06	1.03	34
30°	1.15	1.07	35
40°	1.3	1.14	38
50°	1.56	1.25	41
60°	2	1.41	46
70°	2.92	1.71	56
80°	5.75	2.4	79

13. It will be noticed that above 60 degrees the loads and hence the stalling speed, increase rapidly. It must be understood that it is impossible to do a continuous steady vertically banked turn since the lift of the wings, by acting horizontally, will have no vertical component to carry the weight of the aircraft.

14. In order to develop the extra lift required, it will normally be necessary to keep a backward pressure on the stick.

15. The rate of descent in a really steep turn is rapid.

16. If, when the speed builds up in a steep turn, the pilot attempts to reduce it by simply pulling back the stick, the aircraft will in consequence tighten up into a steeper spiral, and the speed instead of being reduced may even increase. Reduce bank before attempting to reduce speed.

17. Keeping a good look-out is important. It is not sufficient to look round before the turn and before coming out: even during the turn it is necessary to keep looking round and searching the sky for other aircraft.

* * *

It is not possible to make good turns until you can CONTROL THE ANGLE OF BANK. If you can keep bank constant throughout the turn, corrections for speed or slip and skid are easy. If the bank is allowed to vaguely increase or decrease at will, it is difficult to sort out mistakes.

4. TAKE OFF AND CLIMB

Winch and Car-Tow

1. The object is to get the glider to the maximum height without imposing undue stresses upon it. This means that the launch must be so made that it does not impose excessive loads on the cable, and that should the cable break at any moment, or the power fade, the glider will be in a position from which it can be landed safely.

2. At the beginning of the ground run coarse use of the ailerons will be necessary to keep the glider level. Steering should be done with the rudder.

3. The actual technique of using the elevator control will vary to some extent with the aircraft—the position of the hook and the type of undercarriage. However, on gliders which have a wheel placed near the centre of gravity, it is best to get the glider running along on its wheel, without either nose or tail skid touching the ground. This may require a definite elevator movement.

4. The initial climb must be made smoothly and gently. The position of the release hook will determine the extent to which the elevator control has to be used.

5. The glider should not be climbed steeply until it has reached 100 feet or so and has adequate speed. The angle at which the climb can be made will depend on the position of the hook, the speed of the launch and the roughness of the air. If the speed is slow, it is inadvisable to attempt to climb steeply because the aircraft will "mush" and this will apply more load on the engine which may make it difficult for the winch or car driver to increase speed. If, on the other hand the launch is fast, the glider should not be climbed more steeply in order to reduce speed, as this will impose heavy stresses on it.

6. Certain gliders with the release hook fitted far forward may "buck" during the latter part of the launch. This bucking, which takes the form of a pitching oscillation, can be damped out by slightly lowering the nose.

7. The stresses on a glider during a launch are considerable even in calm air; if the air is rough and the glider is climbed very steeply the stresses will be severe.

8. Winch or auto-tow launches may often be made out of wind. Under this condition the greatest height will be obtained by keeping the nose towards the winch and allowing the glider to drift. The disadvantage of this is that the cable may be dropped in an inconvenient position. It is better, therefore, to make the climb on a straight track over the line on which the cable was laid out. This can only be done by keeping the windward wing down slightly.

* * *

After release you will want to retrim. Select the attitude at which you wish to fly, and wait for the speed to settle down. If the speed is not what you want, re-adjust the attitude, and again wait. When the speed is correct and has settled, and while still holding the attitude, retrim.

5. THE APPROACH AND LANDING

1. The first consideration in making a good landing is to make a good approach; and a good approach is the result of accurate positioning on the circuit.

2. Forgetting for the moment either soaring or any method of steepening the glide path, from any given height of launch the glider will travel a certain distance through the air before it

comes into contact with the ground. The problem of approach planning is to fly a path of this length so that the glider touches down in the desired part of the landing ground.

3. Planning of the circuit is made easier if a certain basic shape is adopted. The conventional and simplest shape is the square circuit. This consists of a cross-wind, a down-wind, a second cross-wind (base) leg, and a final approach straight into wind, with turns through approximately a right-angle in between. Because the pilot wants to exploit his height, he therefore wants to use only as much of the circuit as enables him to execute an organised approach, and avoid endangering other aircraft. The early part of every flight should be used for some specific exercise, or in a search for lift, and he should aim to join the circuit at a suitable height at a point about a quarter of the way along the down-wind leg.

4. This down-wind leg should be used for making major adjustments in position, and the pilot should consider all the time that he is flying along it his relation to the landing ground. If he considers that he is high he should edge away from the landing ground, and if low, edge in towards it.

5. The position in which the second cross-wind turn (on to the base leg) is made will depend on the height available and the strength of the wind. Normally the turn will be made when the glider is some distance down-wind of the boundary of the landing ground, but as the vital consideration is to keep at all times within easy gliding distance of the field, if the wind is strong the glider must not be allowed to go far beyond the field boundary.

If the glider is very low the turn will have to be made early, before reaching the down-wind boundary. If the glider is high the turn can be delayed, but not so much that an excessively long into-wind leg will be required.

6. As the turn is being made, the pilot must again consider his position in relation to the landing ground, judging the angle at which it appears to him, and his height. If the approach has been judged correctly so far he will straighten up and fly across wind. If he has any doubts about his height he must continue the turn and fly straight towards the field; while if he thinks that he has too much height he should not turn so far, so that this cross-wind (base) leg will edge him further away from the field.

The strength of the wind can be assessed by noting the way the glider is drifting; if the drift is appreciable the nose of the glider will have to be turned in towards the field in order that a track across wind can be made good.

Judgment of the moment to start the final turn is difficult; it is partly a matter of noting the height and distance away from the boundary, but much more one of observing the angle at which the landing ground is seen. Airbrakes should be used as required to achieve the desired path.

In the perfect circuit the final turn will be made as the glider approaches the line of the landing run. However, this cannot always be achieved, as thermals or sinking air, upset the approach. If the glider is much too high even using full airbrake, the cross-wind leg should be continued either until it is in a position from which the final turn can be made or, if it is still too high, turned back so as to fly across wind in the opposite direction. It is essential that all turns be made into wind.

7. It is highly undesirable to do low turns. The last turn into wind should have been completed by a height of at least 150 ft. The distance the glider will travel from this height into wind depends, of course, on the wind speed, but unless the wind is strong, and airbrakes are used, the glider will go a considerable distance after the final turn.

Airbrakes

8. All modern gliders are fitted with means of steepening the glide path. They are (*a*) dive brakes, and (*b*) spoilers.

9. Dive brakes usually consist of surfaces arranged to extend above and below the wing profile. They can be used for (*a*) limiting the speed in a dive, and (*b*) adjusting the approach angle.

10. Spoilers consist of flaps hinged on the upper surface of the wing, and are used primarily as a means of increasing the rate of descent. They are usually found on older gliders. The term airbrakes will be used generally.

11. Effect of Airbrakes. Opening the brakes may have four effects (*a*) the drag will be increased, resulting in the aircraft descending at a steeper angle through the air. (*b*) The stalling speed is often, but not necessarily always, slightly increased. The amount is seldom more than one or two knots. (*c*) The maintenance of the same flying speed will require the nose to be lower. (*d*) There may be a change of trim. This means that if the aircraft is in trim at a particular speed with the brakes shut a push or pull load may be required on the stick when the brakes are opened and the same speed maintained. With dive brakes this effect is usually small, but spoilers often cause a nose down change of trim, which has to be counteracted by a backward pressure on the stick or retrimming to prevent the speed from increasing.

12. Control Loads. When dive brakes are shut, the aerodynamic loads on them are normally such as to tend to pull them open. This is prevented by a lock (usually an over-dead centre mechanism). In flight an appreciable pull may be required to unlock, but thereafter the brakes may want to open fully of their own accord. To prevent this a push force is required on the lever, which is considerable when flying fast, to prevent the brakes jerking fully open. At approach speeds this effect is less marked, but may still be disconcerting.

Spoilers, on the other hand, are normally kept closed by springs, requiring an increasing pull back force to open them.

13. Because of the tendency of dive brakes when unlocked to ride open, it is important that once the pilot has put his hand on the lever he should keep it there until either he has landed, or he has re-locked the brakes. This is, of course, not necessary with spoilers, but if it is not practiced from the beginning the pilot may subsequently fail to lock his airbrakes and run into trouble. It is important that the distinction between the control loads on air-brakes and spoilers is understood.

14. The effectiveness of airbrakes varies with different types of glider, but dive brakes are normally powerful. If a glider has a gliding angle of 1:25 (about 2 degrees) this will become about 1:8 (7 degrees) when the brakes are opened. Spoilers are less powerful, and because of this speed will build up if the nose is lowered too far.

15. Both dive brakes and spoilers can be used to provide any degree of braking between no brake and full brake. However, the response to the movements of the control lever is not linear, and, particularly with dive brakes, the initial movement of the lever produces a disproportionately large amount of braking effect. This is due to the fact that once the brakes project from the wings by more than an inch or so, the braking effectiveness is dependent on the distance between the top of the upper brake and the bottom of the lower brake, and not by the distance by which the brakes project.

16. When flying at a steady speed with the brakes shut the position of the nose is a definite indication of the aircraft's speed. This is no longer the case when the brakes are opened since the nose has to be lowered to maintain the same speed, the amount varying with the amount of brake.

17. The airbrakes should be used as a continuously variable control, being eased gradually in and out to keep the aircraft on the chosen glide path at the selected speed. The brakes should be used to control the rate of descent, and the elevators to control the speed.

18. In full brake landings the speed will fall off more quickly during the round out, and as the aircraft also has to be rotated through a large angle, it will be easy to land heavily unless adequate speed is maintained until close to the ground. This may be due to a slowness in bringing up the nose, a lack of elevator power, or because the aircraft is stalled. When descending rapidly with full brake the effect of wind gradient will be more marked, and it may be undesirable to use full brake in strong winds.

19. If the brakes are opened suddenly during the hold off, without alteration in the attitude, the glider may land heavily. This is not necessarily due to the slightly higher stalling speed associated with open brakes, but because the flight path is different.

Landing

20. The final approach should be made as smoothly and steadily as possible towards a part of the landing ground which is clear of obstructions. The glide is continued at a constant speed down to a height from which a progressive round out can be made. The glider should then be held just off the ground until the attitude is right for landing. It will sink on to the ground, touching main wheel and tail-skid together.

21. If the landing is to be made on an up slope, the change in angle between that of the final glide and the two-point landing attitude will be greater than usual. In order to be able to rotate the aircraft through this larger angle without stalling, the approach must be made with a greater margin of speed. If the landing has to be made on a down slope there will be no need to round out either as much or at all, as the aircraft is already in the landing attitude relative to the ground. The only problem is to get it there, as the gliding angle is likely to be flatter than any except the most gentle slopes. The best way to deal with this undesirable situation is to bring the aircraft in with full brake, and at a slow speed, allowing only enough margin to deal with wind gradient, and to maintain full control. The steady descent should be held until the aircraft is on the ground. Should the slope of the ground have decreased or become level at the point at which the aircraft is likely to touch down, the amount of brake must be reduced, before any attempt is made to round out in the normal way.

22. Wind gradient. This describes the diminution of wind strength near the ground. Normally the wind has no effect on the way in which a glider flies, but if it is flown suddenly into a region in which the wind is blowing at a different speed, the airspeed of the glider will be affected for a short time until it has steadied down in the new conditions. If a glider is coming into land against a strong wind (which will be blowing less strongly close to the surface) the airspeed will tend to fall off as the glider gets closer to the ground. This can be obviated only by putting the nose further down during the later stages of the approach, although if this is done too late, or with inadequate speed in hand to begin with, the aircraft may arrive on the ground without enough control to round out and make a normal landing.

In any case the approach in a strong wind should be made at a faster speed than usual in order to ensure adequate control in the turbulent air.

* * *

It is easy to make an approach by flying much too fast, and then rely on the drag of the airbrakes to both keep the speed from getting out of hand, and bring you down rapidly. If field landings are later to be accomplished safely, you must learn to select a safe approach speed, and, *flying at this speed,* control the glide path by using the airbrakes as necessary.

6. THE STALL AND SPIN

1. In order that a glider may fly at all, the wing must produce lift equal to the load upon it. The lift produced by a wing depends on the speed of the airflow past it and the angle at which it is held to this airflow. If the glider is flying fast this angle, called the angle of attack, is quite small. When the speed is reduced, the angle of attack is increased. But the speed cannot be reduced indefinitely, because at a certain angle of attack the airflow over the top of the wing breaks away and the lift is reduced. The nose drops even if the stick is moved farther back. This is the stall.

2. The wing will always stall at the same angle of attack, that is the same angle between the chord line of the wing and the airflow. For most aerofoil sections this angle is about 15 degrees. This angle must not be confused with the angle at which the glider is flying in relation to the horizon. The glider will stall in any attitude whenever the angle of attack reaches this critical angle.

3. The speed at which the stall occurs depends on the load which has to be carried by the wings; if the load is increased the stalling speed becomes higher. The weight at which a glider is flown does not usually vary much and so in straight flight the stalling speed will be more or less the same. If, however, the glider is being flown around a curve, either in a turn or by pulling out of a dive, the wing will have to carry an extra load due to the centrifugal force, and this will increase the stalling speed.

5. Symptoms of the approach to the stall are:

(*a*) The position of the nose. If the nose is kept too high for any length of time the glider will stall.

(*b*) Slow airspeed shown by absence or change of noise, and reduction of airflow on the pilot's face.

(*c*) Ineffectiveness of the controls, particularly the ailerons.

(*d*) Increased rate of descent, even if the stick is moved back.

(*e*) On some types of glider buffeting will be felt.

It is important that these symptoms are learnt well, so that they will be recognised in flight instinctively.

4. In order to recover from a stall, all that is required is to reduce the angle of attack until it is below that at which the airflow becomes turbulent. This may happen to some extent automatically, because at the stall the nose drops and the glider takes up a new flight path, but the reduction in the angle of attack is assisted by moving the stick forward. The recovery from the resultant dive is made by gently raising the nose.

5. Sometimes if the glider is not flying straight or has one wing down, or if the air is gusty, one wing may drop at the same time as the nose. If this happens opposite rudder should be used as a means of keeping straight. The ailerons may be quite ineffective or may even have the opposite effect to that desired, since the result of lowering the aileron on the down-going wing is, in effect, to increase the angle of attack of that wing still further. Hence

its lift will be reduced and it will continue to drop. As soon as speed has been gained the aileron can be used to level the glider in the ordinary way.

6. An inadvertant stall in straight flight is comparatively rare. A pilot is far more likely to stall off a turn. The symptoms given above still apply, but in addition there is usually a pronounced tendency for the inner wing to become heavier as the aircraft nears the stall.

The Spin

7. A spin is a condition of stalled flight in which the aircraft makes a spiral descent, losing height rapidly. During a spin the aircraft is simultaneously rolling, pitching and yawing: its motions are, to a large extent, automatic and outside the control of the pilot.

8. Whenever the aircraft is near the stall there is a possibility of a spin developing, especially if the rudder or ailerons are producing a roll or yaw.

9. In a spin the inner wing is more fully stalled than the outer, and so this inner wing produces less lift, but also, because it is at a higher angle of attack, more drag than the outer one. This drag causes the aircraft to rotate.

10. The actual form which a spin takes varies in different types of aircraft; some spins are steep and quick, others flat or slow. Some gliders will spin continuously if the stick is held back and full rudder applied, but others may alter their spinning characteristics after entry. The glider may come out of the spin of its own accord, or alternatively, the airspeed may increase and the spin change to a spiral dive.

11. The position of the centre of gravity of the aircraft will effect its behaviour in a spin. If it is back the glider may spin easily and continuously. If the c.g. is behind the permitted rearward limit, recovery from a spin *may be impossible.*

Many modern gliders are reluctant to spin steadily if the aircraft is being flown with the c.g. fairly far forward, or if full control movements are not used to enter, or if the attempt at entry is made without the aircraft being fully stalled. In the circumstances an attempt at a spin may result in the nose and wing dropping rapidly, and the aircraft starting to rotate in a manner very similar to a true spin. However, after half a turn or so it will be found that the speed of rotation, the airspeed, the sensation of g, and the load on the controls all increase rapidly. This is because the aircraft is doing a spiral dive. If this is allowed to continue heavy loads can be imposed on the aircraft, particularly if the pilot is still under the impression that he is spinning, still has on full pro-spin rudder, and is holding the stick back. It is possible to exceed the safe loading in as little as 1½ turns. The recovery will commence as soon as the controls are eased off, but because the aircraft is in a steep attitude, and going faster than it would be if it had been doing a spin, there is a real risk of exceeding the permitted speed before regaining level flight. If the pilot finds himself getting too fast, he should open the brakes.

12. Most gliders will recover from a spin if the controls are centralised; but recovery may not be very quick and this method will not always be successful. Only the standard method of recovery should be used, as this has been found to be the most effective on all types of aircraft.

13. The standard method of recovery from all spins and incipient spins is, FIRST to apply full opposite rudder, a slight pause, and THEN to move the stick steadily forward until the spinning stops. The rudder is applied to help stop the rotation, but the spin will not stop unless the wings are unstalled, so the stick must also be moved forward. On some types of aircraft, if the stick is moved forward at the same time as the opposite rudder is applied, the rudder or elevator may be ineffective, probably because one is shielded by the other. That is why the standard method is to apply the rudder first.

14. Most gliders will recover as soon as the opposite rudder has been applied, and the stick moved a small distance forward. This is, however, only part of the full procedure, and on certain types of aircraft the stick has to be held hard forward for one or two turns of the spin before the aircraft will recover. The pilot must remember the procedure as "apply full opposite rudder and then move the stick steadily forward UNTIL THE GLIDER STOPS SPINNING.

* * *

It is only dangerous to stall by mistake. Many pilots are so surprised when they do, that they rarely take recovery action until too late. There is no substitute for thoroughly learning how the glider behaves, and what it feels like when being flown too slowly.

7. CABLE BREAKS

1. Throughout every launch the glider must be flown in such a way that should the cable break, or the power fade, the glider may be safely landed.

2. Unless the glider is fitted with a hook placed very far aft, when the cable breaks the nose, relieved suddenly of the cable load, will want to rise.

3. Adequate flying speed is necessary in order to maintain control. To retain it the nose must be put down at once. It is not enough to just lower the nose a little. It must be put down to the attitude required on a normal approach at that height. At about 100 feet up in a wind gradient, this means a surprisingly large change of angle. If, when the cable breaks, the climb is being made at a slow airspeed, and at steep attitude, the glider will decelerate

rapidly; considerable height will then be lost in getting the nose down and allowing the speed to build up again. If, however, a less steep climb at a faster airspeed is made much less height will be lost in the recovery.

It follows, therefore, that the glider must not be climbed steeply or at a slow speed until it is well clear of the ground.

4. The cable breaks when too heavy a load is put upon it. In order to avoid this the launch should be made as smoothly as possible and very steep climbs should not be made in gusty conditions. In particular the transition from level flight at take-off to the steep climb at 100 feet or so should be made without a sudden change of attitude.

5. The cable must be released from the glider immediately the launch fails, or the pilot decides to abandon it.

6. The action to be taken after the aircraft has been put in the gliding attitude and the cable released will depend on the height at which the break occurred, and the size of the landing ground. If it is possible to land straight ahead without over-shooting this should be done. But if this is impossible some turns will have to be made. As it may be difficult to judge from a low height when a circuit is possible, it should be made only if the pilot is quite sure that he has ample height and that it is impossible to get in ahead. If it is decided that a turn to one side must be made, this should be towards the nearer airfield boundary, or if the launch is cross-wind the turn should be made away from the wind; this allows the glider to be turned back again, with more space ahead in which to land, or to be into wind.

7. If a break occurs when taking off in a strong wind more height will be lost in the recovery than it would in still air owing to the wind gradient effect. In a powerful gradient, unless adequate flying speed already exists, it may be impossible to gain more, even by diving.

8. The above still applies in the case of a failure of the motive power of the launch, but as the failure may come gradually it is important that the pilot does not hang on too long in the hope that it will pick up. Either his speed will get dangerously low, or he will arive at the upwind end of the field without height to manœuvre safely.

* * *

The best way to avoid trouble on a cable break, is to have already considered a course of action before each take off, and to anticipate the cable break during the launch.

8. SIDESLIPPING

1. A glider is said to be sideslipping when its path of descent is at an angle to the heading of the nose.

2. The result of a sideslip is to increase the angle and rate of descent without a corresponding increase in forward speed; this feature makes it a useful correction for overshooting.

3. The sideslip provides a method of counteracting the effects of drift over the ground; it is sometimes used for this purpose when launching or landing out of wind.

4. A glider can be sideslipped while gliding straight or while turning, and both methods may be used as corrections for overshooting. The slipping turn, in which height is lost during the turn, is useful during an approach made to clear high obstacles. Used in conjunction with airbrakes the rate of descent can be extremely high.

5. Sideslipping is an unnatural condition of flight; both the lateral stability and the weathercock stability tend to prevent it. The lateral stability tries to take off the bank, while the weathercock stability tries to make the glider turn into the sideslip. So, to keep the glider in a sideslip the aileron control must be used to maintain the bank, and the opposite rudder used in an attempt to overcome the weathercock stability. The ailerons are usually powerful enough for their purpose, but on many gliders the rudder is comparatively weaker and this necessitates the use of full rudder at a small angle of bank. If the bank is increased beyond this angle, insufficient rudder control will be available to keep straight.

6. During the sideslip the elevators are used for their normal function of controlling the position of the nose so far as pitching is concerned; they cannot, however, prevent the nose from dropping towards the lower wing tip, as a result of yaw.

7. Much the same considerations apply to the slipping turn, which is simply one with insufficient rate of turn for the angle of bank.

However, in this case the weathercock stability is being allowed to take effect to some extent by yawing the glider, and so less rudder is required to keep the nose up than in a straight sideslip. For this reason, on some types of gliders which can be held only in a very gentle straight slip, a slipping turn is a much more effective way of losing height.

8. If the usual gliding speed is to be maintained during a sideslip the position of the nose will be higher than normal.

9. Owing to the high lateral moment of inertia, the large span, and slow rate of roll of many gliders, the recovery from a sideslip takes some time. Allowance should be made for this and the sideslip should not be continued close to the ground, particularly when there is a strong wind gradient.

10. Airbrakes provide the simplest method of regulating the approach, and sideslipping is in consequence infrequently employed. But its importance should not be forgotten, for it is an essential manœuvre for landing gliders without airbrakes. Used with them it, of course, increases their effect.

* * *

Many modern gliders do not sideslip well, but a very high rate of descent can be achieved by doing a fast slipping turn, with brakes out, into a wind gradient. Unless you stop this manoeuvre with plenty of height in hand, you will be about the two-thousandth pilot to have slipped neatly and expensively into the ground. If your glider has a pot-pitot, or static vents, the A.S.I. reading during sideslipping may be incorrect.

9. TAKE OFF AND LANDING OUT OF WIND

1. Taking off and landing out of wind may be necessary when the best run is at an angle to the wind, or when there are obstructions on the boundary or landing ground which limit the run into wind, or because the pilot has not discovered that he is not into wind until close to the ground.

2. When an aircraft runs along the ground out of wind the following factors must be considered:
   (*a*) The aircraft wants to weathercock into wind.
   (*b*) The wind tends to blow the aircraft sideways. If there is friction between the skid or wheel and the ground, this will prevent the aircraft from moving sideways, and it will tend to blow over.

3. When the aircraft is flying out of wind, it moves sideways over the ground, and if it comes into contact with the ground the sideways movement will be checked and side loads will be imposed on wheel and skid. The problem is that the aircraft is pointing in one direction and either going, or trying to go, in another. Therefore, the aim in both take off and landings is, in the first place, to ensure that the aircraft is transferred cleanly and deliberately from the ground to air and vice versa, and, in the second place to see that before placing the wheel or skid firmly on the ground on landing, the aircraft is facing the direction in which it is travelling over the ground.

4. When sideslipping, a glider is not travelling through the air in the direction in which it is pointing. This fact is of use in landings and taking off across wind, since by keeping the windward wing down the tendency to drift down-wind can be reduced.

5. Having decided than an out of wind landing is necessary, the pilot should pick a definite landing line. He can keep his aircraft on this line in two ways:
   (*a*) By keeping the nose to the windward side of the line.
   (*b*) By keeping it along the line and sideslipping the machine into wind.

6. In (*a*) if the approach is made with the wings level and the nose to windward, the drift will be noticeable, and should the glider be landed travelling crab-wise, as it is, severe loads will be placed on the undercarriage. This can be avoided by yawing the machine by applying down-wind rudder, so that at the moment of touchdown it is travelling in the direction in which it is pointing.

7. When sideslipping (*b*) the aircraft can be landed without drift by keeping the heading of the aircraft on the landing line and maintaining a sideslip into wind. Owing to the large span and small wing tip clearance of most gliders a steep sideslip near the ground is impossible, and this method cannot eliminate much cross-wind drift. Method (*a*) is more satisfactory, but some judgment is required in swinging the nose the right amount at the right time, and it is easy to get confused. Furthermore, as the nose is swung down-wind, the windward wing will tend to rise and, should the glider make contact with the ground while drifting, and with its windward wing up, the leeward wing may dig in and the machine turn over.

8. For these reasons, a combination of the two techniques is the best.

* * *

Many pilots have difficulty landing out of wind, because they do not recognise they are drifting until too late. Other pilots build in their own drift by flying with crossed controls—by coming in with a wing down, and "correcting" this with opposite rudder. Learn to recognise drift, and fly accurately.

10. AEROTOW

1. The normal tow position is just above the slipstream and is used for the following reasons:

(*a*) The glider is kept in the same position in relation to the tug, from the moment of take off.

(*b*) It is possible for the glider pilot to see both the tug and the ground clearly.

(*c*) The tug pilot can see the glider.

(*d*) The glider can release or be dropped at any time without chance of the rope fouling.

2. Since it is unwise to release if below the slipstream (in low tow) it is not advisable to tow in this position when looking for thermals. However, the glider and tug are both more stable in the low tow position than in normal tow, and it may, therefore, be found more convenient when towing in rough air on a long flight.

3. The optimum position for the glider in relation to the tug will depend on the available power of the tug, and the angle at which it is climbing. In normal tow, with an aeroplane of moderate power, it will be found most convenient to keep the glider level with or slightly above the tug. However, if the aero-

plane is particularly powerful, the normal tow position may be slightly lower than the aeroplane. In any case, the glider should be kept clear of the slipstream, otherwise the rate of climb will be reduced.

4. The minimum towing speed will normally be dictated by the considerations of the tug—its lack of control or tendancy to over-heat if flown below a certain speed. The maximum towing speed will normally be fixed by the glider's placard speed. The best rate of climb will usually be obtained by flying at the minimum permitted speed. On a cross-country tow on a rough day the tug pilot should keep the speed down to reduce the difficulty and effort which would otherwise be required by the glider pilot.

5. The rate of climb of the combination depends on the h.p. which is available in excess of that required for level flight. Since this excess may be only a small proportion of the aeroplane engine's total horse-power, a minor alteration in the engine's performance will alter the rate of climb to a disproportionate extent. Fifty engine r.p.m. or a slightly different propellor may make an appreciable difference. Because of the small reserve horse-power, the take off run will be lengthened much more than in the case of a solo aeroplane by such factors as long grass, uphill slope, soft ground, absence of wind, high temperature or altitude.

6. When the glider is flown in the correct position, the handling characteristics of the tug will be indistinguishable from those of the aircraft flown by itself, apart from the reduced rate of climb. However, if the glider becomes displaced, the load in the tow rope acting on the tail of the aeroplane will no longer be in line with the longitudinal axis of the aeroplane. To maintain the correct attitude and direction the tug pilot will have to apply elevator or rudder. A small displacement is easily dealt with, but if it is allowed to increase much, larger control movements will be needed. Ultimately, if the glider is flown widely out of position, the moment may be reached when the aeroplane pilot has insufficient control to maintain his original flight path. Things then happen quickly, as the motion is divergent. This is particularly the case if the glider is flown too high, because the tail of the aeroplane will suddenly be pulled upwards and it will go into a steep dive; even if the rope is released, or breaks, several hundred feet may be needed for recovery. It must be appreciated that a really crooked tow rope has much more effect on the tug than it does on the glider; as the rope is attached to the tail of the tug which has a long lever arm about the centre of gravity, whereas it is fastened to the nose of the glider where the leverage is much less.

For these reasons it is most important that the glider is not allowed to get too far out of position, particularly too high; if this does happen, the rope should be released immediately.

7. On many gliders, the hook which is used for aerotowing is comparatively low down and far back; when flying steadily in the correct position the behaviour will be similar to that

experienced with a hook on the extreme nose. However, if there is a sudden surge in the cable, or if the glider is allowed to get high, there will be a tendency for the glider to climb higher, with only insignificant stick loads, in the same way as a glider goes up on a winch launch. This is an additional reason against flying too high.

8. Turns will be most easily carried out if the glider pilot flies in such a way that the rope leads straight back from the tug. Since there inevitably will be a lag in the realisation by the glider pilot that the tug has commenced turning, the tug pilot should go into and come out of his turns gently.

9. It is fundamental that when two craft are in formation, one should maintain a steady course, and the other formate on it. In aerotowing the tug is the leader, and the pilot of this aircraft should, therefore, concentrate on keeping a steady heading and speed regardless of what the glider pilot does.

10. It is possible that the glider pilot may lose sight of the tug, as a result of inattention, being blinded by the sun, bad vision through a misted up canopy, or because he is towed into cloud. The almost inevitable consequence is for the flight paths of the two aircraft to diverge rapidly. To avoid the effects of a violent tightening of the rope or of a collision, the glider pilot should release immediately he loses sight of the tug.

11. Most tows are made with the object of gaining height, but on a cross-country flight it may be desirable to descend on tow. If the tug pilot does this gradually, the glider pilot will not be affected, but if he does it rapidly the glider will tend to overtake the tug. This can be avoided by use of the airbrakes, but such action should be avoided if at all possible, since it may be difficult to close the brakes again if the speed is high.

12. When using a resilient rope (such as nylon) there is no need to fiddle around trying to keep the rope tight all the time. The smoothest ride is obtained by keeping the glider in the right place and letting the rope look after itself. The optimum length of a resilient rope is about 150 feet (45 metres). Ropes less than 100 feet (30 metres) should only be used by experienced pilots.

13. The glider pilot should do a gentle climbing turn immediately after release. For Aerotow Signals see page 29.

* * *

Aerotowing is an unusual situation in that safety depends on the skill of two people—the tug pilot and the glider pilot, and the difference in the behaviour of the pair of you. For this reason, if anything goes wrong, things may happen quickly. Before they become disastrous you should release—you will be better off on your own.

11. FLYING SAFETY

(Extracts from Laws and Rules)

THE LAW

A glider shall not be operated in a negligent or reckless manner so as to endanger life or property, nor flown in such proximity to another as to create danger of collision nor in formation without prior agreement of the pilots.

A pilot on meeting hazardous conditions in flight shall, as soon as possible, report to the appropriate Air Traffic Control information helpful to the safety of other aircraft.

The aircraft which has the right of way shall maintain its course and speed, according to the following rules:

(a) **Converging.** When two aircraft are converging at approximately the same altitude, the aircraft which has the other on its right shall give way.

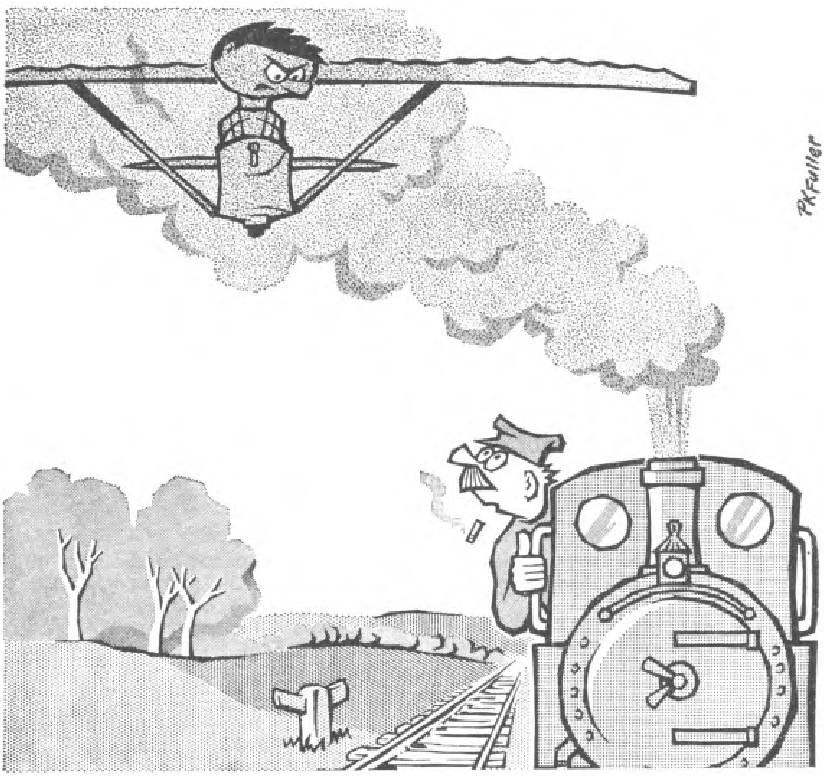
(b) **Head-on.** When two aircraft are approaching each other head-on, or approximately so, each shall alter course to its right.

(c) **Overtaking.** Overtaking aircraft shall at all times keep out of the way of the aircraft which is being overtaken by altering course to the right, provided that a glider overtaking another glider in the U.K. may alter its course to the right or to the left.

Whereas aeroplanes shall when converging give way to aerotows and gliders, and gliders shall give way to balloons, it is nevertheless the responsibility of all pilots at all times to take all possible measures to avoid collision.

When landing, the lower aircraft has right of way, but may not cut in front of another which is on the final approach, nor overtake that aircraft. If the pilot is aware that the other aircraft is making an emergency landing he shall give way to it.

Aerobatics are prohibited over congested or urban areas, or within controlled airspace without the consent of the appropriate air traffic control unit.



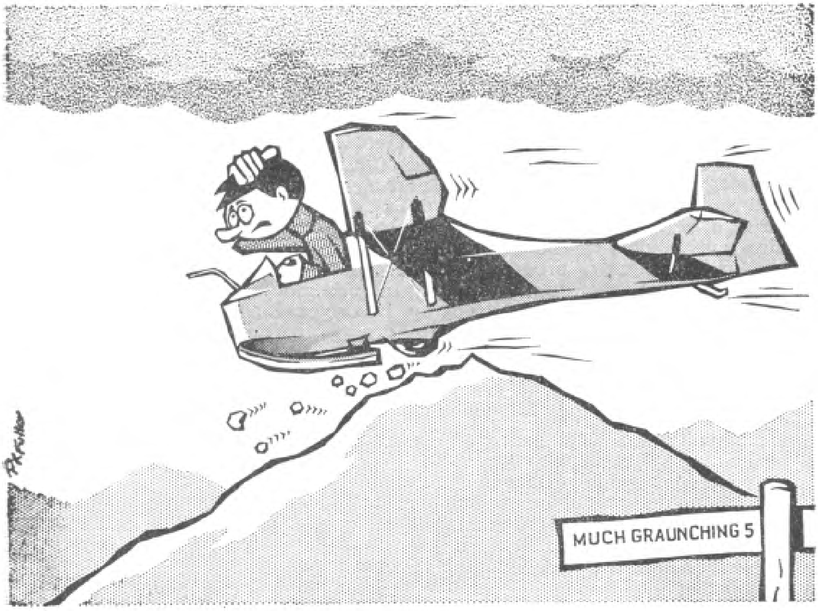
Aircraft following roads, railways or other lines of landmarks in the U.K. shall keep such landmarks on their left.

B.G.A. OPERATIONAL REGULATIONS

No persons may fly in a glider unless they have individual harness which is kept fastened throughout the flight.

A pilot in charge of a glider may not fly out of gliding range of his base field unless he holds a "Bronze C" or higher qualification, and carries with him maps marked clearly with the airways and control zones.

A glider joining another in a thermal shall circle in the same direction as that established by the first.



No glider shall enter cloud within a radius of five miles of a gliding site except from at least 200 feet below the lowest part of the cloud.

No glider shall enter cloud unless all its occupants are wearing serviceable parachutes and have been instructed in their use.

The launching cable must not be attached to the glider until the pilot is ready to be launched, and the launching signals must not commence unless the projected take-off path is clear.

All pilots must report any suspected defects or heavy landings to the instructor in charge before the aircraft is flown again.

AEROTOWING LAW

The Certificate of Airworthiness of the tug must be valid for glider towing.

The total length of the combination from nose of tug to tail of glider shall not, in flight, exceed 500 feet.

The tug pilot is responsible for ensuring that, before take off, the tow rope is suitable and serviceable, and that the proposed flight can safely be made by the combination, and that adequate signals have been agreed and can be made between pilots, and between pilots and ground crews, including emergency signals ordering the glider pilot to release, or informing the tug pilot that the glider cannot be released.

For the purpose of avoiding collision the tug and glider shall be regarded as a single aircraft under the command of the tug pilot.

On airfields tow ropes shall be dropped only in the area designated and in the direction of landing, unless agreed otherwise with flying control.

B.G.A. OPERATIONAL REGULATIONS

The sum of the tows made by the tug pilot and glider pilot, in their respective capacities, shall be not less than six.

It is the responsibility of the tug pilot to ensure visually that the glider is, in fact, released.

B.G.A. RECOMMENDATIONS

Weather

To reduce the chance of electrical strikes down the winch wire to an acceptable level, winch launching or car towing should not take place (a) if lightning strikes have been observed or (b) it is anticipated that they are imminent within five miles (i.e. 25 seconds between flash and thunder). In highly unstable and thundery conditions it should be realised that storms develop rapidly as well as drift with the wind. During the passage of the storm the wind can be extremely gusty and variable in direction. Gliders should be put under cover before the storm strikes.

In hilly country orographic cloud can form well below general cloud base, and lower than high ground. It may develop rapidly and extensively. In conditions in which the formation of orographic cloud becomes likely, or on the first appearance of such cloud pilots, particularly if inexperienced in instrument flying, should land, so as to avoid being caught in or above cloud close to the ground.

Thermal Soaring

No abrupt or large change of direction or speed when centring, or joining or leaving a thermal, should be made unless the pilot is absolutely certain that there is no other glider in the thermal, or anywhere near.

No pilot should closely follow another glider, or remain flying in its blind spot, unless he is absolutely certain that its pilot has seen him and exactly knows his whereabouts. This is particularly important if there are only a small number of gliders in the thermal.

Aerobatics

Any pilot pulling more than 3½g in the air should report this, and the aircraft should not be flown again until it has been inspected, and a log book entry made and signed by an approved inspector. It should be realised that damage incurred by one pilot might result in structural failure when the aircraft is being flown by another pilot.

12. FITNESS TO FLY

The human body is sensitive to cold, changes in air pressure, accelerations and by being moved in a number of different directions at the same time. The extent to which it is affected depends on the health of its owner, e.g., the common cold obstructs the free movement of air in the bone cavities of the head and ear. This can cause some deafness, and may upset the organs of balance in the middle ear.

THE EARS

The eardrum, which separates the inner ear from the outside, is deflected when the air pressure on each side of it is unequal. If it is deflected too far it will burst. When the air pressure on the outside of the ear is altered, as it is when flying, the eustachian tube—which connects the ear with the throat—normally allows air to flow freely and balance the pressure outside.

When going up the air inside the ear escapes down the eustachian tube, but when descending into air of higher pressure air has to be forced up into the middle ear. To do this it is usually only necessary to swallow, work the lower jaw, or yawn. If, however, the ears become blocked and start hurting when coming down, the nose should be pinched and breathed into hard, with the mouth closed.

If the ears remain blocked after flying medical advice should be obtained.

AIRSICKNESS

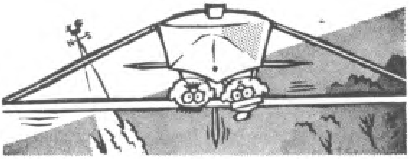
People can become airsick if they are cold, too hot, have a hangover, dislike strong smells such as petrol, or are sure that they are going to be sick. They can also have their balance mechanisms upset, and so become disorientated, by rough air and aerobatics; this frequently leads to the same result. Any tendency to airsickness when learning to fly usually disappears as experience is gained, particularly if the pilot can avoid flying in rough conditions, or for too long at a time in the the early stages. If it persists one of the motion sickness drugs may get him over the trouble; but while taking them *no solo flying should de done.*

ILL HEALTH AND FATIGUE

Flying needs concentration and quick, correct, decisions. It follows that if a pilot flies when he is tired or unfit, he will be less competent. If, at the same time, he is also taking drugs such as tranquilisers, antibiotics, or cough or cold mixtures, he may well find himself judging things badly, or feeling sleepy. It is essential, therefore, that if taking any drugs, clearance should be obtained from a doctor before flying. No pilot should ever fly on a mixture of drugs and alcohol.

If a person has suffered from giddiness, fits, or any condition which might incapacitate him in the air, he must obtain his doctors advice as to whether it is safe to fly. Intense concentration, suspense, or fear, may cause the symptoms to recur, however long ago he had his last attack. Any disability must also be declared to the C.F.I.

THE EFFECT OF g



Anything which is moving will continue to go on moving in a straight line and at a steady speed unless a force is applied to it. For example, when starting a loop, the glider wants to continue in its original direction, and an upward force has to applied to it in order to curve the flight path upwards. This causes, in effect, an acceleration to the aircraft, and is expressed in g units. If a loop is said to be carried out at 3 g, this means that the pilot is subjected to an upwards force of three times his own weight. The actual value will, however be only two g, since one g, his normal weight, is, due to the gravitational field of the earth, still acting as a downwards force.

Positive g pushes the pilot down into his seat, as in a loop, and reduces the circulation of blood to the head causing upset vision; initially everything goes grey, and if continued, black.

Negative g gives rise to excess blood pressure in the head. Since gliders are not normally flown upside down, the most likely occasions when the pilot experiences negative g is in severe turbulence, or following a cable break on a winch launch if the nose is put down too sharply.

The amount of g a person can withstand depends on (1) his attitude in relation to the acceleration—lying on his back is better than sitting up; (2) the duration of the acceleration—a man in an ejector seat can withstand 40 g for a small fraction of a second; (3) His physical fitness.

The sensation of g on the pilot means that the aircraft is being subject to large loads. It is as well that this is so, because when flying fast it is literally possible to pull the wings off a glider by pulling back too hard or too much on the stick.

Resistance to g by the pilot is reduced by tiredness, age, and when unfit.

B.G.A. OPERATIONAL REGULATIONS

Before going solo a glider pilot is required to sign a Declaration of physical fitness. Before starting to carry passengers or pupils the Declaration must be endorsed by the instructor's own doctor, or, if this is not possible, he must produce a medical certificate. Exemption exists for pilots holding a Private or Commercial pilot's licence, or Service personnel holding appropriate medical certificates.

B.G.A. RECOMMENDATION

Eyesight

Pilots who cannot see well enough without their spectacles to land safely and accurately, should also carry an easily accessible spare pair when flying as P1.

13. PARACHUTES

Parachutes are worn as general practice on aerotowed and soaring flights. They are primarily a safeguard when flying in large clouds, and in the event of collision. If a parachute is carried, it might as well be worn correctly and the pilot know how to use it. If the glider becomes structurally badly damaged, or the controls have failed, the decision to jump should be made without delay, provided that the glider is not less than 500 feet up. The glider parachute is usually made of nylon; it will descend at 1,100 feet per minute with a pilot weighing 110 lbs., and at 1,500 feet per minute with one of 220 lbs.

ABANDONING THE GLIDER

1. Get rid of the canopy by using the jettison release, or by undoing the normal canopy catch.
2. When it has gone, undo the harness.
3. Get out: stand on the seat and dive head first away, trying to go under the wing (unless it is a low wing aircraft). If the glider is spinning exit towards the inside of the spin if possible.
4. Pull the ripcord when clear of the glider; this means about a three second delay, and the parachute should then fully develop within three seconds.
5. Try to assess the drift, so as to discover where you are likely to land.

6. You can steer the parachute to some extent by pulling down on the risers, which tilts the canopy and spills air from it, e.g., to reduce forward drift pull down on the back risers.
7. To land, reduce drift by pulling down on the appropriate risers and tuck in chin.
8. Press feet and knees tightly together, with knees slightly bent, and feet parallel to the ground.
9. Turn sideways to the line of drift so as to roll on landing—feet, hips, buttocks, and over on to the other side.
10. Retrieve canopy and bundle into pack.

If the wind is strong on landing, get out of the harness quickly, or if this is difficult, run into wind round canopy, or lie on it so it cannot redevelop.

HIGH ALTITUDE BALE OUT

If a pilot has to leave his glider above about 15,000 feet he may suffer from cold and lack of oxygen, and he may be in such a strong upcurrent that his parachute will go up. In cumulo-nimbus clouds there is a risk of frostbite, and lightning strikes. To avoid these hazards some pilots have fallen free until they are at a lower height. Delayed drops in cloud, however, introduce two other difficulties: the pilot may become stabilised on his back and start spinning, which makes it hard, or impossible to get at the ripcord, and he has no means of knowing how far he has fallen. If there is heavy rain in and below cloud, he may be blinded by it and not see how close to the ground he is. On balance, certainly below 20,000 feet, it is better to avoid a blind delay. In clear air any free falling should be done in a face down position, with legs and arms outstretched, to prevent tumbling.

UNSUITABLE LANDING AREAS

Trees

If the pilot is clearly going to end up in trees, he should keep his feet and knees tightly together, with bent knees and feet in front of the body. He should cross his arms across his face with his hands under his armpits.

Water

When still about 100 feet up, the quick release box should be unlocked, but the parachute harness must *not* be released until the pilots feet *touch the water*. He should then get free of the harness quickly, and clear of the canopy (unless it is pulling him towards the shore). If he becomes entangled with the parachute, the pilot should hold it clear with his arms above his head so that he can breathe, and while treading water methodically untangle himself.

PARACHUTE CARE

Parachutes should be kept away from oil, acid and strong sunlight, being stored singly (not in piles) in a dry place. They should be repacked at not more than three month intervals, or less if they are damp.

Daily Inspection

1. Has the parachute been repacked within the last three months?
2. Is the ripcord handle in its pocket, are the ripcord pins (under the flap) in position, not bent, and with the red thread intact?
3. Is it free of grease or acid stains?

Adjust harness to fit before getting into the cockpit.

14. GROUND HANDLING AND SIGNALLING

B.G.A. REGULATIONS

A glider should not be moved without crew on the windward wing tip, and at either the tail or the nose. If it is moved into wind the nose must be held down and the tail up. If moved tail first into wind, the controls must be prevented from slamming. In strong winds the crew should be doubled, and the airbrakes opened. If towed by a car, the tow rope should be at least 20 feet long. The car driver must be able to hear instructions and should therefore have the windows open and the radio quiet.

The glider should be parked across wind with the windward wing weighted, so that any gusts or expected shifts of wind will come from aft and not forward of the wing. As the glider will want to weathercock, the tail skid should be picketed or blocked on its lee side. A tyre jammed under the nose will help to prevent the tail jumping over the block in gusts.

When unparking to fly in strong winds, the pilot(s) should get into the cockpit before the glider is turned into wind. The tail should then be help UP, and there should be a crew on each wingtip, only one of which should actually run with the wing for take off.

In winds of 20 knots or more, training flying should cease, and the gliders put away. The risk of blowing over is considerable, and the pupil obtains little or nothing useful from flying.

If the launch points slopes downhill, the glider should be prevented from over-running by a crew on each wingtip. They should both hold back until the take-off run actually starts, when one only should run.

ICE ON WINGS

Gliders should not be launched with hoar frost, rime, frozen rain or snow on the wing surface, or if it is wet and the air temperature is at or below freezing. Even small amounts of roughness on the wing surface can have a disastrous effect on both the efficiency of the wing and the stalling speed. Before flying the wing and tailplane surfaces must be cleaned of all traces of frost or snow, and be dry.

LAUNCHING SIGNALS

An adequate system of communication must exist between the person in charge of launching and the winch or tow-car driver, or tug pilot.

One of the following procedures must be used for all launches, other than bungey launches, unless a serviceable telephone or radio system is installed between the person in charge at the glider end of the cable and the winch or car driver or tug pilot.

One Bat Method:

Bats to be easily visible at the distance required:

(*a*) Take up slack, take-off path being clear: One bat moved to and fro in front of the body.
(*b*) All out: One bat moved to and fro above the head.
(*c*) Stop: One bat held stationary vertically above the head.

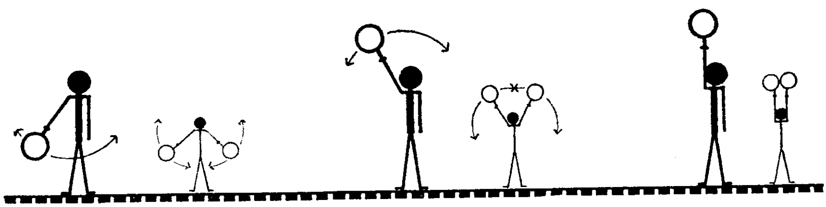
Two Bat Method:

(*a*) Take up slack, take-off path being clear: Two bats moved up and down, on each side of the body.
(*b*) All out: Two bats moved up and down above shoulder height.
(*c*) Stop: Two bats held vertically above the head.

Light Method:

(*a*) Take up slack, take-off path being clear: Dashes of one second duration and three seconds interval.
(*b*) All out: Quick dots at one second interval.
(*c*) Stop: Steady light.
Lights may not be red or green.

TAKE UP SLACK — ALL OUT — STOP



One bat or two bats — One bat or two bats — One bat or two bats

Signalling

The launch point signaller should realise that he is signalling to the winch or tow car on behalf of the glider pilot to be launched. He should therefore face the glider and not the launching mechanism so that throughout the time that he is signalling he can be certain that nothing is going wrong, or can interfere, with the launch. He continues to be responsible for the safety of the launch until the glider is fully airborne and can be seen directly by the winch or tow car driver.

When telephonic or radio signalling is used, means must exist for an emergency stop signal which can be received notwithstanding the noise of the engine.

Launch Speed Signals

Speed of launches. If the glider is being launched too fast, the pilot should yaw the glider from side to side with the rudder. If the launch is too slow he should waggle the wings with slow coarse movements of the ailerons. In both cases he should lower the nose and maintain a safe speed before signalling.

Aerotow Signals

When aerotowing, the order of the tug pilot to the glider pilot to release shall be the rocking of the tug laterally. This order must be obeyed immediately.

The signal by the glider pilot that he is unable to release shall be that he flies out to the left side of the tug as far as is practicable and rocks the glider laterally.

Do you know your Air Law . . .

A person under the age of 16 shall not act as pilot in command of a glider.

"Night" starts half-an-hour after sunset and ends half-an-hour before sunrise, determined on the ground.

An accident which causes injury or substantial damage to an aircraft must be reported to the police and the B. of T. accidents investigation branch at Temple Bar 1207 and confirmed in writing. The aircraft must not be moved without the permission of A.I.B., other than to extract animals or persons, to avoid damage by fire, or danger to the public.

The glider radio frequencies in the U.K. are 129.9 and 130.4 Mc/s. The operator requires no form of licence when operating only on these frequencies.

15. WINCH DRIVING

The winch driver needs to know two distinct things. The mechanics of his machine, and the proceedure for launching.

He must appreciate that he is in charge of the launch. If he is not entirely satisfied that he can launch safely, as, for example, when another glider lands near the cable, he should not do so simply because he is being given the signal to take up slack. On the other hand, the STOP signal means what it says.

The actual technique of taking the glider off will depend on the construction of the winch, but the aim is to achieve a gradually increasing rate of acceleration without a jerk, and without a sudden easing of the pull. Normally the glider should be accelerated until it has taken off and is started in its climb; then the speed will normally cease increasing and remain steady for the first third of the climb. On most winches all this can be done at a constant throttle opening, and it will be necessary to throttle back only as the cable lifts off the ground. At this moment it is wise to take a quick look round to see that there is no other aircraft converging on the one being launched.

During the latter part of the climb, a further progressive throttling back will usually be needed, so that when the glider gets to within about 20 degrees of the vertical the throttle should be almost completely closed. When it is certain that the glider has released, the engine can be speeded up again to bring the cable in smoothly.

If the glider has not released within a couple of seconds or so of the driver throttling back, the engine should be declutched and the drum stopped. If the glider is still attached by the time this has been done, the cable should be chopped.

The signals from the pilot for speed corrections are given on page 29. On receipt of them the speed should be varied gently and appropriately.

Occasionally a situation arises when the glider comes toward the winch hardly climbing at all, and it is not clear whether this is because (*a*) the pilot is going too slowly to feel justified in starting his climb, or (*b*) he is going so fast that he is reluctant to pull back. Each of these can be due to either winching at the wrong speed in normal conditions, or to a sudden change of wind speed. In particular a gentle headwind, which changes to a tailwind at 100 feet or so, can be very confusing.

The best way to learn how to give launches at the right speed is to concentrate on the "sit," or attitude, of the glider in the air, and the sag in the cable; further, to get comments from the glider end.

Tow Car Launching

There is no *fundamental* difference in the technique of launching a glider with a tow car, except to remember (*a*) to avoid running into obstructions, and (*b*) to stop launching in time to slow down before reaching the end of the runway.

B.G.A. OPERATIONAL REGULATIONS

All equipment used for launching, including the wire, rope, or cable, must have been inspected and approved as serviceable each day before being used. Winches and tow cars shall, as a minimum, be checked for sufficient fuel, oil and water for the proposed launches, and that there is a serviceable cable cutting or releasing mechanism.

A weak link not exceeding 1,000 lb. in breaking load or in accordance with that specified in the C. of A. of the glider to be launched, whichever is the lower, shall be used on every launch other than bungey launches except where the strength of the cable, as manufactured, is below this figure.

The glider end of all launching cables must be fitted with linked rings designed to fit the release mechanism on the glider. Distorted or cracked rings may not be used.

To ensure that the winch or car driver can see clearly when the cable is released, the glider end of the cable must be made visible by a flag, parachute or similar device. A length of rope or cable at least 18 feet long must be inserted between the parachute and the release linked rings.

On multi-cable winches, the engine must not be run while work is being carried out on any cable.

If cable runs are nearer to each other than 200 feet:

(*a*) Only one glider may be attached to a cable at any one time, and

(*b*) After every launch the used cable must be drawn in to the winch before another cable is used.

B.G.A. RECOMMENDATIONS

If there is any jerk or hesitation in power at the commencement of the launch, the winch or car driver must terminate the launch, and wait for a fresh set of signals before restarting. If the glider pilot suspects over-running or other failure at the start of the launch, he should release the cable at once. If the power slowly fades out during the launch, the pilot should abandon it while there is still room to land ahead.

It is easy for cables to get crossed on a multiple pull-out. If the pull-out has not been absolutely straight, or it is suspected that the cables are close together, they should be separated before the start of the launch. A tyre can be used to anchor the spare cable until it is required. The downwind cable should be used first.

The driver is responsible for understanding how to use the cable chopping equipment and should ensure that any cutting blade is sharp enough.

16. AIRWORTHINESS

B.G.A. OPERATIONAL REGULATIONS

All gliders flying at Club sites shall possess one of the following which shall be valid:

(*a*) B. of T. C. of A. or Permit to fly.

(*b*) B.G.A. C. of A. or Permit to fly, with card displayed in the cockpit;

(*c*) Equivalent Service document;

(*d*) Equivalent document for visiting aircraft from abroad.

All club gliders shall be inspected each day by a club approved person, who must sign that the glider is serviceable before it is flown on that day.

CARRYING OUT A DAILY INSPECTION

The inspection of such a simple aircraft as a glider is a perfectly straightforward task, and one which does not require much skill. The qualities which are needed are care and honesty; if the job is to done at all it must be done thoroughly and the aircraft should not be signed out as serviceable unless the person doing it is prepared to justify his reasons at an inquest.

The object of carrying out these inspections is to ensure that no defect has occurred which might render the aircraft unsafe. Such defects can arise in four ways:

(*a*) Fair wear and tear.

(*b*) Maladjustment.

(*c*) Careless handling.

(*d*) Severe flight or landing loads.

Of these the last is the least common, but potentially the most serious.

The defects include:

(*a*) Actual failure (cracked plywood, wood or metal, frayed cable, failure of glue, etc.).

(*b*) Deterioration (rotten wood, brittle fabric, rusty steel, etc.).

(*c*) Excessive wear, looseness or lack of lubrication.

(*d*) Incorrect assembly, wrong adjustment, or actual loss of a particular part.

(*e*) Presence of foreign bodies.

It is quite impractical to ensure that an aircraft is airworthy by merely insisting on the inspection of a number of listed items, since to include every conceivable eventuality would call for a fantastically lengthy list. All that can be done, therefore, is to ask for the inspection of a limited number of items and to trust to the sharp eyes and imagination of the inspector to "smell out" trouble. Signs which often act as indicators of more serious trouble are cracks in the paint, distortion of fabric or plywood and the excessive flexibility of components.

Once a fault has been discovered it is necessary to find its cause and to ascertain the full extent of the trouble; in doing this it is important not to jump to conclusions. For example if a control cable is found to be unusually slack it is most unlikely that the cable has stretched, it is far more probable that a control horn has been bent, or a lever or pulley bracket has been strained.

The inspector should take nothing for granted and should devote his energies to actually inspecting the aircraft. Above all he should realise what he does not not know, and if in the slightest doubt should ask someone with more experience.

The Daily Inspection includes, as a minimum, the following:

1. **WINGS.**
   - (*a*) Visual inspection.
   - (*b*) Aileron hinges control horns, and mass balance weights.
   - (*c*) Aileron cable tension.
   - (*d*) Airbrakes and their mechanism.
   - (*e*) Wing-wing and wing-fuselage attachments (including struts).
   - (*f*) Aileron and airbrake control attachments to fuselage.
   - (*g*) Wing root fairing strip.

2. **TAIL.**
   - (*a*) Visual inspection.
   - (*b*) Elevator, rudder and trim tab hinges and control horns.
   - (*c*) Attachment of tailplane (including struts).
   - (*d*) Connection of elevator and trimmer.
   - (*e*) Attachment of fairing.

3. **FUSELAGE.**
   - (*a*) Visual inspection.
   - (*b*) Condition of skid, wheel and tail skid.
   - (*c*) Elevator cable tension.
   - (*d*) Rudder pedal bungeys or springs.
   - (*e*) No junk in cockpit or luggage locker.
   - (*f*) Condition of interior of cockpit and harness.
   - (*g*) Canopy: cleanliness and serviceability of attachments.
   - (*h*) Instruments and batteries. (If turn and slip batteries are changed. the sense of movement of the turn needle must be checked).
   - (*i*) Check C. of A. card expiry date and that the speed and weight placards are fitted and legible.
   - (*j*) Release hook and its control.

4. **CONTROLS.** Movement fully and freely AND IN CORRECT SENSE of:
   - (*a*) Elevator.
   - (*b*) Ailerons (also check droop).
   - (*c*) Rudder.
   - (*d*) Trim tab (with lever forward tab should be up).
   - (*e*) Airbrakes (check locking).

5. **EQUIPMENT** (if appropriate).
   - (*a*) Serviceable parachute.
   - (*b*) Ticking barograph.
   - (*c*) Cushions.

17. INSTRUMENTS

THE AIR SPEED INDICATOR

The Air Speed Indicator indicates the speed of the glider through the air. Strictly speaking it only does this at ground level, and at all other altitudes it reads low. However, for our purposes this is not very important, and we may consider that it does indicate the speed through the air. The instrument is actually a very sensitive pressure guage and it measures the difference between the pressures in an open ended tube which faces forwards into the airstream, and the static pressure of the air. This is one of the difficulties, because the glider affects the static pressure of the air for quite a distance around it. For this reason the static pipe of the A.S.I. is connected to a carefully positioned pair of vents on the side of the glider and the pressure pipe is connected to a small "pot" sunk into the nose of the glider. This "Pot pitot" as it is called has advantages over the old type of pipe, as it does not ice up, and this means that the A.S.I. continues to function even in icing conditions. It must be realised that the A.S.I. does *not* indicate the speed of the glider over the ground.

Do not allow people to blow into the pipes of the A.S.I. as the instrument is very delicate.

THE ALTIMETER

The Altimeter is a small barometer and measures the barometric pressure. It is calibrated in feet instead of the more usual "Stormy, Wet, Change, Fair, Very Dry, etc." but the principle of the instrument is the same as that of the barometer that hangs in the hall. The important thing to remember about the altimeter is that it does *not* indicate the height of the glider above the earth. All it can do is to indicate the height of the glider above the spot where the instrument was set to zero, and it can only do this provided that the atmospheric pressure has not changed appreciably in the meantime. Since the atmospheric pressure does change from time to time, the altimeter is fitted with an adjusting knob so that it can be set to zero, or to the airfield height above sea level. There is also a small subscale attached to the mechanism that the setting knob controls and this is calibrated in millibars, or in the case of American instruments in inches of mercury. The altimeter is a delicate instrument and the habit of tapping the thing in the air should be avoided, as it is damaging to the mechanism.

VARIOMETERS

These instruments, and there many types, show the pilot whether his glider is rising or sinking. They are extremely sensitive, and all types work on basically the same principle. A volume of air, usually insulated from thermal changes by being contained in a vacuum flask, is connected to the atmosphere through a small flowmeter. The latter detects whether air is flowing into the vacuum flask or out of it, and how fast the flow is taking place. A little thought will show that, if the glider is rising, the pressure of the atmosphere around it is reducing, so air will try to flow out of the vacuum flask. If the glider is sinking, the reverse will happen. The instrument may take various forms, red and green pistons in a pair of tubes, a hand on a clock face, etc. In advanced gliders the electric variometer is popular. In this type, the principle is the same, but instead of making the air move pistons, needles, etc., the actual indication is done electrically and the movement of the air detected by a pair of thermistors inserted into the pipe. Since the air does not have to do the indicating itself, but simply move in and out of the vacuum flask, these electric variometers can be made extremely sensitive, and, perhaps even more important, they act with almost no time lag.

BLIND FLYING INSTRUMENTS

When the pilot of an aircraft is unable to see the horizon or any other fixed object, he is unable, by his senses alone to tell the difference between straight flight and a steady turn. Therefore he needs instruments which will give him this information. The first is the **Turn and Slip Indicator.**

Seen from the pilots angle, this instrument has a needle with "R" and "L" on the right and left side respectively of the centre zero and the needle moves to the appropriate side when the aircraft is turning. The tighter the turn the greater the movement of the needle. This is the "Turn" indicator, but usually in the same case is a "Slip" indicator, and this may be nothing more than a spirit level with a large black ball in it. This Slip indicator will read central when the aircraft is flying straight and level, or when it is executing a correctly banked turn. Sometimes the Slip element of the instrument is a simple pendulum connected by levers to a second needle on the dial.

The "Turn" indicator needle is driven by the movements of a small gyroscope which is mounted with its axis athwartships in the aircraft. The frame on which the gyro is mounted is pivoted fore and aft so that the gyro can roll from side to side, but this movement is restrained by a spring. Now, one of the properties of a gyroscope is that if an attempt is made to turn the axis in one plane, the gyro tries to "precess" or rotate so that its axis shall lie in the axis of the turn. This precession of the gyro is opposed by the spring, and the amount that the gyro has precessed is shown on the dial of the instrument. Some means has to be found of driving the gyroscope, and the most usual method is to use a small electric dry battery, and to make the rotor of the gyroscope in the form of the armature of an electric motor. It is possible to drive the rotor of the gyroscope by a jet of air, and in the past this was one of the most favoured ways, but it has snags from the glider point of view. First the venturi tubes that produced the suction have to be very large owing to the slow speed of gliders, and, further, the venturi tubes have a habit of icing up in cloud just when they are most needed, thereby putting the Turn indicator out of action.

The Artificial Horizon

The Artificial Horizon makes blind flying rather simpler as it provides the information that the pilot requires in an immediately recognisable form. The pilot sees on the dial of the instrument a small aeroplane against a line which represents the horizon. As the aircraft banks or pitches, the horizon line on the dial follows exactly the real horizon outside the aircraft. Thus the pilot sees the little aeroplane on the dial do exactly what his aircraft is doing, and in fact he can "fly the little aeroplane on the dial."

The principle of the instrument is also gyroscopic, but in this case the gyro is a free gyro, running with its axis vertical. As the aircraft rolls or pitches the gyro maintains its position in space and the relative movement is shown by the rising and falling or rolling of the horizon line on the dial. The verticality of the axis of the gyro is checked and monitored by some means of pendulum which varies from type to type, but any error is corrected by torque motors.

The gyroscope can be driven by electricity or by an air jet, but the same snags are apparent here as in the Turn and Slip indicator, so electric means are usual in gliders. Further, since the gyro is a free gyro, and must be allowed complete freedom, alternating current is usually employed as this means that the rotor can be spun without the necessity of leading wires into and out of it.

18. COCKPIT LOAD AND THE CENTRE OF GRAVITY

Gliders are sensitive to the fore and aft position of the centre of gravity. The position is roughly one third of the way back from the leading to the trailing edge of the wing. The loads on the aircraft, its stability, and its whole flying behaviour, depend on the position of the centre of gravity. Ideally, the aircraft should be flown with the centre of gravity always in one position, but this is impractical since the pilot sits out in front. A heavy pilot will bring the centre of gravity forward, and a light one will move it back. Because of this a glider is designed to operate satisfactorily with the centre of gravity within a certain range, and the behaviour with the centre of gravity in different positions is one of the factors which is carefully investigated during the test flying of the prototype aircraft. In the case of the Swallow, for example, the centre of gravity is allowed to be anywhere between 19 in. and 23 in. behind the leading edge of the wing root.

In order to stop the centre of gravity of the complete loaded glider being too far back it is necessary to have a certain weight in the cockpit, this weight defined as *minimum cockpit load* comprises the pilot and his parachute. The precise figure will vary slightly with the individual aircraft, typically for a Swallow it is about 170 lbs. In the same way, if the cockpit load is too high the centre of gravity will be too far forward. For the Swallow this is about 250 lbs.

These are not just academic figures, they are important, particularly the *minimum* cockpit load. Flying a glider with the centre of gravity too far back—that is too small a cockpit load—will have two effects: (*a*) the longitudinal stability will feel quite different; much smaller stick movements and push forces will be required to change speed, and the aircraft may be unstable, that is, it will need continual movements on the elevator to maintain a steady speed. This "twitchiness" of the elevator can be most disconcerting, particularly during a winch launch or aerotow; (*b*) the behaviour in the spin will be different. With the centre of gravity fully forward most gliders are reluctant to spin, doing a spiral dive instead, with the centre of gravity in the rear part of its permitted range, most gliders spin steadily with an easy recovery. However, with the centre of gravity too far aft, spin recovery may be impossible.

The rear-most permissable position of the centre of gravity is determined during the test flights of the prototype. The c.g. is moved progressively backwards and the spinning and stability characteristics investigated. The rear-most position at which both are satisfactory is then specified for that type of aircraft.

Flying with the centre of gravity too far forward—that is with too heavy a cockpit load, is less hazardous, but the following two effects may be apparent (*a*) the longitudinal stability will be greater than usual, needing greater pushes or pulls on the stick, and much more movement, and (*b*) there may be insufficient elevator power to make a rapid pull out, this may be noticeable when making a steep slow approach, the glider may go straight on into the ground inspite of making a full backward movement with the stick.

For those reasons, the cockpit placard must be respected. If it says minimum cockpit weight 140 lbs., and a parachute is going to be carried, this means that the pilot must weigh at least 120 lbs. If he does not weigh this amount then he must not fly unless the glider is suitably ballasted.

Ballasting can be done by fitting weights in a permanent stowage; since the weights are normally at a different leverage than the pilot, the label in the cockpit explains how much ballast is needed for pilots of different weights. If there is no ballast stowage, it will be necessary to fit sandbags or shotbags on the seat. These must be securely lashed down so that in the event of negative g, there is no risk of their coming forward and jamming the stick. Since the handling is more pleasant with the centre of gravity in the middle of its range, it pays not to be parsimonious with the amount of added ballast.

CONVERSION TABLES

METRES		FEET	KMS		MILES	KILOS		POUNDS
0.305	1	3.281	1.609	1	0.621	0.454	1	2.205
0.610	2	6.562	3.219	2	1.243	0.907	2	4.409
0.914	3	9.843	4.828	3	1.864	1.361	3	6.614
1.219	4	13.123	6.438	4	2.485	1.814	4	8.818
1.524	5	16.404	8.047	5	3.107	2.268	5	11.023
1.829	6	19.685	9.656	6	3.728	2.722	6	13.228
2.134	7	22.966	11.265	7	4.350	3.175	7	15.432
2.438	8	26.247	12.875	8	4.971	3.629	8	17.687
2.743	9	29.528	14.484	9	5.592	4.082	9	19.842
3.048	10	32.808	16.093	10	6.214	4.536	10	22.046
6.906	20	65.617	32.187	20	12.427	9.072	20	44.092
7.620	25	82.021	40.234	25	15.534	11.340	25	55.116
15.240	50	164.042	80.467	50	31.069	22.680	50	110.231
30.480	100	328.084	160.924	100	62.137	45.359	100	220.462

Langham, Herald Press, Farnham

Name ....

Club ....