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**Small Arms Training**  
**Volume I, Pamphlet No. 6, 1937**  
**SUPPLEMENT No. 1**  
**Anti-Aircraft**  
**(INCLUDING AIRCRAFT RECOGNITION)**  
**1941**

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## PART I. ANTI-AIRCRAFT DEFENCE

### GENERAL NOTES

#### Section I. Introductory

1. The general principles of anti-aircraft defence have been described in Small Arms Training, Volume 1, Pamphlet No. 6, 1937. Since the outbreak of the present war, certain additions and amendments to these principles have become necessary, and have been recorded in various Army Training Memoranda.

For the guidance of all commanders this information is now embodied in this supplement, as are relative extracts from Infantry Training, 1937, and Field Service Regulations, Vol. II, 1938, which are summarized and brought up to date.

Information obtained from the Royal Air Force provides essential training notes, not included in S.A.T., Vol. I, Pamphlet 6, but which are under present-day conditions a vital part of the syllabus in anti-aircraft defensive or offensive training.

2. The key to all successful anti-aircraft training is early **recognition of aircraft**, and the principle that "offence is the best means of defence," applies equally in the case of aircraft, as in the case of ground forces.

**Recognition** is a subject which not only requires a knowledge of its principles, but perhaps more than any other military subject, requires practice on every possible opportunity. Such opportunities daily present themselves, and every commander should take the fullest advantage of exercising their commands in the recognition of the various types of aircraft.

**Only the highest standard of "recognition training" will ensure success against hostile air attack.**

3. Aircraft attack and reconnoitre ground targets from various heights. Many such aircraft are well out of range of small arms fire, and must be dealt with in other ways, such as by fighters, heavy and light anti-aircraft guns, etc.

Others, such as low level bombing and reconnaissance, dive bombing and machine gunning aircraft, operate at lower heights and, if at under 2,000 ft., present very suitable targets for small arms anti-aircraft fire.

Hostile aircraft, when making low level attacks, frequently present themselves "head-on," where recognition is most difficult.

National markings offer a means of identification, but it must be remembered that such markings are recognizable only at close range, and should, therefore, serve only as confirmation.

National markings are difficult to recognize much over 1,000 ft. even in clear weather, and at 2,000 ft. (the critical height) the existence of markings is discernable, but details cannot be recognized except by the use of field glasses. To be able to recognize aircraft outside effective small arms range, knowledge of the silhouettes of the various types of machines is essential. In a later section of this supplement a simple system of teaching the principles of recognition is explained, and should form part of the normal training of all ranks.

4. It will invariably be the aim of hostile aircraft to effect surprise; this may be obtained by three methods:—

- i. An attack out of the sun.
- ii. Use of low-lying clouds.
- iii. Sudden appearance over wooded hills.

If anti-aircraft defence is to be effective, speed in the giving of warning, and immediate action is necessary. Attack may be made by a single machine, or by numbers of machines all converging from different directions. Constant vigilance, and quick movement must at all times be the watchword.

Strict fire discipline as laid down in S.A.T. Pamphlet No. 6, Lesson 7, is a decisive factor, and must be practised over and over again, until a high state of efficiency is shown by all officers and other ranks, in all units.

5. Fire against aircraft must under no consideration be allowed to be indiscriminate: it will **always be controlled**, no matter to what extent dispersion may become necessary.

S.A.T. Pamphlet No. 6, Lesson 7, lays down that the section or corresponding sub-unit will be the fire unit, unless further dispersion into groups of 3 or 4 men becomes necessary.

Against "air" targets, as on the ground, fire opened too soon is usually ineffective and gives away your position to the enemy. Success in bringing down or "winging" enemy aircraft is regularly being achieved by units who have learnt "to recognize early"—"to take instant preparatory action," and "to hold their fire until the aircraft is an easy target."

6. In the case of direct air attack, on a column on the move, the column should continue its move, and the attacking aircraft should be engaged by L.M.Gs. mounted on vehicles at intervals down the column (provided the aircraft comes within range), unless, in the opinion of the commander, to do so would entail heavy casualties. Guiding factors will be:—

- i. The nature of the country.
- ii. The density of the column.
- iii. The scale of the enemy attack.

The commander, when appreciating the situation, must consider whether his object is to arrive at his destination at an appointed time, in which case he should be prepared to accept some casualties to attain that object. The commander's intention in this respect will be made known, and responsibility for suitable action delegated to junior commanders as necessary.

Should dispersion be considered necessary, it should be immediate, and effected down to the fire unit. When movement has been stopped, it must be resumed at the earliest moment.

7. It must be emphasized to all ranks that care must be taken not to hamper the activities of our own army co-operation aircraft (the Lysander, though of a distinctive type, is somewhat similar to the German Henschel 126). The role of these machines is an essential part of any successful operation. They form an essential means of communication between commanders and staff officers for observing and directing the movements of the forward troops, and in consequence, often fly low, and well within range of small arms fire.

8. i. It should always be borne in mind that personnel detailed for anti-aircraft defence must not allow themselves to be distracted from the primary role. Resolute offensive action against air attack plays just as important a part in modern warfare as does the engaging of enemy ground forces. L.M.Gs. with a primary role of A.A. defence must, therefore, remain in that role as long as the situation on the ground permits, and vice versa in the case of L.M.Gs. with a primary role of ground defence.

ii. A.A. personnel must be on the alert for descending enemy parachute troops, and for the aircraft which carry them. Parachute troops usually leave their aeroplanes at heights under 1,000 ft., using parachutes opened by a line attached to the aeroplanes. They usually descend in larger numbers than six at one time. Less than six are probably crews of damaged aircraft, who always jump from greater heights, to give their parachutes time to open, and who should not be fired on.

## Section 2. Training

1. The main principles of Small Arms Action against Aircraft are enumerated in S.A.T. Pamphlet No. 6; such

amendments and additions as appear in this supplement should therefore be read in conjunction with Pamphlet No. 6, and the lessons therein.

As developments in modern aircraft have made necessary the teaching of aircraft recognition as part of a soldier's standard training, this supplement contains a section giving the method of instruction on this subject.

**2 Principles of anti-aircraft action.** The following principles should be observed in all training:—

- i. Although the section or corresponding sub-unit is the normal fire unit, dispersion may, in a heavy hostile air attack, have to be extended down to groups of 3 or 4 men. Whatever the dispersion, fire will always be controlled by the senior officer, N.C.O. or man.
- ii. Concentrated air attack can, at the most, only delay movement. Dive bombing is effective against material targets and may have considerable moral effect against inexperienced troops, but the casualties inflicted on personnel are surprisingly few when all ranks understand the principles of anti-aircraft defence, and realize that small arms fire, when controlled, is effective not only in bringing down aircraft, but in raising the morale of the firer, and imposing caution on enemy pilots.
- iii. Personnel, below ground level, rarely suffer casualties from air attack. All troops must be trained to dig slit trenches as soon as they arrive in a new position. When siting such trenches, cover from air observation is an essential factor. The subsequent widening and inclusion of a fire step for ground defence should always be borne in mind.
- iv. Where anti-aircraft L.M.G. posts have to be established, the use of natural camouflage, with frequent change of position is preferable to weapon pits, or slit trenches.
- v. Special attention is drawn to S.A.T. Pamphlet No. 6, para. 9 of general notes.

It cannot be emphasized too often that successful anti-aircraft defence depends on:

- (a) Early recognition of the type of aircraft approaching and whether enemy or friendly.
- (b) Measures to ensure that all weapons detailed for A.A. purposes are able to open fire in a matter of seconds.

(c) Strict control of the maximum volume of small arms fire, so that fire is opened only when the target is in the easiest position.

- vi. Small arms fire is not effective against aircraft at a range beyond 2,000 ft. To be able to judge whether aircraft is within range is of vital importance and efficiency can alone be obtained by constant practice by all ranks. No opportunity should be lost, whenever our own machines are in the air, of estimating the range.  
Firing at aircraft out of range, i.e., beyond 2,000 ft., causes no material damage to the enemy and serious wastage of ammunition.  
Only in exceptional circumstances is it possible to arrange for demonstration flights by the R.A.F. Such demonstrations are invaluable in the training of air sentries, and for practice by all ranks in the estimation of ranges.
- vii. Vehicles, when halted, should be as widely dispersed as possible, and should be well concealed in small groups of from five to two. Camouflage nets should be opened up whenever vehicles are halted, and fire should not be opened unless there is some certainty that the vehicles have been spotted. As in all other cases of anti-aircraft defence fire must be rigidly controlled, and should be withheld until the last moment.
- viii. In the case of troops at the halt, having the advantage of a concealed position, this advantage must not be sacrificed by unnecessary movement or by the premature opening of fire. Definite orders must be given as to the circumstances under which fire is to be opened.
- ix. The principle of anti-aircraft protection, when employed by columns on the line of march, should be based on the maximum use of rifles, supported by the L.M.Gs. of the anti-aircraft platoon equipped with their Motley mountings. The firing of other L.M.Gs. within the column is difficult and likely to handicap the rifle fire. L.M.Gs. should, therefore, be deployed to a flank and normally fired from one of the positions stated in sub-para. xii below, as there is insufficient time to mount the tripod.
- x. When bivouacs or billets are to be protected in the fire plan for anti-aircraft L.M.G., defence guns should be disposed in a series of equilateral triangles.

The guns should be approximately 500 yards apart with selected alternate positions. In particularly vulnerable areas, L.M.Gs. should be mounted in pairs so as to enable the whole area to be covered.

xi. The importance of air sentries and warnings cannot be over emphasized. The air sentry has a similar role in attack from the air, as the scout has on the ground. It is his duty to give due warning of enemy movement so as to allow the commander to effect his dispositions. In the selection of air sentries fitness must be a first consideration, the work is exhausting and the considerable strain on the eyes calls for frequent reliefs. Experience in the recognition of aircraft is essential, as is the ability to appreciate the most likely direction, such as "Out of the sun," from which a hostile attack may develop. With the most efficient system of warning, the time available for action will seldom be more than a few seconds, fire discipline training must be so practised by all ranks that its immediate application is instinctive. To secure this, subordinate commanders must practise their formations continuously in the recognized warning signals, both visual and by whistle.

xii. The absence of the Bren tripod need not prevent hostile aircraft from being engaged with this gun. Very efficient shooting is possible with the Bren L.M.G. when fired in either of the following ways :-

- (a) With the butt of the gun on the shoulder, the left hand grasping the carrying handle, adjusted into the anti-aircraft position.
- (b) With the butt of the gun on the hip, or under the arm-pit, the left hand grasping the carrying handle.

With practice, either of these alternative methods will produce effective results, and all ranks should receive the necessary instruction in these methods, in addition to the normal method laid down in S.A.T., Vol. I, Pamphlet 6, Lesson 10.

xiii. An anti-aircraft role has been assigned by some units to the anti-tank rifle. This weapon is not suited for such a role, and should not be so used.

### WHEN TO FIRE

3. It will not always be possible to open fire on enemy aeroplanes at the moment they present the easiest target.

But for the reasons given below, attacking aircraft should be engaged at the narrowest possible angle of approach :-

- i. The head-on shot is the easiest target.
- ii. An aeroplane is more vulnerable in front.
- iii. When tracer is used, the pilot may see the tracer coming up towards him. Even if this does not turn him away from his target, it will certainly distract him, possibly putting him off his course and missing his target.
- iv. Penetration is increased if the plane is flying into rather than away from the bullet.
4. The "going away" shot is not so satisfactory because :-
  - i. All operational planes are now armoured against attack from the rear.
  - ii. More casualties are often inflicted by the rear gunner as the aeroplane is climbing away rather than by the release of bombs and forward firing guns in the attack.
  - iii. The penetrative power of a bullet fired at a receding plane is considerably reduced owing to the speed at which the plane is flying.
5. The wide deflection shot at a crossing plane is not so satisfactory, because :-
  - i. The wider the angle of deflection the greater the margin for error. If tracer is available, and being used, the greater will the difficulty be of observing fire correctly.
  - ii. The largest part of the target with a crossing shot will consist of the fuselage which is the least vulnerable part of the aircraft.

### Section 3. Tracer ammunition

1. When available, tracer ammunition can help to improve the results of anti-aircraft L.M.G. fire, by making use of the hosepipe method of directing fire on to the target. In this, the sights are not used, except for the initial aim, and the eyes are focused on the target, allowing the arrival of the tracer near the target, to indicate the corrections of aim necessary.

The appearance of tracer is described in S.A.T., Vol. I, Pamphlet 6, Lesson 9, and Appendix II should be carefully studied. As explained in Appendix II, the appearance to the eye, when following an aircraft, of a successive number of rounds fired from a swinging L.M.G. is that of a curve.

This is because the eye is seeing, perhaps, six separate tracer bullets, and thinks it is seeing the flight path of a single

one. It is therefore misleading to focus on the tracer at any part of its flight, because every bullet, of course, follows a straight line path, and therefore no help in aiming is possible from an illusory curve.

Once the necessary lead has been gauged, the eyes must therefore be trained—and this may take a little practice—to focus at once and only on the aircraft, the tracer being taken notice of only as it passes the target, when it will aid any correction of aim necessary.

#### Section 4. Anti-aircraft practice firing

1. Practice firing may be carried out on anti-aircraft telescopic ranges, out to sea, or on suitable areas of moorland where a 90-degree arc, with a radius of 3,500 yards are available as a danger area, free from roads, buildings or land under agricultural cultivation.

Two types of practice target are suitable:—

- i. Sleeve target towed by aircraft.
- ii. Balloons filled with hydrogen.

Target (i) is of course the ideal, but when it is not available, hydrogen-filled balloons give useful practice.

The following points should be observed when anti-aircraft practices are fired on open ranges, and it should be constantly in the firer's mind that, at a wide deflection angle, aircraft actually move at 150-200 yards per second, and not at 100 yards per second in the case of a towed drogue, or at greatly decreased speeds in the case of balloons.

- (a) Note and mark clearly the limits of the area, and the points at which fire may be opened, and at which it must cease. If a 90-degree arc is being used as the danger area, fire should start and finish 10 degrees inside each flank limit.
- (b) Judge the speed and direction of the wind, and arrange to release balloons accordingly.
- (c) Balloons should be released at a point outside the danger area for safety, and so as to allow the balloons to reach a reasonable height before entering the firing arc.
- (d) Balloons may be released singly or in twos or threes, tied together, with one sometimes filled with air, as a check on very windy days.
- (e) A code of signals between the officer i/c of the firing point and those releasing the balloons is of course necessary.

- (f) Rifemen may be practised in a similar manner to A.A. I.M.G. teams, the section, or its equivalent, being the firing point detail. Magazines should be charged with ten rounds, sights set at 500 yards. Fire discipline training as laid down in Pamphlet No. 6, Lesson 7, should be observed.

## PART II.—RECOGNITION OF AIRCRAFT

### Section 5. Introductory instruction

1. Whilst S.A.T. Vol. 1, Pamphlet No. 6 has provided a syllabus for the training of personnel of the army in the method of engaging aircraft targets, the subject of "recognition of aircraft" has not previously received the attention which it merits. It is daily becoming more apparent that the failure of ground troops to bring down or wing a greater number of hostile aircraft is due to inability to recognise the aircraft in sufficient time to give the warning necessary for effective fire to be opened when the target is most vulnerable—at most—a matter of a few seconds.

It is certain that quick and accurate identification of aircraft is the key to successful anti-aircraft defence. To attain efficiency in quick recognition is well within the power of the modern British soldier, but it entails proper instruction and continuous practice. Every commander down to the junior section leader must appreciate that *instruction in aircraft recognition must be just as thorough and carefully prepared as, say, instruction in the rifle*, and that it must have its part in the general training programme.

To be able to recognize aircraft requires knowledge of their "silhouettes," as it is as such that aircraft first come into view.

2. The ability to recognize aircraft correctly requires:—

- i. An elementary knowledge of the main features of an aeroplane, and what they are for.
  - ii. A general appearance of an aeroplane that gives the clue to recognition.
  - iii. Continuous practice on every aeroplane seen.
- Lucky guesses are as useless for identifying aircraft as lucky shots for defeating an enemy attack.
- Incomplete evidence such as wing shape, or the number of engines, alone is not enough for certain identification.

The end to be aimed at is the instant and instinctive recognition of aeroplanes at one glance in a similar way as the make of a car is recognized at a glance.

3. Both the enemy and ourselves are continually bringing out new types of machines. It is therefore not possible to include more than a list of the main types which have proved their value, and are likely to be retained as a type. It is, however, most important that all ranks should be capable of recognizing the principal types in use, and should keep this knowledge up-to-date by a close study of silhouette diagrams, books and pamphlets, issued from time to time.

4. Should projector apparatus, films and R.A.F. aeroplane models not be available to units, improvisation, using officially issued recognition charts, the shadowgraph, press illustrations and the use of the blackboard will provide an excellent substitute.

5. Plate I gives one method of constructing a simple form of "Shadowgraph," using cardboard silhouettes of types of aircraft to be demonstrated, when a projector apparatus and films are not available.

#### Section 6. Theory of aircraft recognition training

1. The whole basis of recognition training is bound up in the fact that the time taken to identify an aeroplane under operational conditions must be cut down to a minimum. It is the overlooking of this point which has often resulted in methods being tried which are in practice of little value.

2. In order to introduce some method into the training of personnel the question was reviewed on the following lines:—

It was found that although numerous people could identify aircraft correctly in a very short time, they were at a loss to explain how they could do it. On investigation, it was at once noticed that they had been interested in aircraft previously, and thus had become so familiar with the "planes, that they could tell them on sight. This also held good for motorists who were able to spot cars on the road as a result of seeing them frequently.

3. It was obvious therefore that training should be devised to produce this complete familiarity which brings about almost immediate or "sub-conscious" recognition. Other methods had to be discarded because they did not fulfil the conditions required.

4. Many people have tried to introduce analysis systems to differentiate between various types of aircraft, and although

these have a certain value for elementary training, it is most important that under no circumstances must they be used for operational work. In the first place, they do not produce an answer in a sufficiently short time to satisfy the first essential. Secondly, they have to be altered to include new types, which may have very far reaching effects on the conclusions reached at the analysis. Lastly, and most important, since the analysis consists of dividing the aircraft into types by means of constructional features, the whole system will collapse if the original dividing feature is not visible in the first view obtained (e.g. split-up planes by means of wing position into high wing, mid wing, and low wing, the first view of a particular plane is a side view as it comes out of cloud a little above horizon level; in this case the wing position will not be visible and the system fails). There is also the very serious objection that the system gives the temptation to carry a reference sheet in the pocket and this may leave the person concerned without help, either during poor visibility or when the sheet has been mislaid.

5. In succession to the analysis system, it has been suggested that the aeroplane should be reviewed or inspected in a set sequence, e.g. wings, engine, fuselage, tail. This may lead, where the first feature is indistinct, to time being wasted on that feature, when the aeroplane could be identified by its general appearance, apart from the indistinct feature.

6. The method of identification by familiarity does not confine the spotter to any one feature, and in some cases the aircraft can be recognized by the "sit" in the air alone, without the other features being discernable. Nor does it confine him to any one view or position. If he is familiar with the aircraft he will spot it from any angle. This has the advantage that it places training for all on the same basis.

7. This latter method of identification by general appearance has been found by experience to be the most satisfactory method to meet the requirements of recognition for service use and will be adopted.

8. The most obvious method of attaining this object would be to let all necessary personnel see the actual aircraft in flight until the required standard was reached. This, however, is impossible, as even if we could collect a complete set of all our own aircraft types in one place, the provision of hostile types for practice would present some difficulty.

9. The system of making up "flying circuses" by the R.A.F. has been helpful, but has very definite limitations in view of the organization involved to give a comparatively small



section of the people concerned a view of the aeroplanes in flight. It is also in the same sense, rather a wasteful method of training, as the aircraft are only seen for a short period and much waiting is entailed before their next appearance.

10. Luckily these disadvantages can be overcome, by the use of scale models. If a scale model is made so that it is accurate for appearance in outline at any angle from a short distance (small details are not necessary), then it can be used for training in a very satisfactory manner. Thus a 1/72nd scale model viewed at a distance of 100 yards is equivalent to seeing the real aircraft at a range of 7,200 yards or 21,600 ft.

The chief advantages of the models are:—

- i. That it is easier to provide a complete set of models to units for training on comparison with arranging for the real aeroplanes to be flying for training purposes in various areas, thus tying up numbers of operational aircraft.
- ii. The training can be carried out irrespective of weather conditions for flying and observation, since obviously an aircraft flying at a low height, does not present the difficulty of recognition at long range. Using models the training can be graded to suit the standard of the personnel under instruction.
- iii. The training can be carried out to suit the programme of the unit for time, since it is under its own control and does not involve arrangements with other units.
- iv. The training can be concentrated on any particular aircraft required under unit arrangements and can be repeated as and when required without the necessity of co-ordination with other units.

11. It is useless, however, to leave personnel to study the models unaided or without directing their efforts. They must be shown the differences between the various types until they know all the details of their appearance. For this purpose large scale silhouettes are required. By means of these the shapes of various features of the different aeroplanes are pointed out and thus impressed on the mind.

12. To supplement the silhouettes, which are flat and only two dimensional, sheets of photographs are also necessary, especially if they can be used with an epidiascope for spotting practice on various types of aeroplanes. Their chief advantage, however, is that they provide a compact means of providing the "repetition" necessary to achieve complete familiarity.

13. The main point to watch in the arrangement of training is that the interest of the students must be aroused. It was due to this interest that the people given as examples before, became so conversant with aircraft types that "spotting" or recognition came so quickly and accurately. The aircraft must be given a "character" or background for the learner to pin the appearance to, thus aiding his memory. To this end he must be given some simple explanation of the "how and why" of aircraft, and short talks on the structure and operation of controls, etc. This will enable him to follow up his instructions by reading at least semi-technical press descriptions.

14. Spare-time activities should be encouraged by the use of silhouette playing cards and by the provision of prizes for model making competitions. Visits to aerodromes have good interest value if used to supplement other training. As an original form of training they are not so good, as personnel do not see aeroplanes in correct perspective.

15. Encouragement should be given to personnel to make up scrap books in aircraft cuttings taken from both daily papers and "Aeroplane" and "Flight" if available. "Aircraft Recognition," by Saville-Sneath, published in the "Penguin" series, is also strongly recommended.

## Section 7. Notes on training

### Notes on Programme for Course for Instructors in Recognition of Aircraft

#### Objects of course

1. To train instructors in recognition of aircraft.
2. To discuss methods of training.
3. To disseminate latest information regarding both our own and enemy aircraft.

#### Theoretical lectures

As it is considered men cannot take an intelligent interest in aircraft or their features until they understand the reason for and the purpose of these features in the design, theoretical lectures on theory of flight, aircraft design and aircraft construction should be included in the programme.

It should be noted that these theoretical lectures should be of an elementary character and should be designed purely to develop interest in aircraft.

### British aircraft

It has been considered that it is better to deal fully with aircraft regarding which complete details are available rather than to deal with foreign aircraft where information may be slow to come forward and of which the accuracy in the early stages is doubtful. As a result, instruction should be concentrated on giving students a full knowledge of British types in service.

### German types

All types of German aircraft likely to be seen over this country should be studied in detail and brief details of other types should be given.

### Foreign aircraft

Under this heading other foreign aircraft which are liable to be seen over this country should be dealt with. This includes American types which may be purchased.

### Training

The remainder of the lectures should be devoted to training the instructors in giving lectures on recognition features of aircraft and to discussing methods of instruction and the equipment available.

### Notes on Individual Training in Recognition of Aircraft

1. The only successful method of identification of aircraft is by familiarity with the types in service. Only by this method can the difficulties of the time factor and the viewpoint be overcome.

2. It is therefore necessary that personnel should know all aircraft liable to be seen by them under operational conditions and the means of achieving this is by repeated instruction.

3. Training films have been issued, but it has been found that these are of much greater value if shown subsequent to lectures and other instruction, as they can never be complete enough to cover the subject fully.

4. It is considered that the best method of training personnel in aircraft recognition is to deal with the subject rather in the manner adopted for physical training, i.e., short periods of instruction at regular intervals. By this means the aircraft required can be dealt with according to a pre-arranged schedule, and by frequent revision during the series of lectures, the men, who have been absent for any reason during the initial lecture on any aircraft, can learn sufficient to bring them up to the general class standard.

5. One of the outstanding features is that if the subject is put forward to the men in an interesting manner by an instructor who is obviously enthusiastic and expert, there is a very great incentive to spare time study. This usually takes the form of studying aircraft periodicals and photographs and later the making of scale models.

Both of these methods raise the general standard of knowledge very considerably and should be encouraged.

6. A certain amount of equipment in the form of models, silhouettes, photographs, etc., is required for use of the instructor, as he must capture the students' interest at once.

7. The main features of any scheme for individual training should be:—

- i. Trained instructors capable of arousing keenness in the class and able to direct and encourage spare time study on the part of the men.
- ii. Short periods of instruction at regular intervals. Programme to be of a varied nature, to maintain maximum interest.
- iii. Issue of equipment to instructors to enable them to instruct to the best advantage.

### Sequence of Lessons

After the two initial lectures have been given, careful consideration is necessary as to what, and how many, types of aircraft are to be taught. The guiding principle in this connection is to keep the number down to a minimum. The types of aircraft taught should be those most likely to be encountered in the particular locality and country. The list of types must be elastic and adaptable; as new types of aircraft are introduced they should be taught, if necessary, whereas aircraft becoming obsolescent may be omitted.

It will be found, however, that once interest has been stimulated, men will readily learn other types for themselves.

Below is given a list of aircraft, as a guide only, which may be suitable for teaching at home; the method of teaching any one is also given as specimen lesson. After any type has been taught, much further valuable training can be given:—

- i. By the showing of films.
- ii. By the use of models—shadowgraph.
- iii. By the use of an epifluoroscope.
- iv. By blackboard drawing.
- v. By actual practice at real aircraft.

## SUGGESTED LIST OF PLANES AND HOW TAUGHT

British	German
Spitfire, Marks 1 and 3.	Messerschmidt 109.
Hurricane.	Messerschmidt 110 and
Defiant.	Jaguar.
Whirlwind.	Junkers 87b.
Blenheim, Marks 1 and 4.	Junkers 88.
Wellington.	Dornier 17 and 215.
Whitley.	Heinkel 111.
Hampden and Hereford.	Junkers 52.
Hudson.	Junkers 89.
Boston (Havoc).	Henschel.
Lysander.	
Stirling	
Halifax	
Manchester	
Liberator	
Fortress	
Beaufort	
Beaufighter	
Tornado	
Typhoon	

To teach any of these the only kit necessary is the official diagram of the aircraft concerned, or failing this, silhouettes in lieu. A blackboard and chalk are of assistance. It is possible to teach each type in about 15 to 20 minutes. The important thing to remember is sequence; by this nothing is missed and the lesson is taught in the shortest possible time. The importance of questioning by the instructor cannot be over emphasized; he should question before starting on previous types taught, and after on the type he has taught.

The method and sequence of teaching is here shown applied to a Hurricane:—

- i. Introduction. Name (Hurricane).  
Country of origin. (British.)  
Type. (Single seater fighter.)

Here should be briefly stated anything to arouse interest, e.g. when first used; what success it has had; its future; manoeuvrability; speed; ceiling; duration; wing span; length.

### ii. Construction.

Type of machine	Low wing monoplane.
Engines .. ..	Single in line Rolls Royce Merlin of about 1,000 h.p.
Speed .. ..	335 m.p.h.

Ceiling .. ..	Maximum 34,000 ft. (Service).
Armament .. ..	8 M.Gs. (4 in each wing).
Camouflage .. ..	Duck egg blue underneath with green and black on top.
Undercarriage .. ..	Retractable.

### iii. Silhouette characteristics.

(Instructor's note. Take the 3 main views in turn, and deal with points in methodical sequence.)

(a) **Head on view.** (Start in centre and work outwards.) Low wing monoplane; single in line engine; deep fuselage; radiator central; wing has short centre section with little dihedral outward. Taper outward. Tail plane at medium height.

(b) **Plan view.** (Start at nose and work back to tail piece.) Pointed nose; straight taper on both edges of wings; rounded tips; small fillet joins them to a small tapering fuselage; tail plane has straight taper and rounded tips.

(c) **Side view.** (Start at nose and work along top of fuselage, fin and rudder, bottom of fuselage.) Pointed nose low wing monoplane; cockpit about one-third along fuselage; deep fuselage with humped back appearance given by cockpit; rounded fin and rudder; medium high tail plane; straight keel; radiator beneath wing.

### iv. Summary of recognition points.

Low wing monoplane, single in line engine giving it a pointed nose. Straight tapered wings with rounded tips, very little dihedral, centrally placed radiator. Humped back appearance of fuselage, well rounded fin and rudder.

## LESSON 1. ELEMENTARY—THEORY OF FLIGHT Stores.—

Blackboard, chalk, silhouette wall chart, large model and charts.

Illustrate with chart showing two sheds, and wind lifting off roof.

1. **Lift.** A moving object in stationary air acts in the same manner as a stationary object in moving. Air offers resistance to a moving body (and vice versa).

A force acting at right angles to the line of movement is produced when an inclined object moves against air resistance.

In the case of an aeroplane wing, the suction force on the upper surface of the wing is more important than the pressure on the underside (kite action or sailing).

Lifting power depends on:—

- i. Shape of wing (including size).
- ii. Tilt of wing.
- iii. Speed of movement.

Doubling speed of movement increases lift about four times.

2. **Angle of incidence** is the angle the wing section makes with the horizontal.

Tilt increases the lift until stalling angle (15 degrees) is reached—then lifting power falls.

Stalling is due to the air breaking away from above the upper rear portion of the wing, causing lack of lift and control.

3. **Drag** is air resistance to forward movement. Wing drag varies according to:—

- i. Shape of wing (size).
- ii. Angle of incidence.
- iii. Speed of movement.

Increasing angle of incidence increases drag as well as lift. Doubling speed of movement also increases drag as well as lift.

Object of aero design is to obtain a best compromise between lift and drag, dependent on what the plane is required for, i.e. for a fighter, low drag and high speed is more important than high lift (load), and for bombers or transport planes the reverse is the case.

Lift to drag ratio:—

- 25 to 1 on level.
- 11 to 1 at 15 degrees.
- 2½ to 1 beyond 15 degrees.

Fuselage—engines and undercarriage also produce drag, and streamlining these is of great importance.

4. i. **Slots**—designed by Handley-Page and put on leading edge of wing to smooth out air flow at high angles of incidence and in slow forward movement and so prevent stalling—operate automatically.

ii. **Flaps**—fitted on and in trailing edge of wing near fuselage to increase drag and slow down the machine whilst maintaining lift by kite action; various kinds—plain, hinged and extending (Fowler's), Flaps on both wings operate together.

5. **Airscrew**. Has aerofoil section and acts in same manner as a wing. Lift is at right angles and is forward—it is technically known as "thrust." Lift or thrust varies according to angle of incidence of blades and speed of rotation.

- i. Fixed pitch—explain principle of gears.
- ii. Variable pitch—taking off—top speed—cruising.
- iii. Full feathering airscrews—engine cuts out.

#### 6. **Stability**

- i. Directionable by fin—its position.
- ii. Longitudinal by tailplane—its position.
- iii. Lateral—by dihedral or anhedral, or both.
- iv. Stub wings or spoilers and stab fin.

#### 7. **Controls**

- i. Rudder or rudders.
- ii. Elevators (both move together).
- iii. Ailerons (both move together).

## LESSON 2. PHASE I. GENERAL PARTS OF AEROPLANE

### Instructor's Notes

#### Stores.—

Diagrams on blackboard showing the main parts of aeroplane by name, wall diagrams and models.

#### Object.—

To teach the names of various parts of an aeroplane.

Instructors will point out the following parts:—

- |  |   |
|--|---|
| (1) <b>Wings</b>   | (a) Leading edge.<br>(b) Trailing edge.<br>(c) Root.<br>(d) Tip.<br>(e) Flaps.<br>(f) Ailerons.<br>(g) Slots. |
| (2) <b>Engines</b>                                       | (a) Engine nacelles.<br>(b) Engine cowling.<br>(c) The spinner.   |
| (3) <b>Fuselage</b>                                      | (a) Gun positions.<br>(b) Cockpit.<br>(c) Retractable wheels and floats.                                      |
| (4) <b>Tail</b>  | (a) Tail plane.<br>(b) Elevator.<br>(c) Fins.<br>(d) Rudders.   |
| (5) <b>Instructor questions squad on names of parts.</b> |   |

## Instructor's Notes

**Stores.**—As for Lesson 1.

**Object.**—To teach the functioning of the various parts of an aeroplane.

## Explanation.

**Wings.**—Flaps are used to increase the lift on the wing in order to reduce the stalling speed as the aircraft comes in to land. Their main function is not to act as an air brake, although they do to some extent have this effect. Their true purpose is as above. They operate simultaneously on both wings.

**Ailerons.**—Ailerons operate on each wing in opposite directions, and are used to increase the lift on one wing, while decreasing the lift on the other, i.e., to cause the machine to bank on turning.

Both flaps and ailerons are on the trailing edge of the wing.

**Slots.**—Slots are used to delay the stalling speed of the wing. They do this by smoothing out the air-flow over the wing when the wing is in approximately the critical angle of attack. The slots may be either automatically or manually controlled. They are on the leading edge of the wing.

**Dihedral.**—Dihedral is the characteristic upsweep from the horizontal of the wings, and is put on to prevent the machine rolling. Consequently, the low-wing aircraft usually has a much greater dihedral than the high-wing aircraft.

## Engines.

**Engine nacelles.**—On a multi-engined aircraft house the engines and landing gear and are usually larger than necessary so as to conform to good streamline shape.

**Engine cowling.**—Is sheet metal enclosing the engine to give a streamline flow of air over the engine.

**Spinner.**—Is the sheet metal covering over the part of the propeller shaft which projects in front of the airscrew.

## Fuselage.

**Gun positions.**—There are two main gun positions firing aft, one on top of the centre of the fuselage, called the dorsal position and one on the bottom of the centre of the fuselage called the ventral position. Also blister gun positions on sides of German fuselages.

**Cockpit.**—The cockpit usually refers to a space enclosing the crew, when the latter are crowded together. When they

are spreadeagled, as in the Whitley type of aircraft, the cockpit is usually meant to refer to the pilot's seat. When the cockpit has a long transparent cover, this is colloquially referred to as the "greenhouse."

**Tail plane.**—This is the horizontal part. The trailing edge of the tail plane has a moveable surface, called the elevator which is used to give lift, thus causing the machine to rise or fall.

**Fin.**—This is the vertical part. The trailing edge of this is moveable, the moveable part being called the rudder.

## LESSON 3. GENERAL PRINCIPLES OF RECOGNITION

## Instructor's Notes

**Stores.**—Diagrams showing:—

- (a) Types of Wings.
- (b) Types of Engines.
- (c) Types of Fuselage.
- (d) Types of Tail.

**Object.**—To ensure quick recognition of aircraft.

(1) Explain types of aircraft. Fighters, Bombers, Reconnaissance, Fighter-Bombers, Dive Bombers, Coastal Command and Fleet Air Arm aircraft. There are 400 different types of aircraft. It is impossible and unnecessary to learn all of them.

(2) It is important to remember that men must be trained to distinguish between an aeroplane flying low to deliver a message, and a hostile one diving to the attack. It must however be realised that in actual fact any suspicious action by an aeroplane will render it liable to be fired on. Recognition by silhouette demands a high standard of training, since attacking aircraft will usually present themselves head on, where identification is difficult.

(3) Recognition of national markings offers the surest means of identification, but such markings are only visible at short range.

National markings consist of signs of different shapes and colours, standardized for each country. They are painted on the wings, fuselage and tail.

