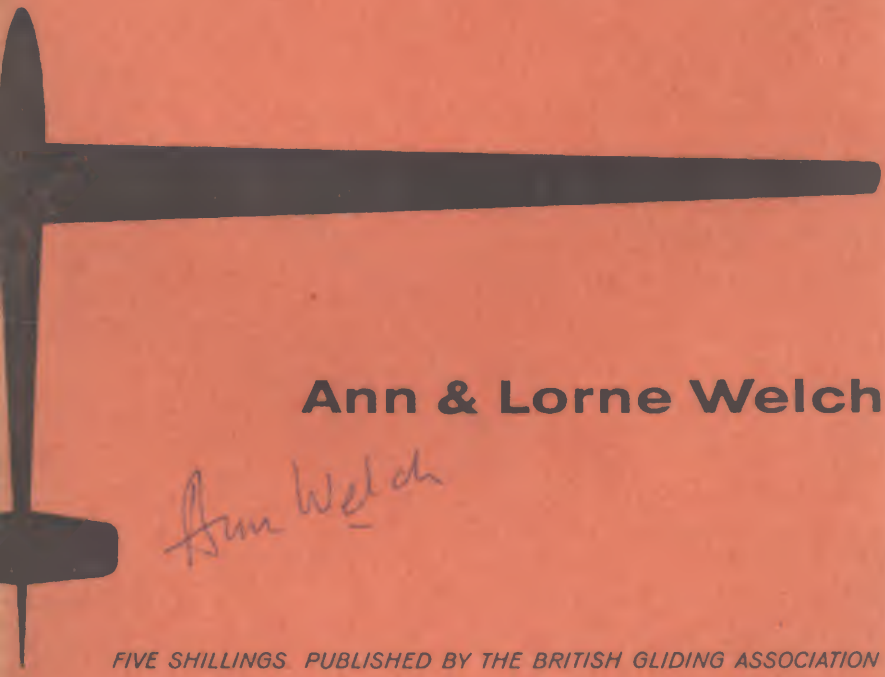
Flying Training in Gliders



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INTRODUCTION

The purpose of the book is to help the gliding instructor to acquire knowledge before he starts instructing, and afterwards to serve him as a reminder of the principles and methods involved. It is also intended to be of use to the pilot who wants to improve his flying.

The book will only be of real benefit to the instructor if he understands how to use it properly and so some explanation of its arrangement and how to use it is given in the following paragraphs

So far as is practicable, the information on each exercise has been divided into three parts:—

A. Considerations

B. Air instruction

C. Advice to instructors

PART A.—CONSIDERATIONS—states a problem, and the aim in teaching the particular exercise. It outlines the principles of flight which are involved, gives a summary of all the factors that have to be considered and sets out the main features of the exercise itself.

PART B.—AIR INSTRUCTION—assumes that the pupil has a sound understanding of all the considerations outlined in Part A, and gives a form of words, some of which are suitable for actual use in the air. This so-called patter must be used with great discretion. It is not intended that the exact phrases of the book should be repeated in a parrot-like fashion. The instructor should interpret them in his own way, adapting them to the characteristics of the particular glider and pupil. Some of the explanations are too long to be synchronised with the manœuvres of the glider and in such cases it is a good idea to give the full explanation before performing the manœuvre, and then during the actual demonstration only the particular points to be stressed need be detailed.

PART C.—ADVICE TO INSTRUCTORS—contains suggestions which should be helpful to the individual instructor in teaching the particular exercise. The advice is based on the experience of others; it should be considered simply as an attempt to hand on hints from those who have had much experience in this work to those who have had little.

In teaching an exercise to a pupil the instructor should divide the instruction into three parts—pre-flight briefing, air instruction, and the discussion after flight.

For convenience of arrangement, and for the purpose of keeping records, the exercises have been numbered. It must be clearly understood that the order and the numbers allotted to the exercises do not in any way imply the order in which they should be taught. Many of the exercises will be taught progressively and concurrently with others throughout the training. It is, however, important that the exercises 1 to 9 should all be completed before the first solo.

The book has been written to cover flying on all standard types of glider; therefore it cannot be suitable in every detail for every particular type, and so the instructor must use his commonsense about any particularity of the aircraft he is using.

There are a few aspects of flying instruction about which even instructors of experience have marked differences of opinion. In such cases an attempt has been made either to find a compromise between the opposing views or to give alternative methods for the particular exercise. It would be impossible, and, indeed, undesirable, to fix an exact standard which every instructor should follow in every detail. This book is a guide for the instructor, and not a book of regulations; the instructor should use it as a means of rousing rather than of stifling his imagination and initiative.

Learning anything new is only possible if there is an adequate background of experience on which to base and interpret the new knowledge. Many people who start gliding have little or no background of flying, and have, therefore, an immense number of new things to learn all at once. This will take time. It further follows that they may be quite unable to learn judgment (of approaches, distance from field in strong winds, height to attempt manœuvres, etc.) for quite a long time.

THE TECHNIQUE OF INSTRUCTION

1. The technique of teaching anyone to fly is basically the same regardless of the type of aircraft. The method used for teaching any aspect of flying is first of all to explain the purpose of the manœuvre, and then to explain and demonstrate how it is carried out; thirdly, to get the pupil to do it himself, and, lastly, to correct his faults. It is vital that the first lessons are given especially thoroughly, so that the pupil obtains a solid grounding on which to build his further lessons and experience.

2. When instructing on aeroplanes much of the necessary talking can be done in the air; owing, however, to the short time available on normal glider circuits the talking in the air must be cut to a minimum. Explanations of the exercise to be carried out should be given before take-off. Mistakes made during the flight should not be discussed in the air unless there is an opportunity for the pupil to correct that particular fault in the same flight, e.g., do not waste the circuit by talking about errors made during the launch; leave the critical discussion till after landing. As the pupil advances, the instructor should progressively reduce the amount of information he gives and at the same time increase the contribution made by the pupil until finally the pupil can do all the analysis and correction for himself. If the instructor wishes to discover if a lesson has been properly understood, he should, at a latter date and without warning, ask him what he knows about it.

3. As this pre- and post-flight talking is an essential part of this form of instruction, arrangements must be made whereby the instructor can have a few minutes uninterrupted time with the pupil before and after each flight. This requires that the organisation for take-off and retrieves, etc., should be in the care of somebody other than the instructor, so that the instructor may devote his entire attention to the pupil. If possible two or more instructors should work together, in order to be able to fly with alternate pupils.

4. Models and diagrams should be used freely to clarify and emphasise explanations.

5. It has been found by experience that the pupil learns more quickly if he is given two or three circuits running, if possible without his getting out of the cockpit. This, of course, does not apply if the pupil is cold or frightened.

6. The pupil only really learns anything when he is actually flying himself, and is allowed to make mistakes. It is, therefore,

important that he be given every opportunity to do this with the instructor's hands and feet completely clear of the controls, and without unnecessary prompting from the instructor. If, with any particular instructor on board, the two-seater invariably makes good approaches and landings it is obvious that the instructor is not doing his job properly.

7. If proper planning is made by the instructor for the exercises to be carried out in each circuit, it is surprising how much tuition can be given in the short time available without muddling the pupil. Sometimes, however, the instructor may find that because of insufficient height he is unable to let the pupil attempt a manœuvre which he has just demonstrated; in such cases it is important that the pupil be given an alternative exercise so that he flies as much as possible in every circuit.

8. On sites where continuous soaring is possible, there is a tendency to think in terms of flying hours rather than launches. It must be realised that the most important part of any glider pilot's training is the approach and landing and it is the duty of every instructor to see that in addition to adequate time in the air his pupil has enough practice in doing this.

9. The pupil cannot be expected to fly properly unless he is comfortable, can reach the controls easily, and see where he is going. This means that the small person must have cushions. It is a complete waste of time flying him without them, and he will find things different on each flight unless he is always sitting in the same position. Particular attention should be given to the ability to reach the stick in the fully forward position.

10. Joyriding and instructing are two entirely different things. If an instructor wants to soar in the two-seater and does not want to instruct, he should make it quite clear to the pupil that this flight is not a lesson. The instructor must ensure that none of his ordinary joyriding pilots give unauthorised instruction to their passengers.

11. If each instructor always flew with the same pupil, it would not matter very much what method of teaching was employed. But as there will always be some interchange of instructor and pupil it is essential that a uniform system is used. This does not mean that the patter must be standardised; this would be absurd, but the same type of circuit, etc., must be taught.

12. An instructor must set a good example in his own flying at all times. If he often lands as close as possible to other gliders he can hardly be surprised if his pupils copy him. In the same way, if he tends to be slapdash about his maintenance and care of equipment, he cannot expect his pupils to know any better.

13. To help himself, and the pupil, the good instructor insists on discipline, and also an atmosphere in which the difficulties can be discussed freely and easily; the value of a sense of humour as a means of creating such an atmosphere is invaluable. The combination of good discipline with willingness to help by patient explanation and an occasional joke is one of the greatest assets that an instructor can possess.

14. A pilot should be grounded only for disobedience to briefing or regulations, or for deliberately dangerous flying (such as unauthorised beat ups). If his action is the result of inexperience, mistake, or error of judgment, he should never be grounded, but given further instruction in the two-seater or by elaborated briefing to ensure that the error will not be repeated.

15. The instructor should study the pupil to find out the best approach to his mind. He should at all times exercise restraint of language, however exasperated he may feel.

One pupil may be nervous or under-confident. Give him more than the usual praise; do not let him suspect that his flying is other than normal. When flying with such a pupil be careful not to show signs of apprehension in the air, nor proceed with his lessons too quickly.

Another may be over-confident or conceited. Set him difficult tasks and criticise him fairly but firmly for his lack of perfection in performing them. Go back over previous exercises and insist on a really high standard of flying.

There is sometimes a feeling of antipathy between pupil and instructor; such a feeling may be purely personal and have little or nothing to do with the ability of the instructor or pupil. In such cases the first thing is to try to break down the antipathy, but if this proves impossible the pupil should be transferred to another instructor.

16. It is often not understood how scared some people are of flying. They naturally attempt to hide their fear, but to them it is so real and paralysing that relatively little of their brain capacity is available to learn the lesson or to anticipate the appropriate action, and they seem stupid or erratic. If you sus-

pect they are really frightened, tell them that this is nothing to be ashamed of, that many pilots are, and above all, ensure that you do not add to their fear by sudden action, or taking them on too fast. Try to keep such pupils with really sympathetic instructors.

17. The instructor should spare no effort—and it requires an effort—to speak distinctly, to find out whether he can be heard and to choose the most suitable words and phrases.

18. The instructor should learn all he can about, and if possible fly, the types of glider on to which his pupils are likely to progress. If a pupil asks questions about these aircraft, the instructor should always be able to say something informative and good about them. The same applies to gliding sites. In the past much harm has been done by rumours, often unfounded and quite untrue, about wrongly named "dangerous" characteristics.

19. The instructor should appreciate that his is a very responsible job. If he feels that the pupil is unfit, that the weather is unsuitable, or the equipment unserviceable, he must not allow flying to take place against his better judgment. He will be respected more if he makes firm decisions and sticks to them.

20. Elementary instruction is difficult enough, but dealing with pilots who can already fly may be much more so. This is particularly true of the "old hand" who, because he has survived so long, thinks that his flying is good, and consequently objects to having his faults pointed out to him. The instructor must not let himself be influenced by the status and experience of such a pilot. He must judge him solely by the manner in which he flies, and if he considers that the man is not competent and safe, he should not be allowed to continue without further instruction, whoever he may be.

21. Some record of pupils' progress should be kept, and this is essential if they are being taught by more than one instructor.

22. As far as is practicable a pupil should have the same instructor, particularly up to the solo stage.

23. Any sign of tenseness in a pupil should be observed and checked. Tell him to relax, and watch for this all through the early stages. A pupil who is nervous and tense does not absorb instruction well.

24. Owing to the number of instructors each pupil may have, there are bound to be occasions when the pupil informs the instructor that his previous teacher told him to do something quite different, and on the face of it, wrong. Never criticise another instructor in front of, or to, a pupil. Tell him that he may have misunderstood what the other instructor intended (this is usually the case), but if in real doubt, see the other instructor privately and find out what exactly did occur.

25. There is a tendency for instructors to feel that they are not doing their job unless they say everything that they can think of concerning the proposed flight. The result is a torrent of words which either passes over the pupil largely unheard, and certainly not understood, or reduces him to a state of acute apprehension. What does not seem to be realised is that there is no point in saying anything about things the pupil already understands. No instructor can seriously consider sending a pupil on his first solo unless he is completely satisfied that he knows how to do a proper circuit, and deal with cable breaks, etc. Nevertheless, complete descriptions of the circuit are given by some instructors before a pupil's first solo flight. These can do nothing but harm.

26. Finally, let the instructor think back on those who taught him to fly; if they were good instructors he knows how they helped him; if they were bad, no one knows better than he in what respects they failed. By following the example of the good and avoiding the faults of the bad and by consulting those more experienced than himself, he should have no difficulty in teaching his pupils to fly well. In doing so he will be making one of the most valuable contributions to gliding which it is possible to make.

METHODS OF TRAINING

The exact method of training will depend on the types of aircraft available, the method of launching, and the site.

Stage of First Solo

The pupil should not be sent solo until he has demonstrated when flying dual, to the satisfaction of his instructor, that he is able to carry out all that he will be required to do on his first solo flight. In addition he must have had sufficient experience to enable him to cope with any eventuality which is likely to occur.

It is, of course, possible to train a pupil dual only to the stage when he is able to do straight hops and landings and then send him solo. Such a course is unsound; his training should be continued until he is competent to fly circuits.

Solo on Two-Seater or Single-Seater

Logically the pupil should go solo on the same aircraft in which he has received his instruction. This method has everything to recommend it because the only change with which the pupil has to contend is the psychological one of flying by himself.

However, initial solo flying is still done on single-seaters. This increases the difficulties of the pupil, particularly the less confident ones, for apart from the psychological effect of flying by himself he has to deal with the peculiarities of a strange type at the same time. The argument put forward in favour of using a cheaper single-seater for the first solo is of doubtful validity; admittedly a two-seater may cost three times as much as a single-seater, but the fact that the pupil has to cope with something entirely different probably increases the risk more than this number of times.

If a single-seater has to be used, its flying characteristics should be as similar as possible to those of the two-seater. The pupil should not be sent solo until he is competent to do circuits, and has developed considerable critical judgment of his own, and including the ability to fly by feel without total reliance on instruments.

Dive Brakes

Flying gliders without using dive brakes or spoilers increases the difficulty of judging the approach, particularly if the site is awkward. As the pupil will have to learn to use them at some stage of his gliding career, there is every advantage in teaching their use at the beginning. But whether or not this can be done will depend on what sort of glider will be used for the first solo. If this has no brakes it would be unwise to allow their use dual

since the pupil will have none when he goes solo. The same applies if the brakes or spoilers on the single-seater have widely differing characteristics; the pupil will be confused by them.

Instruments

There are two rival schools of thought on the subject of instruments; those who consider the pupil should have them from the beginning of his training, and those who insist that he must be able to fly properly before instruments are introduced. It would seem that as the whole object is to train soaring pilots, who have to fly at slow speeds and, when slope soaring, close to the ground, it is important that they should be able to fly accurately by feel, and not need to rely on instruments in the cockpit.

Pupils are frequently confused following instrument failure if they have been taught to depend upon them. Further, as a glider pilot frequently has to make landings in strange fields the height of which he does not know, it is vital that he be able to judge an approach without the use of an altimeter.

Training pilots to fly on two-seaters with open cockpits and sending them solo without any instruments at all is perfectly practical. It would appear to take no longer than when instruments are used.

The two-seater will normally carry instruments, but for the early training these should be regarded as no more than a check on what the pilot has already learnt from his senses and his experience. If instruction is being given from a silent, closed aircraft, it may be considered advantageous to use an A.S.I. from the beginning, but care must be taken to see that the pupil does not get into the habit of watching it continually.

It is, however, considered inadvisable, regardless of the type of aircraft, to allow a pupil to rely on his altimeter at this stage of his training.

Seating

Practically all single-seater gliders are fitted with the release knob and air brake lever on the left, and the stick is held in the right hand. Pupils should have this arrangement of control from the very beginning; in the case of tandem seating this will cause no difficulty. Unfortunately, some gliders with side by side seating have only one release knob and one brake lever in the centre.

As it is better as well as conventional that the pupil should sit on the left-hand side of the cockpit, and thus have a good view when doing the more usual left-hand circuits. It is strongly recommended that an additional release knob (and air brake

lever if it is to be used by the pupil) is fitted on the left-hand side of the aircraft. If this cannot be done, it is better that the pupil sits on the right, where he can operate the centrally placed auxiliary controls without crossing hands. The alternative of putting the pupil on the left-hand seat, making him hold the stick in his left-hand and operate the auxiliary controls with his right should not be considered.

The pupil should always sit in the same seat. With tandem seating this will always be the front.

Left-handed pupils must be made to hold the stick in their right hand.

1. PREPARATION FOR FLIGHT

A.—CONSIDERATIONS

1. Thorough preparation before every flight is necessary to ensure safety. This preparation is as important as any of the exercises in the air.

2. Before the first few flights the instructor should concentrate on the pupil's comfort, and subsequently lead him gradually to the full cockpit check.

3. The pupil should be taught to prepare for his flight methodically, checking both controls and cockpit thoroughly. This discipline, and orderly thinking, will help him to become a safe solo pilot.

B.—INSTRUCTION

1. Before getting into the glider:—
   Take a general look over the aircraft.
   See that it is clear of obstructions and in a suitable position for launching.
2. Before allowing the cable to be attached:—
   See that the harness of both occupants is done up.
   Do cockpit check—see that rudder, elevator, and aileron controls work freely and in the right sense. Check that the dive brakes are shut, the wheel brake off, tail trimmer set and the cockpit hood (if any) is securely shut, etc.
3. Starting:—
   Get the cable attached to the appropriate hook. And, if necessary, make a test release, using the word "Open—Close—Test—Close" when doing this.
   Check that the take off is clear.
   See 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.
5. After landing do not get out of the glider until the ground crew arrive.

C.—ADVICE TO INSTRUCTORS

1. Before the first flight it is a good thing to explain to the pupil that the harness straps are a device for his safety and com-

fort. See that they are done up tightly, in the right order, and not twisted. Ensure the pupil understands the release mechanism. Above all, see that he has cushions if he needs them. See that the cushions cannot interfere with the controls.

2. If any system of intercommunication is used, see that the pupil knows how to use it and that it works.

3. Once a pupil has been taught the starting procedure insist that he make a complete check of this before each flight. Tell him to say aloud what he is doing. It is very important that proper cockpit check proceedure is started at the very beginning of the pupil's training, and carried out properly, even if, in the early stages the pupil will not be using some of the items.

A logical and complete system should be used, which is easily remembered, such as CB SIT CB. This covers Controls, Ballast, Straps, Instruments, Trim, Canopy, Brakes. Such things as canopy and brakes should be at the end of the drill, as these tend to be left to the last minute, on hot days, when it is desirable to leave the canopy open, or in strong winds, when it may be desirable to keep the brakes open until just before take off.

4. It is very easy in the urge to get the glider into the air as soon as possible to hurry the pupil or even to do the check and the hooking on of the cable oneself. This must be avoided and the pupil given every opportunity to do the starting procedure peacefully by himself.

5. The first few days that the pupil is on the field he may feel rather lost. Ensure that someone is detailed to show him how to ground handle and park the glider, how to signal, how to hold the wing tip, and how to attach the cable.

2. AIR EXPERIENCE

1. If a pupil has never before flown in a glider, he should be taken up as a passenger to accustom him to the sensation and to give him the opportunity of looking at the locality from the air. The flight should last about ten minutes, or should consist of at least 2 launches.

2. Before the first flight:—

(*a*) See that the pupil has on suitable clothes and, if desirable, a hat.

(*b*) Show him how to get into the cockpit and how to strap himself in, and see that he has any necessary cushions.

(*c*) Point out briefly the various controls in the cockpit.

(*d*) Tell him very briefly what you are doing in preparation for the flight.

3. Although as far as the pupil is concerned this is in some ways a passenger flight, he should be put in the seat in which he will subsequently fly, and he should be allowed to keep his hands and feet lightly on the controls. Tell him to notice that only small smooth control movements are needed in flight.

4. While it is premature to make any serious attempts at teaching, explain any manœuvres which are simple enough to be understood at this early stage.

5. Point out one or two prominent landmarks. Encourage the pupil to look out and to regard himself as part of the aircraft, taking part in and not trying to lean away from bank.

6. To avoid shaking the pupil's confidence only do gentle manœuvres. Many pupils are frightened and easily put off at this stage, particularly those who do not know whether they really want to fly or not.

7. During the flight watch the pupil to see how he reacts to flying. After landing ask him how he enjoyed it.

8. No one is likely to be sick on a circuit. Do not mention the possibility of this to a pupil before any flight. When soaring, never continue long enough for the pupil to become cold, tired, scared, or sick.

3. EFFECT OF CONTROLS AND GLIDING STRAIGHT

A.—CONSIDERATIONS

1. These are the first few lessons in flying and so should be made as simple and thorough as possible.

2. Before the pupil handles the controls he should be shown the best way to hold the stick, how to place his feet on the rudder pedals, and reminded of the need for a light touch and a relaxed and comfortable position.

3. The three movements of an aircraft—rolling, yawing, and pitching—are governed by the three controls—ailerons, rudder, and elevator. When the stick is moved sideways it moves the ailerons, when it is moved backwards or forwards it moves the elevators. The rudder is moved by the rudder pedals.

4. It is advisable that the instructor should explain the effects of the controls with the aid of a model before giving the demonstration in the air. In addition, practice in the use of controls can be given in a glider on the ground, by wing balancing, etc.

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

6. 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.

7. 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 all 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, in fact, the result of the natural "weathercock" stability of the glider.

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

8. The rudder control may also have a "further effect," but it is of much 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.

9. 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 down-going 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 up-going 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 we apply left aileron the right wing has more drag than the left, and this yaws the aircraft to the right. The effect of aileron drag has unfortunately not yet been completely eliminated on gliders.

10. The aim in gliding straight is to keep the aircraft flying at a steady speed in a set direction without slip or skid. This is most easily done by noting the attitude of the aircraft in relation to the horizon, and by flying towards a set point well ahead.

If it is found that the nose is not pointing in the right direction a very gentle turn using both ailerons and rudder should be made. In order to prevent swinging past the point, the turn should be completed by the time that the aircraft is heading in the right direction. The most common reason for deviations from the straight path is that the pilot allows one wing to drop: frequent checks should be made to see that the wings are level.

11. If the speed is wrong the position of the nose should be altered by a small amount and held while the aircraft adjusts itself, and then if necessary a further correction made.

When flying in calm air only very small corrections are required. In rough air, however, a compromise must be made between making excessive control movements in an effort to correct for every little bump, and allowing the aircraft to wallow about.

B.—AIR INSTRUCTION

1. You will see that if we take our hands and feet from the controls the glider continues to fly on its own. This is because it is designed to be stable. Therefore, do not think that flying is like walking on a tightrope: all that you have to do is to guide the glider in the direction you want it to go.

2. ELEVATORS. When flying a glider we must always maintain a constant speed—this is the right speed. Notice the position of the nose in relation to the horizon, the amount of noise and the feel of the air on your face.

If I move the stick forward the nose goes down, the noise increases and there is more airflow on your face as we go faster.

If I move the stick back the nose goes up, and as we slow down it gets very quiet and there is less air on your face.

Try this for yourself: stick forward, stick back.

Now I want you to try to fly at a steady speed. If the nose is too high and your speed too slow, ease the stick forward a little until the nose is in the right place and then check your movement to prevent the nose going further down.

3. AILERONS. Notice the position of the wing tips in relation to the horizon—you will see they are both level. Now look ahead and you will see how the nose looks when we are flying level.

If I move the stick to the left, the left wing goes down; to the right, the right wing goes down. Now try that for yourself.

Look straight in front of you and fly keeping the wings level. Now put the left wing down. Now level the wings. Put the right wing down. Level the wings.

Now, try to fly at the right attitude, and bank and correct when I tell you. Left wing down, level the wings, etc.

4. RUDDER. Look straight in front of you and you will see that we are going straight towards that wood (town, cloud, etc.). If I apply left rudder by moving my left foot forward the nose swings to the left; right foot forward, the nose swings to the right.

Now try this for yourself.

Now try and keep straight towards that wood using the rudder alone.

5. ALL THREE CONTROLS. Now try to glide straight and keep the speed steady, using all three controls together.

6. FURTHER EFFECTS OF AILERONS AND RUDDER.

Ailerons. If the stick is moved to the left, the rudder being held central, the aircraft will bank and slip down to the left. It

will then start to turn in the same direction because of its natural weathercock stability, but being banked the nose will swing round below the horizon and the speed will increase.

Try this for yourself.

Rudder. If rudder is applied, the ailerons being held central, the nose will swing and the aircraft will skid outwards. It will then start to bank in the same direction, partly because of the effect of the skid, but chiefly because the outer wing, travelling faster than the inner, will get more lift. If we continue the turn the nose will go below the horizon and the speed increase.

Now try this for yourself.

C. ADVICE TO INSTRUCTORS

1. Important points in these exercises are:—

   (*a*) The pupil is quite clear in his mind as to which control he is trying to use and its effect.

   (*b*) That he holds the controls properly and is not allowed to grip.

   (*c*) That he realises that the machine is stable.

   (*d*) That the instructor does not advance to the next stage unless he is quite sure that the pupil has properly understood and absorbed the previous one.

2. Tell the pupil to look well ahead so that he can see clearly how the aircraft moves in relation to the horizon. In side-by-side two-seaters make certain that the pupil looks straight ahead of himself through his own windscreen. Any attempt to steer by some centrally placed object, such as the pitot, will later cause trouble in landings, when the pupil will tend to drift through flying with crossed controls.

3. Demonstrate each point and then tell the pupil to try it himself. This principle should apply to all your instruction.

4. Do not assume that the pupil finds it at all easy to understand; he may have difficulty in appreciating even most simple effects, especially if they have not been properly explained on the ground.

5. Get the pupil to use the elevator alone until he understands which way the stick works, and has some idea of the amount of movement required. Then demonstrate the primary effect of the ailerons: let the pupil try this, and then get him to fly trying to keep the speed approximately correct, and the wings

level or banked as instructed. By telling the pupil to put on bank (in the direction of the circuit) and then level the wings, repeating this as required, the instructor can get the glider flown round almost the complete circuit without having to take over himself.

6. When the pupil is able to fly easily using the elevator and ailerons together, he should be introduced to the rudder. It should be pointed out to him that by using ailerons alone the glider has been made to turn, and that the rudder is merely a secondary control for the avoidance of slip or skid. Demonstrate the yawing effect of the rudder, and get the pupil to try this, then allow him to have all three controls together.

7. If this instruction is being carried out from circuits, arrange the flight so that you have to take over for as short a time as possible.

8. The majority of pupils will be completely unable to understand explanations and demonstrations of the further effects of the controls and of aileron drag if they are given in the first few lessons. Unless the pupil is curious or has any particular difficulty they should not be given until quite late in his training. In fact, some pupils will only become muddled at technical explanations at any stage. In such cases the minimum theory should be given.

9. Encourage the pupil to hold the controls all the time and ensure that he knows who is flying the aircraft. When you take control, standardise on "I've got her," and when you hand over control say "She's all yours," and put your hands up. In the case of tandem seating the pupil must reply accordingly.

10. Do not allow the pupil to get into extremes of attitude.

11. Do not allow the pupil to look down into the cockpit to watch the position of the controls, or get obsessed with instrument readings.

12. As soon as he is beginning to get the idea of flying straight make him look around. He may be reluctant to do this because he feels that he cannot fly so accurately. Tell him that it is worth sacrificing a little accuracy in order that he may be certain of avoiding collision.

13. On any ordinary glider the airspeed can be determined by looking out sideways and noting the angle between the undersurface of the wing and the horizon. The normal flying speed is

obtained when the under-surface of the wing is parallel to the horizon or slightly nose down; when it is nose up the glider is being flown too slowly. This should always be pointed out to pupils, as it is a help to them when converting on to different gliders.

14. These lessons will be made very much easier if they can be made in calm air. If lessons are given in rough air, not only will the pupil not progress, but he will get a false idea of difficulties, and in some cases may be positively frightened.

15. Most pupils have extreme difficulty in realising that a glider flies through the air, and that once it has left the ground the wind has no effect on the manner in which it flies. Make sure that he really understands this.

When dealing with the airspeed, never say "wind on your face" or you may confuse him; instead use "air on your face" or "airflow on your face".

4. MEDIUM TURNS

A.—CONSIDERATIONS

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. However, this effect is not very pronounced in medium and gentle turns, but becomes important in steep turns.

4. The best method of teaching has been found to be to think of each control as having one definite function during the turn; the ailerons controlling the angle of bank, the elevators the position of the nose, and the rudder preventing or correcting any slip or skid. This makes the whole conception of the turn and the correction of faults simple for the pupil, and it eliminates some of the common mistakes, such as the application of too much rudder.

5. It has been explained in the consideration of earlier exercises 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 need only be applied if there is slip. On most gliders this slip is noticeable and the rudder should be used, but only so much as is necessary to correct the slip. After a little practice there will be no need to wait for the slip to occur before correcting it, the pilot anticipates 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. In some gliders the application of aileron may cause the aircraft to yaw in the opposite direction to that in which it is

desired to turn; this effect is called 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, but there is no need to worry about this as a special case since the result of the aileron drag is simply to make the aircraft more inclined to slip inwards, and this will be prevented or corrected in the usual way by the application of rudder in that direction.

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, and the pilot uses his controls accordingly. Such terms as "holding off bank" may be misleading and should be omitted altogether from instruction.

8. The importance of look-out in this exercise must be stressed. 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.

9. 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.

10. Faults in Turns. If the bank is held constant and at about 30 degrees few faults are likely to occur. Too little bank will result in too little turn, otherwise no harm will be done. Excessive bank will result in a steep turn and may get out of hand, so the bank should be kept constant throughout the turn. The nose may rise above or fall below the horizon, and this is corrected by use of the elevator. 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 bottom rudder. Skidding out can only happen if too much rudder is applied.

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.

B.—AIR INSTRUCTION

The Correct Turn

Going In

Look round, and check your speed is correct.

Apply bank smoothly in the direction in which it is desired to turn, and at the same time apply sufficient rudder in the same direction to prevent slip.

When the desired angle of bank is reached keep it constant by use of the ailerons, and prevent the aircraft from skidding by taking off rudder.

Keep the speed steady by slight movements of the elevator control.

Staying In

Keep the angle of bank constant and the nose travelling steadily around the horizon. See that the speed remains constant.

Look round frequently during the turn.

Coming Out

Apply opposite bank and sufficient rudder to prevent the aircraft skidding. Keep the nose in the correct position relative to the horizon with the elevator.

Faults in Turn

If the turn does not feel right, first check the angle of bank, and correct with the ailerons if necessary.

Check the speed and the position of the nose, and adjust with the elevator.

Having got these two right, decide if you are slipping in or skidding out. If you get the sensation of falling in towards the inner wing tip and there is a draught on that side of your face you are slipping in. Correct by applying bottom rudder.

If you get the feeling of being moved outwards and there is a draught on your outer cheek you are skidding out. This is because you have too much rudder; take some off.

C.—ADVICE TO INSTRUCTORS

1. There is a tendency for the pupil to allow the angle of bank to increase during the turn until he wants to come out. Insist

on the turn being made in three stages: "going in," "staying in," and "coming out".

2. In spite of all the efforts of the instructor, one of the most common faults in turning is excessive use of the rudder. This is particularly noticeable in the case of pupils who have had solo training, or whose instructors have failed to teach the first lessons with sufficient thoroughness or accuracy. This fault can only be eliminated by making sure that the pupil understands that the rudder is not the primary turning control. He must be made to make alterations of direction, however small, primarily with the ailerons.

3. Explanation of the faults in turns and methods of correction should be given on the ground. It should be emphasised that the angle of bank must be kept constant throughout the turn, and that if the pupil realises that he is making a bad turn the first thing to do is to check the angle of bank, then check the position of the nose, and then check for slip or skid.

The conception of slipping and skidding is not very difficult for the pupil to understand once it has been thoroughly explained to him. But he finds the difficulty in deciding what is the matter with his turn in the air.

Demonstrate a continuous turn yourself, alternately slipping and skidding from a correct turn. Get the pupil to tell you what you are doing and what corrections should be made.

No pilot really understands turns until he can give this demonstration himself.

4. Teaching a pupil to keep a good look out is the most difficult part of flying training. Insist from the very beginning of this exercise that the pupil looks well round before each turn.The pupil will find it easiest to look in front of him and watch the nose travelling round the horizon when doing turns; he must not be allowed to do only this.

5. On side-by-side two-seaters the pupil sometimes has difficulty in keeping his speed right as the nose appears to be in a different position in left and right turns. This tendency can be avoided by getting the pupil to consider that part of the windscreen immediately in front of him as the nose.

6. Instead of telling the pupil to "straighten up now" from a turn give him a definite feature on which to come out.

7. If instruction in turns is being given on winch circuits the instructor should ensure that the flight is so arranged that the

pupil does the maximum amount of flying. If the instructor allows the aircraft to get badly out of position for the final approach he will have to take over himself, and thus waste valuable practice for the pupil.

8. Some instructors have made a habit of having a length of string tied to the pitot head for use as a slip or skid indicator. With side by side seating this is unsatisfactory. If fitted on the centreline it cannot be correctly interpreted owing to parallax, while, if fitted in front of the pupil, the divergent airflow around the nose upsets it. The pupil should be taught to recognise slip and skid by the feeling on his bottom and the airflow on his face.

5. STALLING

A.—CONSIDERATIONS

1. The aim of this exercise is to teach the pupil to recognise the approach to the stall, to learn what the stall feels like and how to recover from it with minimum loss of height.

2. 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 gets less. The nose drops even if the stick is moved farther back. This is the stall.

3. 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.

4. 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 always 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 held too high for any length of time the glider will stall.

(*b*) Slow airspeed shown by absence of noise, 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 gliders a buffeting of the tail surfaces may be apparent.

6. 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 auto-

matically, 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 easing the stick back.

7. 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 downgoing wing is, in effect, to increase the angle of attack of that wing still further. Hence is 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.

B.—AIR INSTRUCTION

Turn the glider to make sure that there are no other aircraft nearby, especially below.

Gently bring the nose above the normal gliding position and keep it there by moving the stick steadily farther and farther back.

As we get slower the noise and the airflow on your face get less and less, and the time comes when, although we go on moving the stick back, the nose drops of its own accord. That is the stall.

To recover, ease the stick slightly forward and allow the glider to pick up speed.

That was quite a gentle stall. I now want to show you another one with the nose rather higher above the horizon. You see that the stall is rather more sudden and the nose drops farther down. We recover as before.

The controls get less effective as we fly more slowly; you see that as we fly slower and slower the ailerons get more and more sluggish, and at the stall they hardly work at all. If a wing drops the ailerons will not help much; keep straight with the rudder, and then use the ailerons to level the aircraft when speed is gained.

Try a stall yourself. The important thing to notice is the sensations as we approach the stall—the absence of noise—and the lack of airflow on your face, and the ineffectiveness of the controls.

C.—ADVICE TO INSTRUCTORS

1. Many pupils have, for one reason or another, a considerable apprehension, even fear, of this lesson. Try to convince the

pupil that there is nothing alarming or dangerous about stalling, and that he can be quite confident in taking any glider to the point of stall provided that he is at a reasonable height, and provided that he knows the method of recovery. Set out to make him feel happy and confident about it all. Get him to do a number of stalls himself to see how easy it is.

2. The pupil will do better if he understands what is happening and why. Ensure that he understands about the angle of attack. He will have some difficulty in grasping the fact that the airflow does not come horizontally but from the direction of travel of the aircraft. Diagrams will help.

3. Ensure that the pupil's harness is tight enough.

4. At a late stage in this exercise, demonstrate the effect of negative 'g' in order that the pupil shall not confuse it with the feeling of being stalled and continue to move the stick forward.

5. Never forget the aims of this exercise—to teach the pupil to recognise the approach to the stall in order that he may avoid it, and should one occur accidently, recover instinctively and with the minimum loss of height.

6. The instructor should ensure that he can at all times reach the stick, even when mistakenly put hard forward by a pupil, and while being affected by negative 'g', and a harness which is slacker than it ought to be.

6. APPROACH AND LANDING

A.—CONSIDERATIONS

In this section the use of side-slipping is not being considered.

1. The first consideration in making a good landing is to make a good approach; and a good approach is the result of a good circuit; therefore we will first consider the problems of the circuit.

2. Forgetting for the moment any method of steepening the angle of glide, for 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 the circuit 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, consisting of a cross-wind leg, a down-wind leg, a second cross-wind leg and the final approach straight into wind, with turns through approximately a right-angle between legs. When the pilot understands the need for proper planning of his approach, the whole circuit need not be devoted to it. The pilot should be encouraged to use the early part of every flight for some specific exercise, or, as an important introduction to a soaring outlook, the search for lift, and aim to join the circuit at a suitable height at a point about a quarter of the way along the downwind leg.

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

5. For the purpose of initial training the approach should be considered to start as soon as the cable is released. As soon as the speed has been corrected the glider should be turned on to the first cross-wind leg, and the pilot must at once consider how much height he has available for his circuit. If he thinks he is high this leg should be continued, whereas, if he thinks that he might be low he should get on to the down-wind leg at once. The 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 this leg 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.

6. The position in which the second cross-wind turn 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 down-wind.

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.

7. 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 in towards the field; while if he thinks that he has too much height he should not turn so far, so that his cross-wind leg will edge him away from the landing ground.

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.

In the perfect circuit this turn will be made as the glider approaches the line of the landing run. However, even with the most perfect piloting this cannot always be achieved, as thermals, or sinking air, upset the approach. If the glider is much too high as it gets down-wind of the landing line, the cross-wing 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 the turns at the ends of the beat be made into wind.

8. The final approach should be made as smoothly and steadily as possible, towards a part of the landing ground which is smooth and free of obstructions. The glide is continued at constant speed down to a height from which a progressive flattening out can be made. The glider should then be kept just off the ground until the speed is right for landing. It is then allowed to sink gently on to the ground, touching main wheel and tail skid together.

9. After landing the glider is kept straight and the wings level by coarse use of the controls. The length of the landing run will vary according to the wind strength and surface, and type of undercarriage, and on smooth, frozen or slippery surfaces may be much longer than expected.

10. AIR BRAKES.

The air brakes fitted to gliders are of two different kinds: (*a*) Spoilers, and (*b*) Dive brakes.

(*a*) Spoilers, which take the form of flaps fitted on the upper surfaces of the wing, are designed primarily as a means of increasing the rate of descent on the approach.

They have three effects:—

(i) They increase the drag and hence steepen the angle of glide.

(ii) They increase the stalling speed.

(iii) They may produce a change of trim.

(*b*) Dive Brakes. These normally consist of surfaces arranged to extend both above and below the wing. Unlike spoilers, which are not usually stressed for high speed flying, dive brakes are designed for this purpose. They were developed as a means of limiting the diving speed of a glider to a safe maximum, because, without brakes, a glider in a steep dive can reach such a high speed that very severe loads are imposed on the structure.

In addition, they are also used in the same way as spoilers as an approach control. Compared to spoilers, they:—

(i) Produce a greater increase of drag, particularly at higher speeds.

(ii) May also increase the stalling speed.

(iii) Are usually designed to produce no change of trim.

11. When flying with the dive brakes or spoilers shut, the air loads upon them are usually such that there is a tendency for them to open. To prevent this, spoilers are normally fitted with springs and dive brakes with some sort of lock. The springs on spoilers are normally strong enough to return the spoilers to the closed position when the pilot lets go of his control, but dive brakes are usually arranged to ride fully open once they have been unlocked.

12. USE OF AIRBRAKES ON THE APPROACH.

Control of the approach can be achieved by altering the flight path or the angle of glide. With the use of airbrakes the

angle of glide can be varied to a considerable extent, and because of this a simple straight approach can be made without the complication of "S" turns or sideslips.

The basic technique is to make an approach with a long straight final glide into wind, which, if continued with the airbrakes closed, would result in an overshoot. The airbrakes are then opened in varying degree in order to make such adjustments to the angle of glide as may become necessary. Normally the approach will be made at a speed slightly greater than that used in a brakeless approach. However, if, particularly in the case of gliders fitted with dive brakes, it is found that the use of full airbrake would still result in an overshoot, the nose can be put farther down and the path steepened without excessive speed building up.

If the final part of the approach and the hold off is made with the brakes fully open the following should be considered:—

(*a*) Since the approach is steeper the alteration in angle required to level out is greater than usual.

(*b*) Deceleration will be more rapid.

(*c*) Stalling speed will be slightly higher.

(*d*) The wind gradient effect will be more noticeable.

For these reasons, unless the final approach has been made at a fast speed, it is desirable in the early stages to partly (or even completely) close the brakes while making the check and beginning of the hold off.

When actually holding off, any alteration in the position of the brakes will cause a marked alteration in the flight path unless the attitude of the glider is at the same time altered by moving the stick. An inexperienced pilot will find this difficult to do and so for the first few landings he should be told to make the final part of the approach, the check, and the hold off with the airbrake lever in a constant position.

13. Use of dive-brakes at high speed.

The pilot should get used to the idea that dive brakes have been designed for his safety and that at any time when, through losing control in cloud or through bad aerobatics, there is a chance of his speed becoming high, he should open the brakes without hesitation. If he waits until the speed is nearly at the permitted maximum before starting to use the brakes, not only is there a risk of exceeding the permissible figure, but when the brakes are unlocked they may ride open with some violence.

14. Wind Gradient. This rather confusing term is used to describe the diminution of wind strenth near the ground. It was

said earlier that the wind has no effect on the way in which a glider flies; this is not quite true. If the glider 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. Hence if a glider is coming in to land against a strong wind (which will be blowing less strongly close to the surface of the ground) the airspeed will tend to fall off as the glider gets closer to the ground. This can only be obviated by putting the nose further down during the last stages of the approach, and thus ensuring that the glider has plenty of speed.

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.

15. If the decision to make left- or right-hand circuits is not determined by outside circumstances (flying control, proximity of hill, etc.), the following two considerations should be taken into account when choosing the direction.

(*a*) Wind. If this is tending to come from one side of the launching run, or if a sudden veer is expected, the direction should be chosen so that the glider has to turn less than 360 degrees in order to get round into the wind.

(*b*) Sun. If the sun is particularly glaring it will be easier to make the final cross-wind leg down-sun.

The pupil should be given practice in circuits in both directions.

B.—AIR INSTRUCTION

The Circuit: Normal

At the top of the launch check your speed, look round, and then turn across wind. Consider your height. If you think that you are low turn down-wind. If you think you have plenty of height continue across-wind in order to make a bigger circuit.

Now turn down-wind.

As you fly down-wind keep looking at the landing place. If you are low, edge in towards it. If you have plenty of height get farther away.

Turn across-wind when you are a short distance down-wind of the landing ground.

Again, if you are low, turn straight in on the final approach. If you have plenty of height continue across-wind. You can judge the strength of the wind by the way the glider drifts. Have a good look round for other aircraft.

Keep looking at the place where you want to land and try to judge your angle from it. When you think you are right turn in towards the field on your approach.

THE LOW CIRCUIT

If you get a very poor launch you must get on to the down-wind leg as soon as possible. Keep close to the landing ground and turn into wind early, so that your turn is completed at a good height. This will mean that you may land near the up-wind end of the field; it is better to do this rather than make a low turn.

THE HIGH CIRCUIT

If you arrive in the position where you would normally do your final turn into wind too high, even if you use full brake, carry on across-wind. Then turn and fly back across-wind in the opposite direction. If necessary use brakes on the cross-wind leg, as well as on the final approach, until you are in a position to do the final turn into wind.

It is vital that at no time should you lose sight of the landing ground. Always do your turns towards it.

THE FINAL APPROACH AND LANDING

Having done the final turn, get your speed steady and aim towards the least obstructed part of the landing ground, aiming to overshoot slightly. If the glider is drifting sideways, you are not flying into wind. Work out which way you should turn in order to do this. When you are sure you are going to overshoot, open the brakes to steepen the angle of the glide. Keep the speed steady, but faster than normal. Use the brakes to control the approach, varying the amount to achieve the desired glide path.

Remember to look well ahead for the landing.

When you are near the ground, close or partly close the brakes. Do not move the lever during the check, hold-off and landing.

At a reasonable height—this is about it—gradually start to level out so that the glider flies along just above the ground. Keep it just off the ground until it is in the right attitude for landing.

When you are on the ground open the brakes fully, keep the wings level and go straight by coarse use of the ailerons and rudder

C.—ADVICE TO INSTRUCTORS

1. The approach and landing is a matter of judgment, and there is no simple way of teaching judgment to those to whom it does not come easily.

2. The average pupil takes time to learn how to judge the circuit; do not be discouraged yourself and do not let him be discouraged if there are no obvious signs of improvement during the first few lessons. However, pupils who find undue difficulty in learning to judge the approach, should be taken off any responsibility for them until they have a greater background of flying experience to help them.

3. The instructor's task is particularly difficult in this exercise. The pupil cannot learn unless he is allowed to make mistakes, but mistakes, particularly undershoots and heavy landings, must not be allowed to result in damage or undue risk to the aircraft.

4. The square circuit is not applicable to all circumstances, but if the pupil has had practice in this in developing his basic planning he will be able later to more easily adapt himself to varying conditions.

5. Diagrams will be a great help, both in explaining the type of circuit to be made, and in showing the pupil what he actually did.

6. On most gliders fitted with spoilers, if the lever is let go, the spoilers will shut. On the other hand, once dive brakes have been unlocked they may open fully if the pilot lets go of the lever.

Pupils should be instructed, therefore, that once they have started to use either spoilers or dive brakes on the approach, they must keep their hand on the lever continuously until they are actually on the ground.

7. To an aeroplane pilot the air brake control is similar to a throttle; there is a tendency to "close the throttle" during the hold-off, which will result in full brake being applied at an awkward moment. Point this out.

8. Experience has shown that if the brakes ride open inadvertently, particularly on take off, the pilot may not notice this. He may even do a complete circuit without realising why he has had such a bad launch and comes down so quickly. This failure can be particularly dangerous if it occurs on aerotow.

The possibility of this happening should be pointed out to the pupil and he should be told that if anything feels wrong he should immediately check that the brakes are shut by looking out sideways along the wing.

9. The Air Instruction given is that appropriate for the pupil's first few landings using brakes. When he can do these satisfactorily he should be allowed (provided that the wind is

not too strong) to do a few landings with the brakes fully open. Then he can be allowed to vary the amount of brake during the check and hold-off. He must realise the importance of not getting too slow.

10. Once a pupil starts to use the air brakes sideslipping tends to be neglected. The ability to sideslip with the brakes open, particularly in a turn, is of considerable value when making and approach over obstructions into a small field.

11. The pupil often has difficulty in knowing what he has done in landing. The first few times tell him what happened, but afterwards try to get him to tell you. In this way you will soon be able to find out how much he notices and whether he really understands what he is trying to do.

12. The pupil needs guidance on where to look during the hold-off. Tell him to keep looking at a point about forty yards ahead, or similar to the distance he uses when driving a car at 40/50 m.p.h.. This point should be in the centre of vision; not at the top of it. The picture should include the far horizon. If he is looking too far ahead, objects will hardly appear to move, while if too close they will move too fast to be recognised.

There is a tendency to look too close. In side-by-side two-seaters the instructor can look at the pupil's eyes to see where he is really looking.

13. The glider should be held off just above the ground until it is in the right attitude for landing. If the pupil has difficulty in judging this and always lands too fast get him to notice the position of the nose when the glider is at rest on the ground in this attitude, and then next time he makes a landing to hold off until he sees the same picture.

14. Do not talk about the position of the stick when landing. Refer to the attitude and height.

15. It is important that the pupil be made to keep the aircraft straight and the wings level until it actually comes to rest. He will find this difficult. Get him to do it every time.

16. If you are having to teach these circuits without the use of air brakes, do not use them at all. When a pupil is overshooting and is going to land up at the far end of the field, there is a strong temptation to use brake in order to avoid a long retrieve. This temptation must be resisted; if the pupil can get in safely in a straight line, let him. If not, let him sort things out for himself.

17. It is extremely difficult to judge an approach accurately without sideslipping or using the air brakes. Explain this to the pupil and tell him not to worry if he overshoots a little—spot landings come much later. If possible teach the use of air brakes throughout.

18. Finally, remember that a pupil will never make good landings unless he makes good approaches at constant and correct speeds, and that he will never make such approaches unless he learns to fly the circuit properly. The moral is clear.

7. TAKE OFF AND CLIMB

A.—CONSIDERATIONS

Winch and Auto-tow

1. The object is to get the glider to the maximum height without endangering the aircraft or 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 also that should the cable break at any moment, the glider will be in a position from which it can safely be landed.

2. The action in the event of a cable break is described in section 9.

3. The launch can be divided into five parts:—

(*a*) The ground run

(*b*) The take off

(*c*) The initial climb

(*d*) The climb

(*e*) The release

(*a*) At the beginning of the ground run coarse use of the ailerons will be necessary to keep the glider level.

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 slightly behind the centre of gravity, the best technique is to get the glider running along on its wheel, without either nose or tail skid touching the ground.

(*b*) The glider should be allowed to take itself off.

(*c*) 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.

(*d*) By the time that the glider has reached 100 feet or so it should be climbing steeply. 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 the speed as this will impose heavy stresses on it.

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 rhythmical pitching oscillation, can be

damped out by easing the stick slightly forward and holding it still.

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.

The glider is kept straight on the climb by keeping the wings level.

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.

(*e*) The release will normally be made when the glider has reached its maximum height; this, of course, occurs before the glider arrives over the winch.

On many gliders it is impossible to see the winch during the later stages of the climb, and so some prominent feature to one side of it should be noted before take off.

The nose should be lowered just before the release knob is pulled. This is done in order to reduce the load on the hook and so make releasing easier, and also to prevent the nose from jerking up.

Surprisingly enough, pilots may sometimes forget to release or fail to give an effective pull. To avoid this the pupil should be taught to pull the release knob hard at least twice when desiring to release.

Owing to the possibility of a failure at any stage of the launch and the need for immediate release the pilot must be able to do this without any delay. He should, therefore, be taught, from the time that the cable starts to tighen at the beginning of the launch, to after release, that his hand should be close to the release knob.

B.—AIR INSTRUCTION

1. Carry out preparations for flight.
2. See that take off path is clear.
3. Tell signaller that you are ready to be launched.
4. As the glider moves forward keep the wings level and the glider straight with coarse use of the ailerons and rudder. Use the elevator to get the glider running steadily on its wheel.

5. Allow the glider to take itself off and do the initial climb gently.
6. As height is gained, cause the climb to become progressively steeper.
7. Keep straight by keeping the wings level, and the climb steady.
8. Keep looking out to see how the launch is progressing and when the winch is nearly underneath (or the tow car is almost at the end of its run) put the nose down to the normal flying attitude and release by pulling the knob hard twice.

C.—ADVICE TO INSTRUCTORS

1. Different gliders have different launching characteristics from the point of view of stick position and stick load. But they all climb at much the same attitude. As a rough guide, the angle of the wings to the horizon should be 40-45° during the middle part of the climb. It is important that the pupil be taught to judge the launch by the position of the nose and not by the stick position, otherwise he will find difficulty when flying a new type.

2. It is difficult to keep the wings level during the launch, particularly if the glider has side-by-side seating. Get the pupil from the beginning to see that the horizon on either side of the nose is in the same position.

3. Make sure that the pupil really does do a cockpit and control check.

4. Although the pupil may not do the launch until later in his training, it is a good idea from an early stage to get him to tell you when he thinks the glider should be released. Apart from practice in judging the release it helps him to relax and look out.

5. Teach the pupil to do the climb before teaching him to do the take off.

8. SPINNING

A.—CONSIDERATIONS

1. 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.

2. The spin is a result of faulty flying caused by misuse of the controls. 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.

3. 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.

4. The actual form which a spin takes varies in different types of aircraft; some spins are steep and quick, other flat or slow. Some gliders will spin continuously if the stick is held back and full rudder applied, but other types may alter their spinning characteristics after a few turns. 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. For any particular aircraft the position of the centre of gravity will have an effect on its behaviour in a spin.

If the C.G. is far forward it may be difficult to hold a spin, or even start one at all: while if it is farther back the glider can probably be made to spin continuously. If the C.G. is behind the permitted position, recovery from a spin *may be impossible.*

5. Spinning is very seldom used as a deliberate manœuvre. At one time it was considered that a spin should be made if a pilot got into difficulties when cloud flying, but this practice is hardly ever used since it may be difficult to get into and hold the spin, and, in any case, now that gliders are fiitted with dive brakes these are used instead.

6. Since most gliders will spin it is important that the pilot should know under what circumstances a spin can occur, how to recognise one, and how to recover from it. The earlier that he can start the recovery the less height will be lost. Hence the instructor should concentrate on teaching a pupil to recover as soon as the aircraft has shown a tendency to start to spin—this is called the incipient spin. It is, however, also important that the pupil be familiar with the sensations of a protracted spin and be able to recover from one.

7. 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, given below, should be taught, as this has been found to be the most effective on all types of aircraft.

8. 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 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 rudder first.

9. Most gliders will recover as soon as the opposite rudder has been applied, and the stick moved a very small distance forward. It is, however, very important that the pupil understands that this is only part of the full procedure, and that 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. He must remember the procedure as "apply full opposite rudder and then move the stick steadily forward UNTIL THE GLIDER STOPS SPINNING".

10. The use of the ailerons may affect the manner of entry and type of spin. Once the spin has started, the ailerons should be centralised to execute the spin neatly.

11. Most gliders fitted with dive brakes will spin with them open or closed.

12. Considerable height may be lost during spins and the recoveries; they should not be practised too low down.

13. A pupil must be proficient in recognising and recovering from an incipient spin before he goes solo. If it is possible to show him a full spin of a turn or two this should be done.

B.—AIR INSTRUCTION

Turn to make sure that there are no other aircraft nearby, especially below.

"I am now going to show you how it is possible to spin off a really bad turn. I am doing this horrible slow turn with much too much rudder and very little bank. We go round perfectly

steadily, but if, as the nose drops, I try to keep it up by pulling the stick farther back, this happens. This is a spin.

Come out—full opposite rudder, then stick forward steadily until it stops spinning; then centralise the rudder, level the wings with the ailerons and pull gently out of the dive.

We will now try one the other way, but this time we will not let it spin so much; as soon as the nose drops down to one side we will come out. The procedure is exactly the same.

Here we are doing this slow turn with much too much rudder. I get slower and slower and keep the nose turning by putting on more rudder; as the nose drops I try to keep it up by pulling the stick back, and the spin starts. Come out—opposite rudder, stick forward, centralise rudder, level with ailerons and ease out of dive.

Now try this for yourself.

C.—ADVICE TO INSTRUCTORS

1. Most pupils approach spinning with some apprehension. The instructor should try to remove this, first by explaining that there is no deep mystery about it all, and secondly by demonstraing how easy it is to recover at any stage of the spin.

2. There is no great merit in doing prolonged spins—the really important thing is that the pupil should, himself, be able to recognise an incipient spin and make a quick recovery with the minimum loss of height.

3. Make sure that the pupil really understands how people manage to spin in—the pilot undershooting so he stupidly flies slowly, his reluctance to put on bank because he is low down, the resulting attempt to turn with too much rudder, the pull back on the stick as the nose drops, and the consequent spin. Alternatively, the pilot who is flying much too slowly when slope soaring and spins off a turn in the gusty air.

4. Emphasise that the recovery action from a spin is not what one would do instinctively; as the spin starts and the nose drops away every instinct say "Pull back on the stick". Reason must take over and say "I am spinning—opposite rudder, stick forward".

5. There is little object in demonstrating spins from straight stalls; the demonstration should be made from a badly executed turn, and it must be convincing. On some gliders, aileron may have to be used in order to start the spin; do not hide this, but explain how a pilot may do this when making a bad turn.

6. The first few spins, even those of only a quarter of a turn, are rather frightening. The pupil will not feel nearly so worried when he has done one himself, so try to arrange this in the same flight. In gliders with side-by-side seating it is less alarming to be seated on the outside of the spin, and so, if the pupil is a nervous one, the first spin should be made in the direction opposite to side on which he is sitting.

7. Spins should preferably be done high up, but the risk involved in doing them dual with a competent instructor from a high winch or auto-tow launch is one which can certainly be accepted. However, while it is extremely important that the pupil gets practice in spinning solo, he must not be allowed to do this below a height laid down by the instructor (say, 2,500 feet) until he is really experienced. He must be told about this, otherwise, seeing the two-seater spinning at a lower height, he may think that this is the normal procedure, and do the same.

8. In all the flying exercises up to this one, emphasis has been placed on moving the controls very gently and slowly. In recovery from a spin, they must be moved decisively. The pupil may have some difficulty in grasping this idea. On the other hand, it must not be carried to an extreme, particularly with the elevator control, or else, if a pupil is slow to realise when the glider has stopped spinning he may continue to move the stick quickly forward and get into a steep dive.

9. If a pupil has difficulty in pulling out neatly from a dive, practise this off a straight dive without doing a spin at all.

10. The importance of flying within the weight limitations should be stressed. If the pupil is likely to be near the limits, particularly the aft limit, on subsequent solo aircraft, this point should be elaborated and the pupil encouraged to get used to the idea of carrying ballast.

11. Inexperienced pilots may find difficulty in recognising the difference between a spin and a spiral dive. Point out that in a spiral dive speed increases, but in a true spin remains low and steady (although the actual reading may be confused if the glider A.S.I. has a pot pitot). Do not worry if a pupil tends to initially lift up the falling wing with aileron unconsciously, *provided* that he deliberately takes the proper spin recovery action, as, in the event of his spiralling inadvertantly off a steep turn or out of cloud, the action of taking off bank is more likely to be taken, even if the pilot is under the impression that he is spinning, and starts to recover from this.

9. CABLE BREAKS

A.—CONSIDERATIONS

1. The glider must be flown on every launch in such a way that should the winch or auto-tow cable break at any moment during the launch 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, suddenly relieved of the cable load, will rise still higher.

3. In order to maintain control it is necessary to retain flying speed. To do this the nose must be put down at once. 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 is being made at a faster airspeed very 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 does not break of its own accord; it 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. It is essential that the cable be released from the glider immediately the launch fails.

6. The action to be taken after the glider 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 overshooting this should be done. But if this is impossible an "S" turn will have to be made. As it is extremely difficult to judge from a low height when a circuit is possible, a circuit should be made only if the pilot is quite sure that he has ample height to do this, and that it is impossible to get in ahead.

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.

8. The above considerations still apply 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 to

the launch in the hope that it will pick up for such a long time that his speed gets dangerously low.

9. Since it may be necessary to release instantly at any moment during the launch, it is of vital importance that the pilot either holds the release knob, or, if it is so arranged that doing this might lead to an inadvertent release, keeps his hand close by it.

B.—INSTRUCTION

1. If the cable breaks:—

(*a*) Get the nose well down.
(*b*) Release.
(*c*) Think: "Can I land straight ahead without over-shooting ?" If the answer is "yes," do so. If the answer is "no," immediately start a turn to one side, then make up your mind whether you can get in ahead with an "S" turn.

Only if you are quite sure that you have got plenty of height, do a circuit.

C.—ADVICE TO INSTRUCTORS

1. It is essential that the pupil be able to cope without assistance should a cable break occur.

2. Should you have a break at an early stage in the training, explain that there is nothing to be alarmed about and tell him what you are doing.

3. As soon as the pupil can do the take off and climb by himself, the action in the event of a cable break should be explained to him. Then if one does happen he can get useful practice. If, however, he is nearly ready for solo and has not actually himself made a recovery from a real break, it is essential that he be given some dummy ones before he goes solo.

4. Dummy breaks are best done by telling the winch or car driver, before the flight, to throttle back when the glider is at a certain height (say, "at two spans" or whatever you want).

For dummy breaks in side-by-side two-seater gliders it is better not to simulate the break by pulling the release yourself, as the pupil will see what you are doing.

5. When explaining the immediate action after the cable has broken talk about getting the nose well down; do not say "Push the stick hard forward," otherwise the pupil may start to do a

bunt if he has a cable break when flying fast. Demonstrate the sensation of negative 'g', so that the pupil will not confuse the effect with that of stalling, and continue to put the stick forward in error.

6. There is always a temptation to whip around on a quick circuit from a low height instead of going straight ahead or doing an "S"" turn. If you do this yourself when you have a real cable break, you cannot blame your pupil if he does the same thing.

7. This aspect of training tends to be neglected because of the time spent in retrieving the glider from the far end of the field, but the importance of practising cable breaks cannot be over-estimated.

8. The pupil will learn nothing from this exercise unless he does all the flying himself.

9. Insist on the pupil keeping his hand near the release knob on every launch.

10. Before the pupil reaches his first solo, get him to tell you before each take off what he will do if the launch fails, so that he gets into the habit of preparing himself for this eventuality when alone.

10. FIRST SOLO

A.—CONSIDERATIONS

1. A pupil learns most when he is flying solo; he only becomes really confident in his own ability to fly when he knows that he can do so without the aid of an instructor. Therefore, there are obvious advantages in allowing him to go solo as soon as he is fit to do so.

2. On the other hand, there is considerable risk in sending him solo before he is ready for it. The danger is not only one of physical damage to pupil and aircraft, but also the effect on his confidence if he flies badly.

3. It is clear from these two considerations, which are, to some extent, contradictory, that the instructor must exercise very careful judgment in the matter.

4. The standard required for the first solo is safety before polish. Two indifferent circuits sensibly corrected show airmanship; two which happen to be right may be luck.

5. When the pupil is making the flight in the two-seater, the instructor should see that the straps in the empty cockpit are securely fastened and that any necessary ballast is attached. If the two-seater has tandem seating, no ballast will normally be necessary for the C.G. requirements, but it may be desirable to fit some in order that the rate of descent when flown solo will not be very different from that dual. Side-by-side two-seaters usually require ballast for solo flying. If the amount installed is only just sufficient to bring the C.G. within the required range, the pupil will find the stability of the glider and its behaviour on the launch very different from that which he is used to. Avoid this. A greater amount of ballast should be fitted, so that the flying characteristics of the glider are similar to those with the instructor aboard.

6. If the pupil is to be sent solo on a single-seater, the following differences in characteristics will have to be explained

(*a*) The position of the nose when gliding at the right speed.
(*b*) The noise, and the feel of the air on the pilot's face.
(*c*) The feel of the controls.
(*d*) The angle of glide and the rate of descent.
(*e*) The launching characteristics.
(*f*) The cockpit layout.

If the type has very different characteristics, the pupil will have a great deal to assimilate in his first trip.

7. The first solo should be made under the easiest possible conditions, such that the pupil will get a good launch, and have

the largest possible clear area for his landing. He should not have to contend with rough air or a cross-wind or dazzling sun.

8. The instructor should supervise his pupil's departure for his first solo flight, and give him just as much advice as is required by the circumstances, *and no more.*

B.—ADVICE TO INSTRUCTORS

1. The first solo always seems to be a big step to the pupil, but the instructor can do much to make this step appear in its proper proportion—simply a normal part of the training.

2. The instructor must base his decision as to when to send the pupil solo not only on his flying ability but on his health and mental outlook at the time. The pupil should not be told when the instructor has made his decision or at what future time he will be sent solo. The instructor should not allow the approach of the first solo to be turned into an event, or the pupil to feel that he is a guinea pig. Audiences, particularly those which include girl friends or relations, should be discouraged.

3. The pupil should not be asked whether he feels competent to go solo, but should be told that he is.

4. The first solo should be made immediately after a dual flight. Everything must be ready so that the man can be sent off with the minimum of delay.

5. The briefing before the first solo flight should be kept to *an absolute minimum,* and only those things which he will find different when flying solo should be mentioned.

6. If he is sent solo on the two-seater no briefing is required; he goes straight off to do a circuit similar to the dual one he has just done.

7. The following points should be made if a single-seater is used:—

(*a*) Attitude of the glider. Point out the different seating position in relation to the nose. With the pupil in the cockpit lift up the tail until the glider is in the correct gliding attitude.

(*b*) Explain in what way the noise and the airflow on his face will be different. Remind him that he can get a speed check by the angle of the undersurface of his wings to the horizon.

(*c*) See that he can work the controls comfortably and that he knows the position of the auxiliary controls.

(*d*) Explain in what way the launch will differ from those to which he is accustomed.

8. Ensure that the winch launch or auto-tow will go off without a hitch; see that only competent people are used for signalling, etc.

9. The transition from two-seater to single-seater can be made easier if the instructor gets the pupil to fly the two-seater in such a way that some of the characteristics of the single-seater are reproduced. For example, if the two-seater is much quieter than the single-seater, the pupil will tend to fly the single-seater too slowly. But if he is made to fly the two-seater fast so that there is more noise, he will be more likely to fly the single-seater at the correct speed. This need only be done on the last two or three flights before solo.

10. If the pupil is being sent solo on a single-seater fitted with an A.S.I. it is vital to ensure that this is known to be working accurately. This should be checked by a stall made in the test flight.

11. It is common experience that instructors who really allow their pupils to fly on their own during dual instruction are the ones who get their pupils off first on successful solo flights.

11. FURTHER SOLO FLYING

A.—CONSIDERATIONS

1. The whole aim in gliding training is to produce competent, safe pilots who are skilled in all aspects of soaring.

2. Dual training is only a part, although a very important part, of the pilot's training. It is the pilot's subsequent solo flying which will determine his ability as a pilot.

3. After a pilot has gone solo he still has a lot to learn. If this part of his training is neglected he will not appreciate how much he does not know and will become over-confident, but if he is kept on too tight a rein, not only will he get bored, but also, because he has no practice in thinking things out for himself, he will be at a loss if his instructor is not there to look after him.

4. It is, therefore, necessary to strike a mean between these two extremes and gradually to lead the pilot to the stage where he is competent on his own. Discipline must not be relaxed, but it should be exercised less frequently. At the beginning of his solo flying the pupil should be told exactly what he may or may not do on each flight; his flying should be watched and his faults pointed out to him. Later this becomes less necessary and by the time that the pilot is doing advanced soaring the "orders" become advice reminders. However, the instructor must realise that he is in charge of all flying taking place from his field, and if any bad or dangerous flying is done or any regulations broken, he must assert his authority to see that it does not happen again. If he does not stop this bad flying at once other pilots will follow suit and the whole standard will deteriorate rapidly.

5. Until the pupil has gained some experience he should be allowed to advance only slowly. Dual check flights should be given frequently, both to see that he is becoming proficient in what he is practising solo and also to make sure that he is not developing any bad habits. If the pupil has not flown for some time he should be given a dual check before he is allowed to go solo; the same considerations apply if the conditions are different from those to which he is accustomed, e.g., strong winds.

6. The various exercises which the pupil will have to do in his training can be divided into four groups:—

(*a*) Straightforward circuits. The pupil should continue to practice these until he can do them competently and has got used to flying by himself.

(*b*) Stalls, 360 degree turns, sideslipping and spot landings. Practice in these will add some variety to his flying while he is gaining more experience. The importance of

plenty of practice in stalling cannot be over-estimated. The pilot should also get used to setting his altimeter at airfield height.

(*c*) Use of airbrakes, use of instruments, steep turns, slope soaring, thermal soaring, spinning, flying in strong winds, flying new types, aerotowing and bungey launching. Practice map reading, simulated field landings, and cross-country flying.

(*d*) Cloud flying, aerobatics.

It is impossible to lay down any hard and fast rules for the order in which these exercises should be carried out because so much will depend on the types of aircraft available, the methods of launching, the weather and the site. But it should not be illogical, and a new exercise, or the same one under difficult circumstances, should not be introduced until the pupil is proficient in the old. For example, until a pupil has done some slope soaring under easy conditions, he should not be allowed to attempt it on a day when it is difficult. Nor should he be allowed to go across country until he has made several good local thermal flights.

It is often difficult to arrange solo spinning. If this cannot be done until late in the pupil's training, he must be kept in practice by doing it dual. If aerotows are available there is no excuse for not doing solo spins and, in any case, no pilot should be allowed to do aerobatics or to enter cloud until he has done a number of spins solo.

7. The number of hours or launches which a pupil will need to do before he is allowed to proceed to the next stage cannot be given, as pupils vary so much in their ability. Minima can be set, but in practice these tend to become the normal and a pupil may be upset if after doing this number of flights he is not allowed to progress. It is far better to have tests of proficiency, and for the instructor to decide on his own judgment of the pupil's flying and the way in which he performs these tests.

8. There is a tendency for the instructor, once he has got his pupils solo, to neglect them. This must be guarded against and a real interest taken in their progress, their flights must be watched carefully, and, as well as pointing out faults, the instructor should give praise when it is merited. This is particularly important with a slow pupil; a little encouragement will help him a lot.

9. The following points should be watched in solo flying and dual checks:—

(*a*) Excessive use of rudder in turns.

(*b*) Tendency to fly more and more slowly.

(*c*) Failure to keep a good look out.
(*d*) Tendency to pull up too steeply at the beginning of a winch or auto-tow launch.
(*e*) Carelessness (see below).
(*f*) Over-confidence (see below).

10. Carelessness. A pilot may develop a careless attitude to flying as he gains some experience. This may not be due to over-confidence, which will be dealt with later, so much as laziness or an inability to criticise himself. This carelessness may show itself in the following ways:—

(*a*) Slapdash cockpit check, omitting to check controls.
(*b*) Lack of effort to land in a suitable place, or to make self-imposed spot landings.
(*c*) Taking off with a doubtfully clear run.
(*d*) Lack of care in handling gliders and equipment, in driving on the field, in giving signals, etc.
(*e*) Carelessness in attaching launching cables.

These habits must not be allowed to develop.

11. Over-confidence. Over-confidence is a natural tendency with almost everyone, but it is particularly so with pupils who learn easily. Once this habit has been allowed to develop it is extremely difficult, and often unpleasant, to overcome. If the instructor can see its development in a pupil at the outset he can usually avoid trouble. Such a pupil should be given a good measure of fair criticism and difficult exercises to perform. Over-confidence may be inherent in the pupil's character, or its development may be due to watching flashy flying by other pilots (e.g. landings made very close to parked gliders, etc.).

The signs of over-confidence are numerous. Some are listed below:—

(*a*) Low turns.
(*b*) Tendency to fly slower and slower.
(*c*) Trying to cut things too fine—dangerous under-shooting, when trying to land back at the launching point, or landing towards obstructions without room for a mistake.
(*d*) Reluctance to be briefed.
(*e*) Disobedience.
(*f*) Desire to try something new without having gained solid experience.
(*g*) Tendency to hand out advice.

12. Finally, the pilot should never be allowed to get into the state when he goes up merely to "do a circuit", planning nothing and thinking about nothing. He must be persuaded to practice some particular exercise (improvement of turns, searching for lift) in each flight, so that he learns not to waste his time in the air.

12. STEEP TURNS

A.—CONSIDERATIONS

1. The primary object of a steep turn is that of altering course rapidly. In addition, it is an extremely good exercise for improving a pilot's flying, and when carried further can be considered almost as an aerobatic manœuvre.

2. 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

3. It will be noticed that above 60 degrees the loads and hence the stalling speed, increase very 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.

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

5. The rate of descent in a really steep turn is very rapid indeed.

6. 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. The remedy is to reduce bank before attempting to reduce speed.

B.—AIR INSTRUCTION

1. Going In.

Look round. Increase speed and start a medium turn.

Steadily increase the bank to the intended angle, and then prevent it from getting steeper. Keep the speed constant, and the

nose travelling steadily round the horizon by use of the elevator and rudder.

2. STAYING IN.

During the turn it will be found that practically no aileron or rudder is required to maintain the turn, but that some backward pressure will be needed on the stick.

3. COMING OUT.

Come out in the same way as a medium turn. There will be a tendency for the nose to come up, so take care to keep the nose in the normal gliding position.

4. FAULTS IN TURNS.

If the speed builds up, reduce the bank before attempting to reduce the speed.

C.—ADVICE TO INSTRUCTORS

1. There is a tendency to look on steep turns as something quite different from ordinary turns, and teach them in a different way. There is no reason for this; steep turns should be taught as an extension of ordinary turns, and really steep turns should not be attempted until the pupil is proficient at those with less bank.

2. The frightful fallacy of the rudder and the elevator "changing functions" in a steep turn has not yet quite died. Pilots who think in this way not only confuse themselves, but spread this confusion to others. The instructor must emphasise that whatever position the aircraft may be in the controls work the same way — moving the stick backwards brings the nose up towards the pilot's head, and applying left rudder moves the nose in the direction of the left wing-tip.

3. The most common faults in steep turns are (*a*) going in too quickly; (*b*) letting them get too steep; (*c*) failing to pull the stick back enough; and (*d*) letting the nose drop and the speed build up because the bottom rudder is still kept on.

4. The pupil must be shown the effect of allowing the speed to build up and then attempting to reduce it by pulling the stick back; the result, of course, being the tightening of the turn, culminating in a spiral dive without any reduction in speed. He must understand that, should the speed build up, the first thing to do is to take off some bank.

5. The hazards of going into a steep turn suddenly without first looking round to see that there are no aircraft nearby must be emphasised.

13. SIDESLIPPING

A.—CONSIDERATIONS

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 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 particularly useful when, during the approach, one finds oneself very close to the lee boundary of the field. In rare cases it may be used after deliberate overshooting to clear high obstacles on the lee boundary.

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 most gliders the rudder is comparatively weaker and so 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 conditions are not quite so bad because 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 in the normal glide.

9. Owing to the high lateral moment of inertia, the large span, and slow rate of roll of most gliders, the recovery from a sideslip takes some time. Allowance should be made for this and the sideslip should not be continued right down to the ground.

10. The introduction of air-brakes has provided a more simple method of regulating the approach, and sideslipping is in consequence less frequently employed. But the importance of sideslipping should not be forgotten, for, while it remains an essential manœuvre for gliders not equipped with air-brakes, it may also be used on gliders so fitted to increase their effect.

11. In the air the sideslip will be demonstrated and practised by three typical examples: First at height, where it is simply an example of the use of controls under sideslipping conditions; secondly, as a slip into wind near the ground; and thirdly, as a slipping turn. The last two are given as practice for spot landings.

12. On some types of gliders once a slip has been started the rudder loads become reversed. It is important that this is understood by the pilot, as the necessity, when recovering from the slip, of applying a force to centralise the rudder is apt to be rather disconcerting.

B.—AIR INSTRUCTION

1. Effect of Controls During Sideslip

Bank the glider and apply opposite rudder to prevent the nose from turning. Maintain the same speed; the nose will be slightly higher than in the normal glide.

Keep the bank constant to maintain a steady rate of descent.

Note that the path of descent is at an angle to the heading of the nose.

To obtain a greater rate of descent, increase the angle of bank; notice that more top rudder is needed to overcome the tendency to yaw. A limit is reached when full top rudder is applied; if the bank is still further increased the rudder will be unable to prevent the nose from turning.

To recover, level the glider laterally and centralise the rudder, at the same time getting the nose down to the normal gliding position.

2. SLIPPING INTO WIND

Glide towards the field into wind. Bank the glider to left or right, at the same time swinging the nose in the opposite direction to allow the glider to continue descending into wind.

During the sideslip adjust the heading of the nose to keep the glider travelling on the right path.

To recover, level the glider laterally, swing the nose back into wind, and get it well down.

3. THE SLIPPING TURN

Glide across wind and start the final turn into wind rather higher and closer in than you usually do. Increase the angle of bank and make the glider sideslip by putting on top rudder.

When facing into wind, recover.

The rate of descent during the slipping turn will be rapid. If sufficient height has been lost before this turn has been completed, it can be converted into a normal gliding turn. If the glider is still too high at the end of the slipping turn, this can be changed into a straight sideslip.

C.—ADVICE TO INSTRUCTORS

1. Although the sideslip at height is necessary for the pupil to learn how to use the controls, most of the instruction should be given on the actual approach, where the effect of sideslip will be apparent to the pupil.

2. Explain that it is necessary to keep the ailerons applied, and why a sideslip differs from a turn in this respect.

3. A common fault is a tendency to lose speed during recovery, often resulting in a heavy landing. Emphasise the need to get the nose well down to maintain the gliding speed.

4. If necessary, point out to the pupil the effect of sideslipping on the airspeed indicator system. With an ordinary pitot-static head the A.S.I. usually exaggerates the speed; with a pot-pitot and static vents the A.S.I. will usually read low at large angles of yaw, and this false reading may badly confuse the pilot if he does not understand the reason for it.

14. TAKE OFF AND LANDING OUT OF WIND

A.—CONSIDERATIONS

1. Take off and landing out of wind may be necessary when the best landing 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.

2. When an aircraft runs along the ground out of wind the following factors must be taken into consideration.

(*a*) The aircraft wants to weathercock into wind.

(*b*) The wind tends to blow the aircraft sideways. If, as is normally the case, 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 in contact with the ground the sideways movements will be checked and side loads will be imposed on wheel and skid. The essence of the whole 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 landing 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 if of use in landing and taking off across wind, since by keeping the windward wing down the tendency to drift down-wind can be reduced.

5. Out of wind landings may be necessary because of the shape of the field or its approach, or because the pilot has not discovered that he is not into wind until he is close to the ground.

6. Having decided that an out of wind landing is necessary, he should pick a definite landing line. He can keep his aircraft on this line in two ways: either by keeping the nose to the windward side of the line, or by keeping his nose along the line and sideslipping the machine into wind.

7. If the approach is made with the wings level and the nose to windward, the drift will be very 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.

8. In the second method, of sideslipping, 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. The first method is more satisfactory, but some judgement 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 with some drift with its windward wing up, the leeward wing may dig in and the machine turn over.

9. For these reasons, a compromise of the two techinques is the best.

B.—AIR INSTRUCTION

1. Taking Off Across Wind

As the aircraft moves, it will want to weathercock; prevent this by downwind rudder. When the wing tip holder lets go, the windward wing will tend to rise; prevent this, and try to keep the windward wing actually down. Keep the machine firmly on the ground until it has proper flying speed and then lift it cleanly into the air. During the launch keep the windward wing down to reduce drift and ensure that the cable is not dropped away to one side.

2. Landings

Select a landing path, and keep the machine tracking down it by keeping the nose heading into wind. During the check and hold off keep the windward wing down slightly. When flying at a suitable speed for landing, swing the nose down-wind with the rudder to eliminate drift, keeping the windward wing still down a bit. Put the aircraft gently but firmly on the ground, and, still keeping the windward wing down, try to keep it running straight along the ground—it will want to weathercock into wind.

C.—ADVICE TO INSTRUCTORS

1. Pupils are very easily confused over this business, partly because they find it very difficult in seeing any drift at all, and partly because they are often not quite sure whether they should attempt to turn and land into wind, or make an out of wind landing.

2. Make the distinction clear to them, and explain that, should they not find out that they are heading out of wind until close to the ground, it is better that they should land in the direction in which they are pointing rather than attempt a turn low down.

3. Do not further confuse the pupil by teaching both techniques at the same time. Since winch lines are often out of wind, and the pupil will have to keep his windward wing down to get a good cable drop, he will be soon used to doing this for both take offs and landings. It will be adequate for all the cross wind landings that he is likely to do as a pupil. When he can carry out this method instinctively, introduce the downwind nose swing, as an extension of the first method, for use in more extreme conditions.

15. AERO-TOWING

A.—CONSIDERATIONS

1. There is nothing difficult about aero-towing provided that both pilots know what they are trying to do, and the weather is reasonable.

2. When a glider is being towed behind an aeroplane, it is inadvisable to fly in the tug's wake and slipstream, since this air is descending and turbulent. One has, therefore, the choice of flying above or below the wake; that is, in the high or low tow position.

3. The high tow is commonly 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 at any time without chance of the cable fouling his aircraft.

4. Since it is unwise to release when in low tow, it is not advisable to tow in this position when looking for thermals. However, when in the low tow position, the glider and tug are both more stable than in the normal high tow, and this position may, therefore, be found more convenient when towing in rough air, or when making a long flight.

5. The optimum position for the glider in relation to the tug will depend on the angle at which the tug is climbing. In high tow, with an aeroplane of moderate power, it will be found most convenient to keep the glider slightly above the level of the tug. However, if the aeroplane is particularly powerful, the high tow position may actually 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.

6. The minimum towing speed will normally be dictated by the considerations of the tug—its lack of control or tendency 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 the glider pilot may experience difficulty in being towed fast on a rough day, so the speed should be kept down.

7. 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 a 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 an ordinary aeroplane by such factors as long grass, uphill slope, soft ground, absence of wind, high temperature or altitude.

8. Since the rate of climb will be reduced when turning, the route followed on the climb should be planned so as to keep the number of turns to a minimum.

Turns will be most easily carried out by the tug pilot 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 of 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 a fundamental consideration that when two craft are in formation, one should try to maintain a steady course, and the other formate on it. In aero-towing 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. This requires some skill, but a good tug pilot can keep his speed steady within two knots even when he has an outrageous performer on tow.

10. Since, without special instruments, it is impossible to maintain the correct position unless the tug is visible, it follows that the tug must not fly into cloud, and that if it does so, the glider pilot must release at once. The tug pilot should also avoid flying straight towards the sun, as this can be exceedingly tiring for the pilot of the glider.

11. Most tows are made with the object of gaining height, but on a cross-country flight it may be desirable to descend while still on tow. If the tug pilot does this gradually, the glider pilot will not be affected. However, if he does it rapidly, the glider will tend to overtake the tug. This can be avoided by use of the air-brakes or sideslipping.

12. When using a resilient rope (such as nylon) there is no need to fiddle around trying to keep the cable tight all the time. By far the smoothest ride is obtained by keeping the glider in the right place, and letting the rope look after itself. In rough air there may be some surges, but they are nothing to worry about. The optimum length of a resilient rope is about 150-200 feet

(45-60 metres). Rope less than 100 feet (30 metres) should only be used by experienced pilots.

13. If the air is extremely rough, it may be advisable to prevent the glider over-running by using the air brakes; but a beginner should be discouraged from using them as he will almost certainly only make matters worse. A point to bear in mind is that on some gliders difficulty may be experienced in shutting the brakes when flying at aero-towing speed.

14. It is important that the tug pilot does not throttle back and descend suddenly while he is still attached to the glider. When the glider releases, the tug pilot will normally feel it as a jerk, but he must not take this as positive. He must check visually that the glider has, in fact, released, either by looking at the glider and seeing that there is no rope attached, or looking at the rope and seeing that there is no glider attached. To make this check easier, the glider pilot should do a climbing turn to the left immediately after releasing.

15. It is vital that a clearly defined system of signals exists between the tug and glider pilots. Only two are required: (*a*) a signal made by the tug pilot ordering the glider pilot to release at once; and (*b*) a signal made by the glider pilot informing the tug pilot that his release has jammed.

In the U.K. the signals are:—

(*a*) When the tug pilot waggles his wings the glider pilot must release at once.

(*b*) If the glider pilot cannot release, he flies out to the left and waggles his wings.

16. When making aero-tows for training flights or for soaring, the flight will be most profitable if the glider is taken to the right place at the right height. There are very few circumstances in which the glider pilot wants to release downwind of the aerodrome, and unless he specifically instructs, all tows should take place upwind. A suitable releasing zone is from 1-2 miles away from the aerodrome in a sector 90° wide centred on the wind.

B.—AIR INSTRUCTION

1. Cockpit Drill.

The brakes should be checked shut, and the trimmer put in a position suitable to the towing speed.

2. Take Off and Climb.

Take off normally, and then climb up to about ten feet, keeping straight behind the aeroplane. When the tug takes off

it will fly level, and then quite suddenly, or so it seems, start to climb. Be prepared for this, and climb as the tug does. You should at all times try to keep slightly above its level. This is most easily done by reference to the horizon. If you see the tug against the sky, you are obviously lower than it, whereas if you see it against the earth, you must be higher. You must try to keep the tug about half a span below the horizon, and, of course, keep straight behind it.

If you find that you are out of position, work out in which direction you must go, and go there quite definitely, but steadily. Do not worry about the cable; concentrate on keeping in the right position behind the tug.

3. TURNS.

During a turn, you should keep the tug in the same position just below the horizon. You should also keep straight behind the tug, in such a position that you are looking directly along the line of its fuselage. This means that you will have to edge out during the turn, and that although you are looking straight along the tug's fuselage, it will not be straight in front of your nose, but appear slightly on the inside of the turn.

If you see the inner side of the tug's fuselage, edge out a little; conversely, if you see the outer side, edge in. At the same time concentrate on keeping the tug in the right position relative to the horizon.

4. RELEASE.

When you pull the release, first of all satisfy yourself that cable has in fact become detached, by watching it drop away. Then pull up in a climbing turn to the left, looking round for other aircraft.

C.—ADVICE TO INSTRUCTORS

1. Pilots with comparatively little flying experience can be sent on their first aero-tow without any previous dual with complete safety. It is essential, however, that they should be carefully briefed, and that they understand what they are trying to do. The fundamental points to get over are: (*a*) What the tug should look like in relation to the horizon, (*b*) what corrective action to take when it is not in the right place, and (*c*) not to worry about what happens to the tow rope.

2. The first aero-tow should be given when the air is calm, and there is a good horizon. Pilots should not be allowed to go on tow in rough air, or on murky days, until they have done a number of tows.

3. Once a pilot has done a few tows, he knows what the tug looks like when he is flying in the correct position. He can therefore, maintain this correct position without reference to the horizon, merely by keeping in such a place, that, for example, the tail-plane of the tug is in line with its main-plane. Pilots should be instructed to make this kind of observation for themselves. If for their first tow they are briefed to keep in positiion solely by the attitude of the tug, the possibility of error is large and they will have difficulty flying behind a different shape tug. Working on the horizon as a basis, even the dullest pupil can be made to understand what he is trying to do.

4. It is very easy for beginners to lose themselves after their early aero-tows. This should be pointed out to them, and they should be told to work out where they are during the tow, and also to positively identify their landing field immediately after they have released.

5. The instructor must instil into his pupil the idea that if the take off seems long, or the rate of climb slow, he should turn his head and check at once to see if his brakes are open. He should not just sit there blaming the tug or its pilot.

6. In general, pilots with soaring experience make the most proficient tug pilots, since they know in which part of the sky the glider pilot will want to be released.

7. With powerful tugs, towing of more than one glider is possible. Both pilots should be experienced, but the less experienced of the two should be put in the short rope. Position and release proceedures must be made absolutely clear before take off. Vertical separation is better than horizontal separation, even if the ropes are of widely different lengths.

NOTES FOR TUG PILOTS

1. Take off normally, and go into your climb gently.
2. As soon as you have done this, look round to see that the glider's brakes are not open. If they are, order the pilot to release, while he can still get into the aerodrome ahead.
3. On tow, keep your speed as steady as you possibly can, regardless of what the glider pilot does.
4. Enter and come out of turns gently. Do not use more than 30° of bank, unless the glider pilot is experienced.
5. Do as few turns as possible.

6. Avoid flying down wind of the aerodrome, unless specifically instructed.
7. Do not fly into cloud, heavy rain or snow, or towards a blinding sun.
8. Think what the glider pilot wants you to do. If he wishes to soar, take him to the most suitable part of the sky. Plan your route so that the pilot can assess the conditions. For example, if there is a long line of interesting looking cloud, do not fly under the middle of it. Cross it diagonally so that the region of the lift can be discovered.
9. Keep a good look-out for other aircraft.
10. Make sure that the glider pilot has in fact released before you start to descend.
11. Do not fly at more than about 100 knots on the way down or you will thrash the rope.
12. Remember that you have a rope on the back; do not fly low over people or aircraft.
13. The safest system, if the size of the aerodrome permits, is to drop the rope and then land straight ahead. When dropping it, remember that it will descend almost vertically.
14. If, after having dropped the rope, you go round again in order to land, on your circuit make sure that the rope has in fact dropped. Look round while you do a skidding turn.
15. Tug pilots must realise just how much the take off performance can be made worse by minor factors, such as gradient, long grass, high temperature, a skidded glider, etc., and that they do not assume that merely because they have made one successful tow from a particular place, that it will be equally safe next time.
16. When towing a glider on a cross-country, the fuel consumption will be higher than that without the glider at the same r.p.m.
17. When towing more than one glider, ensure that the pilots have agreed position and release proceedure, and realise that take off and climb performance may be appreciably affected.

16. AEROBATICS

A.—CONSIDERATIONS

1. The loads imposed on a glider when carrying out aerobatics are considerably greater than those in normal flight, so before doing aerobatics it is only sensible to understand to what strength requirements the aircraft is designed, and then when flying to ensure that these are not exceeded.

2. Aircraft with the semi-aerobatic category are capable of withstanding accelerations of about 5g at slow speed, and 4g at their maximum speed; the greatest negative acceleration must not exceed 2½g. If, when flying fairly slowly an effort is made to impose a large acceleration on the aircraft by, for example, pulling quickly out of a dive, the aircraft will stall and automatically limit the loads imposed upon it.

3. When flying faster very large loads can be put upon the aircraft before the stalling speed is reached. Since the stalling speed increases as the √ of the acceleration imposed upon the aircraft, it follows that 4g cannot be developed unless the aircraft is flying at √4 x stalling speed in straight flight, that is, at twice the stalling speed.

For 5g, which is the normal design figure, the speed will be approximately 2¼ x stalling speed in straight flight; for most gliders this will be roughly 70 knots. Above this speed it may be possible literally to pull the wings off.

4. Similar conditions apply to inverted loadings, although here the factors are much lower. This is largely because in order to give good stalling characteristics the incidence of the wing tips is reduced (wash out); when flying upside down this wash out becomes wash in, with the consequence that most of the weight of the glider is carried on the wing tips. Because of this, semi-aerobatic gliders are not permitted to fly inverted, or to undertake manœurves which involve inverted loading.

5. Certain gliders possessing high load factors are permitted to carry out inverted flying and slow rolls. Although these aircraft are appreciably stronger than the normal semi-aerobatic glider, they can still be broken by excessive loading or over-speeding. The most common fault when inexperienced at rolls is allowing the nose to drop when inverted, so that speed builds up rapidly. In trying to get out of the muddle, the glider may be subjected simultaneously to high speed, large aileron deflections and high 'g'. Because this situation can arise so easily it it unwise to let pilots experiment on their own with slow rolls unless they have, first of all, had proper dual instruction in them, in either light aircraft or gliders.

6. As flying into an up or down gust can impose large loads on the aircraft, manœuvres which in themselves involve appreciable loading should not be carried out in rough air, since the combined effect may be too great.

7. Quite apart from the question of the loading on the aircraft there is another important limitation, that of speed.

8. If the glider were dived vertically downwards brakes shut, it would go on accelerating until it reached a speed of some 350 knots, provided it did not fall to bits first. If this were actually attempted, the ailerons would first refuse to function, and then possibly work the wrong way; in the region of 200 knots, catastrophic flutter of the tail or wings would probably occur. All gliders are restricted to a maximum diving speed (the placard speed) which the glider has shown on test to be satisfactory. This speed is normally four or five times the stalling speed (110-150 knots) and is thus well below the theoretical TV of the aircraft.

A vertical dive of only 400 feet is enough to reach the placard speed. Since the effect of exceeding the placard speed may be fatal, it is important to ensure that the A.S.I. is accurate.

9. Violent movement of the controls when flying fast may be sufficient to cause structural failure. For example, the application of full rudder at high speeds causes very high loads on the fin and rear fuselage.

10. A glider is designed to fly forwards. If it is flown backwards, as in a tail-slide, the control surfaces will try to snap on to full lock, with possibly disastrous effects on their hinges and control horns.

11. When carrying out aerobatics the pilot should keep his hand on the dive brake lever for two reasons. (*a*) He may realise that he is going too fast and wish to use the brakes, and (*b*) to prevent the brakes opening violently should they become unlocked.

12. Two things can go wrong when carrying out aerobatics. (*a*) The aircraft can suffer structural or control failure, and (*b*) the pilot can fly into the ground. The height at which aerobatics are done must obviously be such that situation *b* cannot arise should the pilot make a reasonable error of judgment. This means, on one hand, that a pilot, however experienced, should not pull out of his loops at 10 feet above the ground. At the other extreme, a pilot practising aerobatics for the first time should be several thousands of feet up, so that should he get out of control he will have plenty of time to sort things out.

Considerations of structural or control failure are quite different. Unless the pilot has several thousand feet in hand, his chances of baling out successfully are small.

13. Although each aerobatic manœuvre must be taught as a separate item, the main attraction of aerobatics is the art of linking different manœuvres together smoothly and gracefully. Even when the number of permissible manœuvres is small these can be joined in a wide variety of ways.

14. When giving a display, timing and placing are most important. The glider should never be placed between the observer and the sun. Loops. generally look better when made up or down wind and chandelles into wind.

B.—AIR INSTRUCTION

See your straps are really tight, and that there are no other aircraft about.

1. LOOPS. Dive the glider to about $2\frac{1}{2}$ times the stalling speed and then pull up into a progressively steeper and steeper climb; the radius of the turn being reduced until the aircraft is upside down. After it has gone over the top and started to go down again ease the stick forward gently and avoid pulling out too violently, to allow the normal flying attitude to be resumed. If the manœuvre is done properly you will be sitting in your seat at the top of the loop. Hanging in the straps is due to starting with insufficient speed, failing to pull up rapidly enough, or, most commonly, failure to keep on pulling back.

2. CHANDELLES AND STALLED TURNS. In the classical aeroplane type stalled turn, the aircraft is pulled up into a steep climb, and shortly before it stops full rudder is applied. The aircraft then, as it were, pivots around one wing tip and goes into a steep dive, following the path it took on the way up. If this manœuvre is tried on a glider it will be found that after putting on rudder the aircraft hardly turns at all; it will either stall and pitch nose down, or do a tail slide. A proper stalled turn can be made in a glider by applying rudder much earlier together with some aileron, but it is not a very satisfactory manœuvre and has a severe penalty for failure. A chandelle is much better. Dive the glider to just over twice the stalling speed and pull up into a steep climbing turn, making the turn progressively steeper and tighter until the aircraft is in a vertical or over the vertical bank. Then reduce the angle of bank and convert the turn into a diving turn in such a way that the aircraft resumes normal flight travelling in the

opposite direction to that in which it started. The loads imposed on the glider are very light, and if it is done correctly there will be no slip or skid throughout the manœuvre.

3. ROLLS. Dive the glider to about 2½ times the stalling speed, and bringing the nose well above the horizon, apply full aileron (say to the right), together with slight right rudder. When the glider assumes 90° of bank, it may be necessary to apply top rudder (left in this case) to prevent the nose dropping excessively. As the glider rolls further, the nose will tend to drop. Prevent this by moving the stick progressively forward, so that when the aircraft is inverted, its attitude is that appropriate to a steady inverted glide. As the glider comes into the three-quarter roll position, it may be necessary to apply top rudder (right, in this case) at the same time easing the stick back. A further backward movment will be required as the glider assumes normal flight..

Throughout the slow roll keep your hand on the airbrake lever, and if the nose drops appreciably on inverting, open the brakes straight away, take off aileron, and gently half loop out.

C.—ADVICE TO INSTRUCTORS

1. Before starting to teach aerobatics to a pupil it is as well to get him to do some dives and zooms, steep and climbing turns, and wingovers, etc., in order to accustom him to the glider flying in unusual attitudes, and learning how to pull out of dives gently. He should be taught to keep his hand on the dive brake lever, and shown how to use brakes at high speed.

2. Some pupils are remarkably frightened of the idea of doing aerobatics at all; they should not be bullied into it, but gently be accustomed to the idea.

3. The importance of not exceeding the aircraft's placard limitations must be emphasised, and pupils must be instructed to open the airbrakes without fail before they reach 90% of the placard speed.

4. The minimum height for pupil aerobatics solo must be clearly laid down and enforced. The choice of this height is difficult. For safety considerations the higher the better, but if the limit is set too high the occasions on which practice is possible are reduced. It is suggested that 2,500 feet above the ground is the lowest minimum which one should accept.

5. Before allowing aeroplane pilots to carry out aerobatics on gliders by themselves the difference between the two classes of aircraft should be pointed out to them. For example, the high

moment of inertia in the yawing plane combined with less effective rudder makes the classic aeroplane type stalled turn a hazardous manœuvre in a glider, since there is every chance of a tail slide with resultant control damage.

6. Aeroplane pilots may be tempted to carry out rolls and other manœuvres which are prohibited for the semi-aerobatic glider. They must be made aware of the reasons for this prohibition and which gliders it applies to. It is not so much that the manœuvres when well performed puts excessive load on the aircraft, but that if the nose is allowed to drop when inverted speed builds up extremely rapidly.

7. Appreciably more skill is required to do a slow roll in a glider than in a light aircraft. If instruction in rolling in a two-seater glider is not possible, the gliding instructor must satisfy himself that a pilot is really competent in light aeroplane aerobatics before allowing him to practice inverted flying or slow rolls in a glider.

8. Pupils should not be sent off to do aerobatics unless there is a good horizon, and the air is not too turbulent.

APPENDIX A. — CLUB TEST FLYING

1. It should be emphasised that the remarks in this appendix are confined to routine test flights of ordinary club gliders. The object of these simple tests is to ensure that the aircraft is in its original condition. The testing of prototypes, new gliders, or of modifications to existing aircraft is an entirely different matter, and one which calls for special knowledge and skill.

2. The reasons for carrying out routine check tests on gliders are:—

(*a*) To ensure that an undiscriminating pupil does not fly a machine which is out of adjustment or unsafe.

(*b*) To find out what routine adjustments are required.

(c) To ensure that the launching arrangements and the weather are suitable for sending a pupil off on an early flight in a particular type.

3. Such tests should be carried out, not necessarily by an instructor, but by a competent pilot after the overhaul or repair of the glider, after re-rigging or control or instrument adjustment, and on the day in question before early flights by pupils.

4. In the majority of cases there is no need for check flights to be made for this special purpose. In normal club operation it can usually be arranged for a competent pilot to fly a solo aircraft for the first time each day, or after re-rigging, etc. However, if the instructor does not ensure that these pilots know what they are trying to do, or does not test the aircraft himself periodically, he may well find that in the course of a few months the aircraft has become unpleasant to fly.

5. The test flight should provide the answer to four questions :—

(*a*) Does the aircraft fly properly and in trim ?

(*b*) Do the controls work properly ?

(*c*) Do the instruments work properly ?

(*d*) Are there any mechanical defects in the structure or in the equipment ?

6. In the air the pilot should definitely observe the following: Is the aircraft in trim ? Will it fly hands off straight and laterally level ? Do the controls work smoothly and easily without excessive friction or sloppiness ? Does the trimmer work ? Do the airbrakes operate correctly, and do they ride proud in flight ?

7. The pilot should stall the aircraft, and when doing this he should reduce speed steadily at the rate of one knot per second, observing the minimum A.S.I. reading. This tests not only the stalling characteristics of the aircraft, but also the A.S.I. and its installation.

8. A glance should be given to the other instruments to see that they are functioning correctly. During the flight notice should be taken of anything unusual—noises, squeaks, draughts, etc., and of course, any unusual flying characteristics of the aircraft. If any defects are found, the aircraft should be put unserviceable until the matter has been investigated.

9. In addition to this check of the aircraft, when testing a glider which will afterwards be used for early solo flights, the pilot should ensure that the weather is suitable and that the pupil will be likely to receive a satisfactory launch. Unless this flight is carried out there may be a chance of the first launch by a pupil being unsatisfactory. This may well occur if pupils are using single seaters, while other flying is going on on two seaters. If only solo flying is taking place, the instructor in charge should have no hesitation in making a flight himself if he thinks that the weather may become too difficult for his pupils. This is naturally best done on the type of glider which they are flying. Considerable judgment is needed to assess whether the conditions are acceptable: the fact that flying has been going on quite well on a gusty day does not mean that it will continue to do so, as a very slight increase in roughness may be critical. Conditions of bad visibility are still more difficult to judge since the visibility can deteriorate to an unsafe level in an extraordinarily short space of time.

APPENDIX B. — ACCIDENTS

1. No Instructor wants accidents to happen to his pilots, or his gliders to get broken, but with the best will in the world it is impossible to eliminate them. All that can be done is to anticipate the situations which result in accidents, and take all possible precautions.

2. Some of the causes of glider accidents are :

(*a*) Solo pupils being allowed to fly in conditions which are too difficult for them.

(*b*) Solo pupils being allowed to become careless owing to inadequate supervision and follow-up training.

(*c*) Solo pupils being advanced on to performance gliders without sufficient experience or instruction to use them safely.

(*d*) Lack of flying discipline which, as a result, produces pilots who fail to develop self-discipline.

(*e*) Untrained or inexperienced instructors being allowed to take on difficult pupils too soon.

(*f*) Incompetent instruction in such things as field landings, because the instructor is not himself skilled enough in them.

(*g*) Flying by pilots who, because of their mental or physical make-up, should never have been advanced so far, or, in rare cases, even allowed solo.

3. If an accident or incident takes place, the instructor should spare no effort to discover not only exactly what happened, but WHY it happened. It is easy to say that the accident occurred because the glider was stalled into the ground, and fairly easy to discover that the pilot stalled because he was convinced that he was going fast enough, but much more difficult to discover why a pilot who had gone through the club's training syllabus, flown the glider in question many times, including previously that day, should make such a mistake. Is the club's training, in fact, adequate ? Which instructor taught him stalling, and how was it taught ? What does the pilot really understand about the principles of flight ? Was he frightened, sick, or suffering from a heavy cold ? Was he showing off, being careless, and does he have other sorts of accidents ? Was his briefing adequate ?

4. Little is known about how people actually learn, to what extent (and this is greater than normally supposed) apprehension and fear cause mental paralysis, or what are the causes of a person being "accident prone."

As a substitute for this knowledge instructors should try to get to know their pupils really well as people. This is usually

easy in a small club where everyone is working together, but in a large one some sort of division and grouping of pupils among instructors is necessary.

5. If an accident occurred as a direct result of disobedience or deliberate dangerous flying, disciplinary action should be severe and swift. If, however, it was due to inexperience, or genuine error, every effort should be made, and without delay, to help the pilot overcome his faults, with more than usual personal care and attention.

6. An incident, particularly of a technical or unusual nature, which does not result in any damage, should be regarded seriously, and reported appropriately so that precautions may generally be taken.

7. All serious accidents must be reported to the police and A.I.B. as well as the B.G.A., and the wreckage must not be moved until official permission has been given, so that every opportunity will exist to discover the true cause, to avoid repetition. It is vital that instructors ensure that this regulation is scrupulously observed.

The British Gliding Association is the organising and controlling body for Gliding Clubs in the United Kingdom.

Membership is divided into different grades:—Member clubs, Associate member clubs, Private owner group members, and Individual Associate members.

The B.G.A. Instructors' Panel arranges for the testing of Instructors and issues categories. Full details are available from the B.G.A., 19, Park Lane, London, W.1. Tel. Hyde Park 3341.

The following books can be supplied by the Association :

"The Soaring Pilot." A. and L. Welch and F. Irving	18/-
"Come Gliding With Me" A. Welch	9/6
"Playground in the Sky." Bill Gotch	12/6
"Further Outlook" Scorer & Ludlam	15/-
"Cloud Reading for Pilots." A. Douglas	15/-
"On Being a Bird." Philip Wills	5/-
"Elementary Gliding." P. Blanchard	5/-
"Gliding." A. D. Piggott	25/-
"Go Gliding." A. Welch and G. Denes	30/-

Also log books, daily inspection books and various instructional leaflets and posters.

Bi-monthly. "Sailplane and Gliding"	3/-
"Weather." R. S. Scorer	9/6
"Cloud Study." Scorer & Ludlam	12/6
"Beauty of Gliding." Philip Wills	35/-
"Meteorology for Glider Pilots." Wallington	25/-

RULES OF THE AIR

1. MEETING HEAD-ON: BOTH TURN RIGHT

2. CONVERGING COURSES: GIVE WAY TO THE MAN ON YOUR RIGHT

3. OVERTAKING: KEEP TO THE RIGHT, EXCEPT, WHEN SLOPE SOARING OVERTAKE ON THE HILL SIDE

4. WHEN LANDING GIVE WAY TO THE GLIDER BELOW YOU